IEA INTERNATIONAL ENERGY AGENCY

Financing Mechanisms for Solar Home Systems in Developing Countries

The Role of Financing in the Dissemination Process

PVPS

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Report IEA-PVPS T9-01:2002

IEA PVPS

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Implementing Agreement on Photovoltaic Power Systems

Task 9

Photovoltaic Deployment in Developing Countries

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Foreword

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

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

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

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

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

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

This report is based on a study prepared for GTZ by

T. Scheutzlich, K. Pertz, W. Klinghammer, M. Scholand, S. Wisniwski
The study was edited and updated considering comments of Task 9 experts by
R. Posorski, K. Pertz and K. Haars

Deutshe Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
PO Box 5180
65726 Eschborn
Germany

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

[1] Australia, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom, the United States of America.

Scope and Objective

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 one of the main barriers hampering the widespread introduction of SHS in rural areas.

This study wishes to shed some light on the question whether 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.

Keywords

Keywords: developing countries, PV, solar home systems, financing

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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

Executive Summary

Background of the study

"Lent and lost" – in the past this was often the fate suffered 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".

The study has made an evaluation of the experience gained with financing systems for SHS - both within GTZ supported projects and those 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.

Limits of the study

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.

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.

Focussed Recommendations

Political aspects

Governments, implementing agencies and donors must be well aware that electrification programmes for the very poor part of the population depend on continued provision of subsidies.

Subsidies

Subsidies for SHS-systems should be considered with caution. Whenever possible, subsidies should be avoided, reduced and/or made self-destructive after the fulfilment of theirs tasks.

Poorly designed or managed subsidies may have detrimental effects. Subsidies on recurring costs result in market distortions and should therefore not be approved.

Well-targeted subsidies can reduce transaction costs for dealers/ banks. They should be spent for institution-building measures, providing incentives for profitable business in rural areas.

Transparency of credit funds and subsidies

An audit system should be established to check the fund recovery and subsidy management. Sustainability can only be evaluated if carefully monitored over years of operation. This task requires the continuous application of a capable and easy-to-handle monitoring & evaluation system.

Roles of private and public actors

The involvement of the private sector in SHS dissemination is a key factor for a sustainable market development. The private sector should offer SHS systems and after sales service on commercial principles. This can be achieved by sales or service delivery models. For regulated energy service concessions, a government agency at an appropriate level must serve as an effective regulator.

Government agencies and Technical Assistance agencies 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.

On the financing side government agencies and 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. Designing the fund supply and fund recovery system is an essential task.

Technical issues

Technical standards support a fair quality - price - competition of products and strengthen customers' rights. In order to secure reliability and quality of SHS,

- Internationally recognised standards and certification mechanisms should be adapted and applied,
- national institutions should be mandated and enabled to test and certify products and to enforce the standards.

The financial independence of the national testing institutions should be ensured.

The transfer of proven technologies must be designed and implemented as a long-term commitment to the local private sector.

Financial issues

The financial scheme should be designed in such a way that financing institutions or financial intermediaries can recover their costs including all administrative costs, such as for the collection of instalments.

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.

It should be carefully evaluated whether the target group is the right one to absorb SHS dissemination/marketing, otherwise the selection of the target group should be reviewed and if necessary changed.

Assessment of creditworthiness of the potential customer should be undertaken by a trained branch officer or experienced representative of the intermediary.

Risk mitigation measures including a system insurance should be adapted to the needs of both the financial institution and the customer, e.g. better information/ training in understanding the SHS technology, development of guarantee models (collateral, involvement of community, PV dealer)

Awareness issues

A careful analysis and determination of the target group and its economic situation is a precondition for SHS dissemination/marketing and for the design of financial services.

It is important to account for the different social cultures and environments of the target group when designing a dissemination and financial service strategy.

Provide clear and comprehensive information to the potential customers 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 contribute from the very beginning in order to sense their appreciation of the value of a SHS.

The successful introduction of SHS that satisfy their customers should be used to convince neighbours and create new customers.

Introduction

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.[2] 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 agrees 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-winoption 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*.[3]

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.

More than 1 000 000 SHS have already been installed world-wide during the past two decades. Success stories have been reported particularly from 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 still 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 manage to create the intended market transformation.

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

[2] /60/ World Bank (1996 (4))
[3] /58/ World Bank (1996 (2))

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. 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.[4] This revised edition takes also account of lessons learnt by other organisations, such as GEF, World Bank, UNDP and bilateral donors and agencies from Japan and Switzerland.

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[5].

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 1 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 2 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 3 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 4 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 5 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 the annex of the study.

[4] Especially in the projects which are/have been carried out by GTZ in Philippines, Morocco and Brazil.

[5] 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.

1. SHS – the Technical and Economic Characteristics

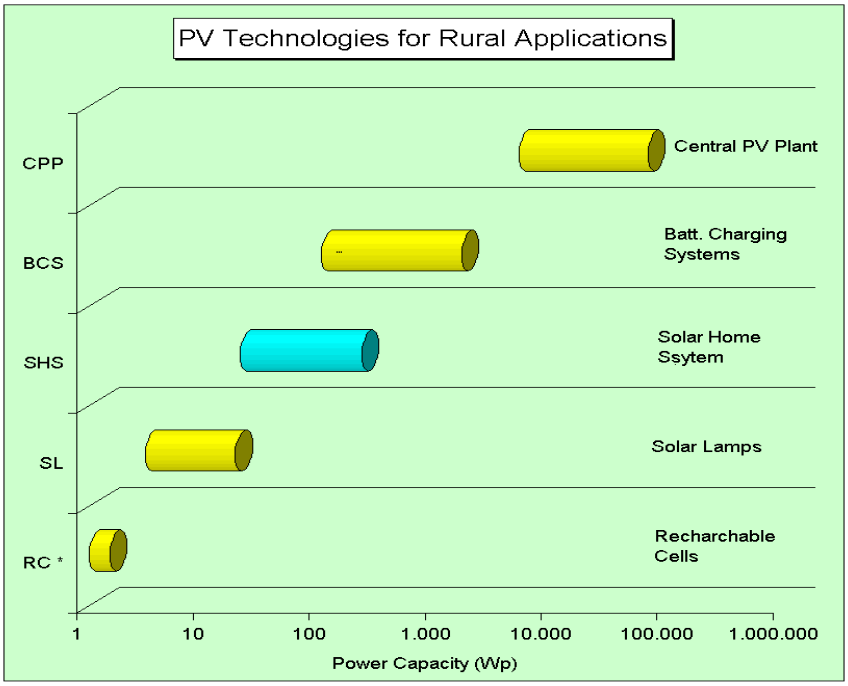
1.1 Potential contribution of SHS to rural electrification

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 Wp 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 such as in China, Indonesia, Kenya and Morocco. There are reports, however, that due to technical problems with locally produced comp-onents, these systems may create a negative image of PV technology [6].

Figure 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 approximately 50 Wp 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 (i.e. for income generating purposes) 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 high priority.[7] Keeping this and the high expectations of the rural population in mind with regard

[6] /37/ Kublank et.al., (1997)

[7] However, there is little evidence that SHS ranks high in priority for the poorest of the poor part rural population.

to electricity, awareness building and correct information are key factors for successful dissemination and commercialisation of SHS.

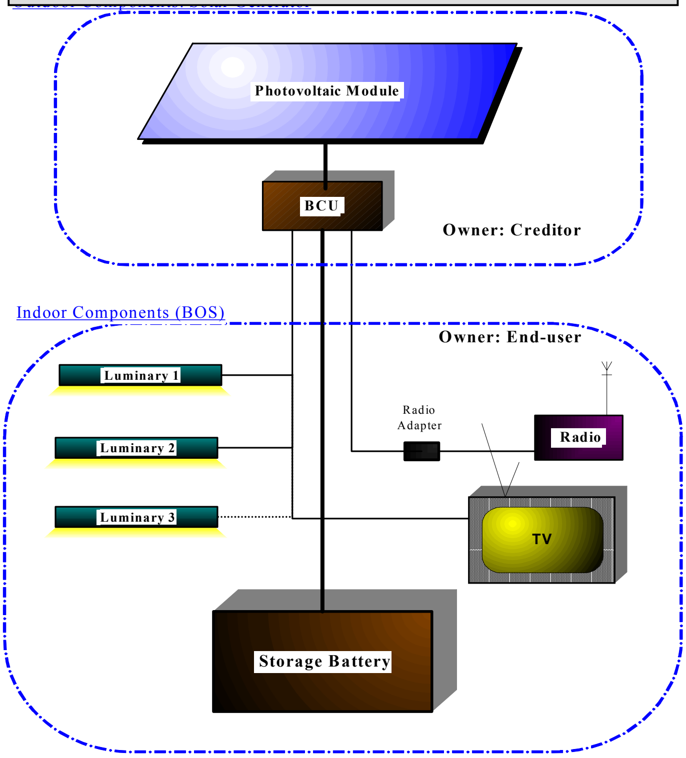
Although current designs are limited to consumptive use, the common view of rural electrification programmes being only for consumptive use with productive use seen as being a luxury seems to be changing. Experts at a specialists meeting organised by the World Bank raised the question that:

"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."[8]

1.2 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)[9] 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.

Figure 2: Components of a SHS



Larger PV-systems with capacities of several hundred 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.

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 Ah 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 Ah to 100 Ah.

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 /62/ World Bank (1997 (1))

9 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 approximately 4 years. Practical experience in many countries shows typical lifetimes ranging from 1 to a 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.

The reliability of components will become evident only during operation. It cannot be recognised by the customer during the purchase of the system. In order to protect the users from low-quality systems and to avoid detrimental effects on the whole SHS dissemination programme, the quality of components and systems has to be checked by independent institutions. While it may not be difficult to install a national testing laboratory, it may be difficult to maintain it as a financially independent and sustainable organisation.

1.3 Economics of solar home systems

The cash price for a basic DC SHS[10] is in the range of 500 USD to 1 200 USD. Depending, for example, on size, origin of components and country-specific taxes and duties, the domestic system price for an installed SHS ranges from 7 USD.Wp^{-1} (e.g. in Indonesia, 1994) to 26 USD.Wp^{-1} (in Kenya, 1993). The price of PV modules dropped from some 20 USD.Wp^{-1} in 1980 to the present cost of about 5 USD.Wp^{-1} and is expected to decrease further due to economies of scale. The cost for the module, however, represents only approximately 50 % of the cost of the complete system.

Although PV technology is regarded as a nearly maintenance-free one, the operational costs[11] over the lifetime of the SHS have to be added to the purchase price of the SHS. While typical monthly payments of 5 USD to 10 USD 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.

Comparing the economic competitiveness of SHS with conventional grid extension (which costs generally some 10 000 USD.km^{-1} 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 USD.kWh^{-1} to 10 USD.kWh^{-1}, PV electricity might be in the range of ‘only’ 1 USD.kWh^{-1} to 3 USD.kWh^{-1}.[12]

There are three main 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.

[10] 50 Wp panel, BCU, battery
[11] Operational costs cover maintenance, repair, replacement of battery, lamps and electronic ballast.
[12] /18/ Eckhart (1998). The price of 1 USD figure is very optimistic compared to another calculation resulting in 3 USD.kWh^{-1} /47/ Pertz,(1998). Extremely optimistic is the figure of only 0.20 USD.kWh^{-1} to 0.30 USD.kWh^{-1} given by IFC/World Bank /65/ World Bank, (1998).

For the economic evaluation of a SHS project the *Discounted Life-Cycle Costing (LCC)* formula is widely used.[13] 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).[14]

The application of the LCC-formula delivers two results:

Firstly**,** annualised life-cycle-cost (ALCC) (e.g. in USD.year^{-1} or USD.month^{-1}) 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.[15] The analysis of the LEC (measured e.g. in USD.kWh^{-1}) provides 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 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. [16]

1.4 SHS – an off-the-shelf-product?

In the past decades 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 hand have led to the widespread belief that SHS is a reliable and a readily available ‘off-the-shelf-technology’.

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13 For a detailed description of this method applied to renewable energy see: /20/ Finck/Oelert, (1985) and /24/ Gregory et. al. (1997)

14 where: CRF = $i/(1-q^{-T})$, q = 1+i, i = discount rate, T = project lifetime.[14]

15 where: LEC = PVC / PVE = PVC * CRF / PVE * CRE = ALCC / PVE * CRF

16 Examples for such difficulties are the projects in Tunisia (see textbox in Chapter 2.4) Bolivia, Morocco and Lesotho (see Appendix: Case Studies)

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 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[17]. 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 government agency for renewable energy, 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 programme involving over 1 000 SHS due to technical problems experienced with the systems' 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.

The technical design of SHS and the sustainability of financial services to promote dissemination are closely connected. Low-quality components may reduce the initial investment but will increase the costs for operation and replacement.

The organisational and financial problems to replace components are often underestimated with serious consequences in the long run. Even a good-quality SHS is not maintenance-free but just needs less maintenance than other technical alternatives. An appropriate after-sales service has to be offered to cover such problems. Establishing an appropriate after-sales service in rural areas is a task that involves strong financial risks for private companies. While this may be a field for external support, it is now widely accepted that finally the user has to pay for such services in order to make it sustainable.

Attention has to be paid that users are aware of the limitations of the systems and of what they have to expect in terms of costs and requirements for maintenance and replacement. Their willingness to pay for instalments and service is strongly affected by the degree to which the SHS reality matches their expectations as well as the real service they enjoy.

[17] 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 (known from Argentina, Tunisia, China, Jordan) that faulty panels of manufacturers had to be replaced on warranty basis after a few years only.

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

2.1 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 500 USD to 1 200 USD 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 example, a refrigerator or other household appliance. SHSs, however, have not yet been established on the market as mature commodities like standard appliances and are not commensurate 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 10 USD-12 USD 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 on 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 considering 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 a 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.

2.2 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
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 useage pattern and 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.

Awareness of System's Capacity
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'.[18] The often-cited process of adjusting

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

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 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 kWh - 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.

Political Disincentives
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.

Subsidies
The issue of subsidies has always caused controversial discussions. In the previous discussions[19] the distinction is made between 'good, smart 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.

The objective to apply 'bad' subsidies for end-users in many projects is to reduce the high initial costs as one main barrier of the SHS market. By increasing the number of customers and hence

[19] /62/ World Bank (1997 (1))

the number of systems sold, the system costs shall be reduced. With the reduced system costs, more people will be willing to purchase the system without a subsidy.

From many years of experience, we now know that costs reductions occur but in a slow and continuous way. Moreover, the number of SHS applied in most projects is and will remain small for many years from the point of view of component manufacturers.

A strategy speculating on falling prices has to be designed on a long-term basis and a continuous flow of subsidies has to be ensured for many years. Even in such a case, subsidies should be applied to all PV systems introduced in the domestic market in order to avoid market distortion.

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 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]

What are the effects of subsidised credit? [20]

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.

[20] /64/ World Bank (1997 (3))
[21] /23/ GEF (2000).

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

3.1 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.

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 long-term basis.

A key factor to help achieve financial self-sufficiency is cost-covering interest rates. These have to include the administrative costs for many small credits and the collection of instalments.

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.

As has already been partially discussed in Chapter 2, 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 [22]

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

3.2 The key elements of credit product design

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

[22] /28/ GTZ (1997 (1))

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[23] 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 (this depends on market situation and technical reliability and may change in future) Other collateral than SHS or „artificial" guarantees	As technical problems often contribute to customer dissatisfaction and unwillingness to repay, SHS guarantee will probably not be effective in enforcing repayment 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	

[23] 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.

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, depending on the socio-economic environment, it can be advisable in some contexts for a financial institution to require additional guarantees to enforce payment, such as private property items, blocked savings, joint liability, etc. This will not be possible in all circumstances.

In cases where the users just pay for the energy service and the SHS still belongs to an energy-service company, theft and damaging of components have to be taken into account. An insurance system has to be introduced. The insurance fee has to be added to the service fee.

Finally, the term structure should consider the technical life cycle of the SHS and the possibility that a grid connection may become available for the customer over time. As a consequence, financial institutions should consider short credit maturities.

4. Financial Mechanisms to Stimulate and Achieve Commercialisation of SHS

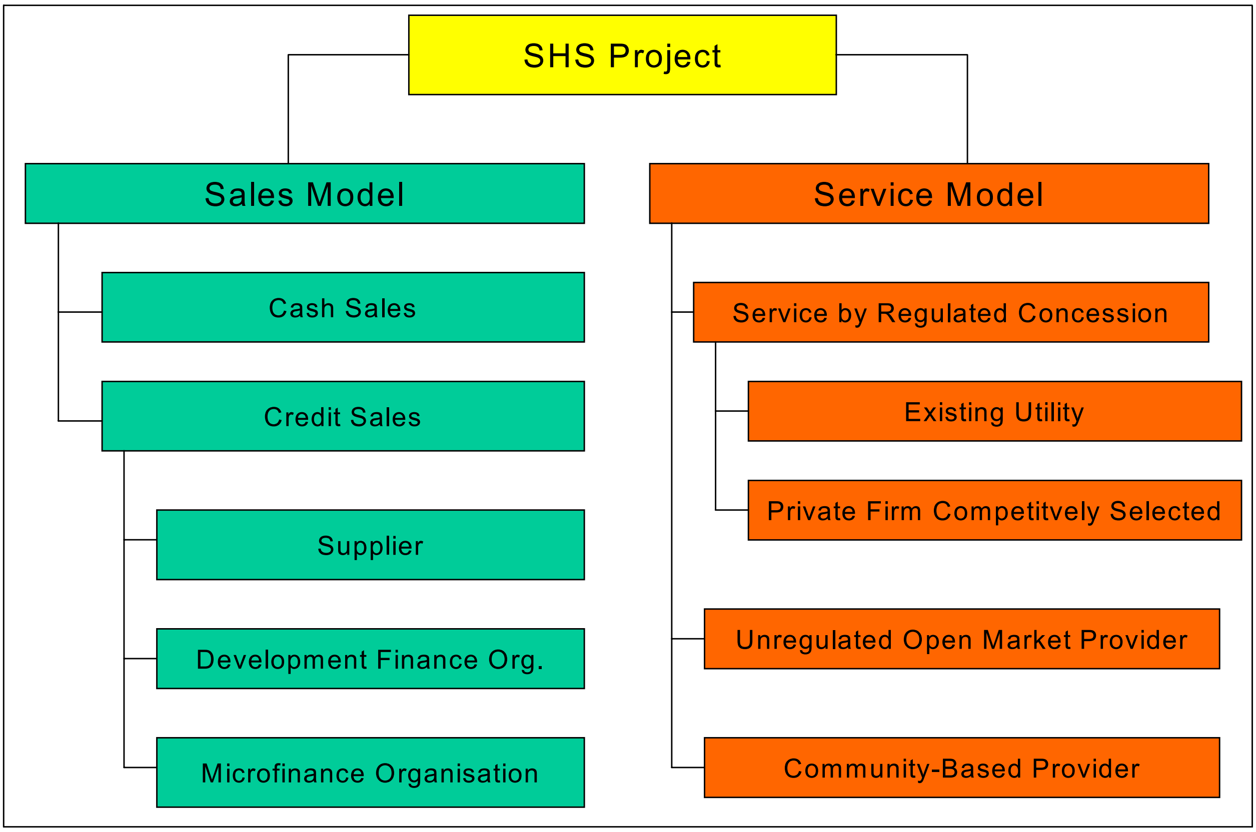
4.1 Primary approaches

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.[24]

Figure 3: Primary approaches of delivering SHS



Source: /23/ GEF (2000)

[24] /53/ 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.

4.2 General experience with sales models

Reviews by /23/ GEF (2000) and /66/ World Bank (2000) of SHS dissemination projects, which employ the sales model, have drawn the following picture:

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.

Customer education on proper maintenance is particularly important.

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.

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 (or to pronounce it from a different perspective: commercial banks have not yet developed attractive services for business finance of SHS dealers). As /66/ 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.”

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.

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.

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.

4.3 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:

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.

Despite the seeming advantages of the service model, SHS market expansion may be impaired by unrealistic and often false expectations of users about rural grid extensions. Such expectations arise by wrong assessments of the user on future grid extension and are additionally driven by false promises of politicians. This is counterproductive whether the service comes from a regulated concessionaire, unregulated open market provider or a community-based provider.

If governments attest rural electrification high priority 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.).

Refinancing and long-term sustainability of financial services are more difficult to achieve since the repayments by the users are spread over a much longer period.

4.4 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.

Informal financial sector

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.

Money-lenders in Cochin, India [25]

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

Semiformal financial institutions

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.

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.

[25] Example taken from /35/ Johnson/Rogaly (1997)

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.

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,

Caisses Villageoise (CVECA) Mali [26]

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 147 USD considering that the new village banks start with credits ranging from 20 USD – 40 USD. In 1996, 83 % of the credits went to the commercial and service sector. The average amount on a current account was 37 USD and of a term deposit 121 USD.

[26] Chao-Beroff (1998)

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 micro-entrepreneurs. In general, two 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 USD –200 USD 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 years -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.[27] 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 1 110 USD 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

27 /64/ World Bank (1997 (3))

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 4, the case study of Lesotho is presented, where a hire purchase model is practised for SHS financing.

Formal financial 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.

Hatton Bank - Sri Lanka[28]

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 550 USD, which is much larger than the average credit size of the NGO sector.

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

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 year – 3 years and housing credits for 10 years. Credit amounts are usually 100 USD to 300 USD 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.

[28] /22/ Gallardo et.al. (1997)

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.

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[29]

Credits can be used for any purpose, including consumption with an average size of 570 USD. The smallest credits are 55 USD and the largest can exceed 10 000 USD. 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.

4.5 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 500 USD; in some countries even below 100 USD) 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.

[29] /40/ Maurer (1997)

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 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:

Grameen Shakti - Bangladesh[30]

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 25 USD to 500 USD, a SHS costs 300 USD to 600 USD. 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 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.

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

[30] /3/ Allderdice (1998)

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.

5. The Way Ahead: Towards Higher Sustainability

5.1 Summary of the case studies[31]

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 the appendix 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 Wp 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, recover 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".

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

[31] Detailed case studies are presented in the appendix.

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[32] (TREND)	High				degree of subsidy		low	
[%] approx.	> 90	> 75[33]	> 50	N.A[34].	> 35	> 30	0 - 30	0 - 30
N° of SHS[35]	4 000	965	2 000	1 300	171	500	several. 100	15 000[36]
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 contributio n	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	Utility	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.

32 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.

33 Maybe even higher, considering the intention to reduce the interest rate to 0 % over 20 years

34 Exact terms of rental schemes not available.

35 Approx. number of SHS installed under the analysed programmes.

36 For Morocco, no number is available for SHS installed under international programmes; the given numbers are related to SHS in the range of 50 Wp to 100 Wp mainly sold on cash basis to rural households.

5.2 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 2.1).

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.[37] 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:

Policy issues
Technology issues
Financial issues
Awareness issues

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

[37] 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[38] or, to a lesser extent, utility based approaches with soft loans from international financial co-operation (Morocco)[39]. In some cases, subsidies are deliberately concealed.[40] 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.	**Subsidies for systems purchases or credits should be considered with caution. It requires long-term funding. Poorly designed or managed subsidies may have detrimental effects.** **Well targeted subsidies can reduce transaction costs for dealers/ banks. They should be spent 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, reduced and/or made self-destructive after the fulfilment of their 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**

[38] 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.
[39] SHS programme PERG of ONE/ KfW.
[40] Like in the case of LADB-concept Lesotho; see case study Lesotho in the appendix

	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.	**An audit system should be established to check the fund recovery and subsidy management.** **Sustainability can only be evaluated if carefully monitored over years of operation. This task requires the continuous 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 sector involvement	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.[41] With a dissemination approach like this, the local private industry can not develop its own market structure and continues	**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.** **The involvement of the private sector in SHS dissemination**

41 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.
42 Complains are known from Morocco /37/ Kublank et.al., (1997), but also from other countries.
43 /42/ Miller (1998).

	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.[42] 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.[43]	**is now a key issue in all major programmes. In order to make this strategy successful companies have to make a profit. An example for 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.[44]** **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. Designing the fund supply and fund recovery system is an essential task.**
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.**

[44] 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.

Findings	**COMMENTS AND LESSONS LEARNED**	**RECOMMENDATIONS**
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. [45] 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 internationally recognised 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.** [46] **Ensuring the long-term financial independence of national testing institutions.** **The transfer of proven technologies must be designed and implemented as a long term commitment to the local private sector.**

[45] Respective reports exist among others from Morocco, Kenya, Bolivia, Philippines Lesotho and South Africa.

[46] 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.

Findings	COMMENTS AND LESSONS LEARNED	RECOMMENDATIONS
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 USD.month^{-1} – 10 USD.month^{-1}, 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. 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 including all administrative costs, such as for the collection of instalments.** **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: i.e. the poorer the target group, the higher is the probability that a programme will fail.[47] 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	**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**

[47] Although strong evidence for this statement were found in the evaluated projects, more investigation and fundamental research is required.

	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. 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.	**and O&M being covered by the user):** **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	Despite the fact that micro-financial services are increasingly offered to rural populations, these financial services do not apply for SHS yet.	

[48] 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?

organisa-tions	Only few examples for involvement of the micro-finance institutions in SHS lending were found. 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.[48] 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 so far no financial scheme exists that is 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, as hire purchase schemes in Lesotho show,	**Instead of the distinction between consumptive and productive use, cost recovery and adjustment for positive/negative external effects should be made the centre of attention.** **Design of risk mitigation measures including a system insurance 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**

49 See respective discussions on 'good and bad subsidies' at World Bank Energy Roundtable Meeting, /65/ 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.

	(although, the Lesotho experience needs further evaluation). 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 avoid market distortions.** **In order to minimise on capital costs, projects take advantage of different kinds of subsidies, the "good ones and the bad ones"[49], e.g. tax exemptions, bulk procurements as well as shifting administration and overhead-costs to other budget heads.**

Findings	COMMENTS AND LESSONS LEARNED	RECOMMENDATIONS
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 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	**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 contribute from the very beginning in order to sense 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.** **The successful introduction of SHS that satisfy their customers should be used to convince neighbours and create new customers.**

	different reasons which are either related to errors in the project design[50] 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.[51]	**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.**

[50] 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.

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

	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.	

Annex A

I. Case Studies of Selected Countries

I.I SHS Dissemination Programmes in Tunisia[52]

The *National Programme on Rural Solar Electrification (PNER)* in Tunisia is an example of a government supported SHS dissemination programme with a high level of subsidises.
Although private PV dealers and suppliers are involved the primary objective is not to create responsive market structures. The financial sector is not directly involved since SHS are not credit financed.

RURAL ELECTRIFICATION AND STATUS OF SHS DISSEMINATION

Though the electricity grid supplies about 50 % of rural households, the remaining households will most probably not be connected to the grid in near future.

Activities on PV utilisation started in the early 80s in Tunisia. The dissemination of SHS increased as a result of support provided by the GTZ-supported Special Energy Programme (SEP) Tunisia. Based on a field test of 110 SHS in the Kef Region, the national energy authority AME gained considerable first-hand experience. Other international partners supported AME as well in the implementation of PV programmes. These included a portable Solar Lanterns Programme (French project), PV refrigerators and SHS (Spanish project) and PV pumps (German project). Other projects financed by the Tunisian Government consisted of PV electrification of primary schools in rural areas.

Based on a recommendation of the SEP the Government agreed in 1993 to launch a *NATIONAL PROGRAMME ON RURAL SOLAR ELECTRIFICATION (PNER).* With technical assistance of GTZ the first project under this programme was implemented between 1994 and 1996, installing approximately 1 000 SHS to the Region of Kef. A second project financed by the World Bank started in 1994 and provided 1 250 SHS for three regions of northern Tunisia. The third project with another 1 000 SHS supported by World Bank was launched in late 1995.

For a fourth project, tender documents were also prepared. In addition, a SHS dissemination project of approximately 1 000 SHS was financed by the newly established National Fund on Solidarity (FNS) for six regions in Central and Northern Tunisia. This project is on going .

As a result of the activities during the last two decades a total of approximately 28 000 SHS were installed in Tunisia.

SOCIO-ECONOMIC ASPECTS

The main objective of the SHS dissemination activities is the substitution of traditional energy sources thus contributing to the improvement of energy supply of approximately 150 000 rural households.

Due to the limited generation capacity of SHS, this approach was not seen as having the potential for rural productive development.[53] The ruling policy prioritised the electricity supply of rural population instead

[52] /4/ AME/GTZ (1999)
[53] Internal project document: Njaimi/Ullerich (1993).

of a sustainable SHS market development. The underlying philosophy assumes rather a social obligation on behalf of the government authorities to improve the living standard of rural communities than to establish a responsive SHS market. Subsequently, this policy diminished the role of financial services and increased the role of subsidies in SHS dissemination programmes.

Although the target group should participate equally in the national solar programme the selection of recipients of SHS is based on economic and social criteria as well as on creditworthiness and energy consumption.

IMPLEMENTATION APPROACHES

AME and SEP claimed that "financing of the national PV programme by international credits should be an exception". Nevertheless, the government stipulated that the implementation of the national PV programme was subject to the availability of funds.

In 1992, a "millime solaire" (solar penny) was approved to be collected by STEG, the national Tunisian electrical utility, in order to finance the national SHS programme. Although, the *millime solaire* was part of a new tariff structure, it did not result in increased funding for the SHS programme as STEG allocated the increased revenue for internal use. Discussions were initiated to establish a new fund to be managed by AME itself, and financed by applying a tax on hydrocarbons.

Under the national solar electrification programme beneficiaries of a SHS are required to make a downpayment of 100 TND (88 USD) in order to qualify for the installation of a SHS. In this scheme, no regular fee for installation, maintenance or replacement cost is requested, thus subsidising not only the investment cost, but also on administrative and operational costs for a limited time of two years.

FINANCIAL ASPECTS

Investment cost

With the national solar programme designed as a mainly politically motivated development measure and understood as a social obligation, financial schemes do not play an important role.

End-users are recipients of an energy service for which they pay up front a contribution of 100 TND (88 USD) in order to qualify. For this downpayment they receive a readily installed SHS. Despite higher capital costs caused by upgrading of the system's capacity during the course of the different programmes, the required downpayment was not adjusted. Consequently, the end-user's share on the cost of installed systems decreased from approximately 13 % (88 USD of 670 USD for a SHS installed) to about 7 % (88 USD of 1 400 USD after upgrade) under the FNS financed project. The additional costs were covered by the Government.

Operational costs

After two years during which AME reserves the right of ownership and cares for the operational costs, the user becomes responsible for operational costs. The experience of the national solar programme show for both the implementing agency (AME) and the user that this approach bears serious risks like unexpected high costs. To take over the operational costs after two years may result in a high financial burden for the user, since this is often the time when critical components like batteries, fluorescent lamps and the BCU have to be replaced.

Since there is no credit component no financial institution is involved either. That means that the user has no access to any kind of SHS credit facility.

TECHNICAL ASPECTS

Technical design

Within the national programme the standard SHS was equipped with one 70 W_p PV panel and an enhanced automotive battery with 90 Ah capacity. Under the fourth project of the national programme as well as under the FNS financed projects, the configuration was modified to a system with two PV panels of at least 100 W_p and batteries with 180 Ah capacity. Moreover the lead-acid batteries were upgraded from an automotive type with grid pasted plates to industrial type batteries with tubular plates, improving overall performance of the units.

Technical Problems

The reason for changing the design was the frequent failure of system components. Life spans of the fluorescent lamps, the BCU and battery components turned out to be very short. Batteries had to be replaced after only 1-2 years. BCUs, fluorescent tubes and electronic ballast's required frequent replacement as well[54]. An assessment of technical failures revealed that 45 out of a first batch of 100 SHS were faulty. The break down of the type of failures showed 25 % battery problems, 13 % problems with electronic components and 7 % of failures were caused by tampering of the user.[55]

After negotiations with the manufacturers related to warranty periods of the batteries, the problem of their poor life span was ultimately resolved by switching to industrial batteries instead of automotive types. Reliability problems with the other electronic components, however, continued to cause problems. At one point in 1996, installation work of the third project of the national programme was suspended completely. The reason for this was that locally manufactured components had replaced the more expensive foreign equivalents. The quality of the local products in particular the electronic components, however, was very poor resulting in low efficiency and short lifetime of the systems.

It is, however, not known to the authors to what extend local and/or international suppliers guaranteed their products and whether their warranties were invoked (and if so, with what result).

LEGAL ASPECTS

A contract stipulating the terms of the agreement between AME and the end-user is signed prior to the handing over of the system. The SHS have a 2-year warranty period, during which time AME is responsible for maintenance and service. After this period all subsequent O&M costs become the full responsibility of the users. The recipients are prohibited from selling the units for a period of 10 years.

LESSONS LEARNED

1. The NATIONAL PROGRAMME ON RURAL SOLAR ELECTRIFICATION is a SHS dissemination programme receiving strong support from the Tunisian Government to incorporate the use of PV technology in rural electrification. Considered as a valuable contribution to improving living conditions in rural

[54] /28/ GTZ, 1997 (1)
[55] Internal project document: Moncef, 1991

areas, the programme is highly subsidised. Considerable efforts were made in the preparation, implementation, monitoring and evaluation of projects, as well as the documentation of results. With more than 4 000 SHS installed the national solar programme achieved a remarkable outreach in terms of numbers of installations. There is however, no reliable data available about the impact of SHS on rural living conditions.

2. Being implemented by a single agency, the programme maintained sufficient flexibility to accommodate adjustments in project implementation to meet specific needs, thus solving technical problems. These adjustments, however, were caused by quality problems and poor technical design of SHS. From the users view, the responsibility for the functioning of the SHS was with AME and not with the PV-dealers. As a result, AME and SEP stated that “the problems which endanger the success of the national SHS dissemination programme are primarily not financial but rather of a technical and organisational nature”[56].

3. Both the establishment of a suitable implementation structure and the mobilisation of numerous funding sources represent a considerable achievement on behalf of the respective authorities. Nevertheless, it has to be recognised that the problems highlighted earlier, continue to undermine and threaten overall sustainability of the SHS programme. The programme does not allow for the development of responsive market structures with strong involvement of both private PV dealers and financial intermediaries although both might be willing to invest in the development of a demand-driven indigenous SHS market. As an indication for non-responsive market structures, a study reveals that 23 % of users had to wait for more than one year before necessary repairs on SHS were carried out.[57]

4. Problems encountered by SHS users after the two-year-period of AME ownership expired. The operational costs were unexpectedly high due to earlier than expected battery replacement and poor after sale services.

The following graphic shows the distribution of responsibilities of the players involved on the different levels and their interaction.

The graphic illustrates that

- *no financial intermediaries are involved*
- *PV dealers do not sell SHS directly to the customers but to the implementing agency AME*
- *PV dealers do not have a chance to develop their customer base under market conditions.*

[56] /28/ GTZ, 1997 (1)
[57] Internal project document: Njaimi/Ullerich (1993).

Figure 4: AME (Tunisia) responsibilities in SHS projects

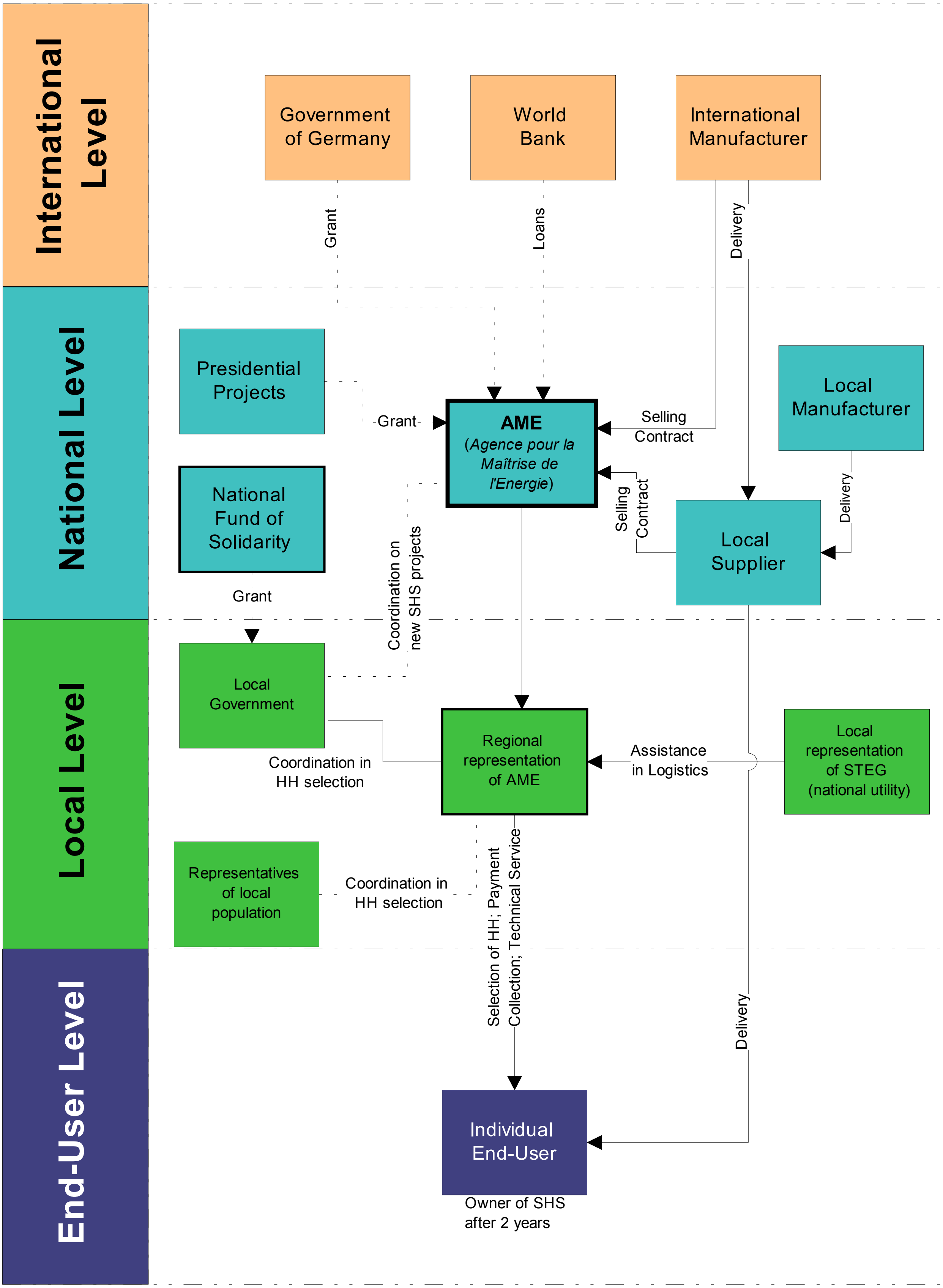


Table 4: Design parameters of the National Programme on Rural Solar Electrification (PNER-FNS)

Parameter	SHS dissemination approach
No. of SHS installed and **Duration of the programme**	> 4 000 1993 to 1996 (new initiatives ongoing or under preparation)
	Technical parameters
Rated power capacity [Wp] **Battery capacity [Ah]** **Type of battery** **Potential use**	106 180 Industrial 3 fluorescent lamps (+ radio/cassette, TV, Video)
	Cost structure
Purchase price of SHS [USD]	1 400
Additional costs	For handling, administration, installation, M&O during first two years (exact figures n. a.)
Total cost of SHS installed and operational [USD]	1 400 & additional costs (n. a.)
Credit administration fees	Does not apply for customer/recipients of SHS, no credit scheme
Capital cost	Purchase price & additional costs & credit costs (on government side)
	Financing schemes
Financial agent	Local representative of AME
National/international co-financing	FNS (national), WB, GTZ
Selection procedure of recipients	Selection by AME with support from representatives of local population according to established and known criteria
Subsidy element[58]	> 93 %
Payment **Schedule**	Single downpayment of 100 TND (88 USD), no further payment to AME (after 2 years user takes over full responsibility for all O&M costs)
	Risk mitigation measures
Late payment fee	DOES NOT APPLY
Credit Appraisal procedure	See: selection procedure
Guarantee (Collateral)	No guarantee required (however: SHS must not be sold for 10 years)
Cancellation of Credit agreement	Does not apply
Collateral enforcement	Does not apply

[58] Estimate only (7 % downpayment of purchase price of 1 400 USD).

I.II SHS Dissemination Programmes in the Philippines

In the Philippines, PV systems have been in use for rural electrification since more than 10 years. Since 1987, GTZ provided technical assistance in the PV sector supporting the national programme for SHS based rural electrification RPE (Rural Photovoltaic Electrification)

RURAL ELECTRIFICATION AND STATUS OF SHS DISSEMINATION

The rural electrification rate in the Philippines increased from 47 % in 1992 to about 60 % in 1998. Under the *Philippine Energy Plan* the NEA (National Energy Administration) plans to reach "*100 % electrification of potential 10.2million households by the year 2018*".

The responsibility for rural electrification is with 119 Electric Co-operatives (EC) in 15 regions and private energy service companies covering the entire Philippine archipelago. Mainly for economic reasons, the possibilities for conventional grid extension are limited and photovoltaic systems present an option for decentralised electrification of rural households.

The Philippine-German Special Energy Programme (SEP) started in 1987 as a joint project of NEA (National Energy Administration) and DOE (Department of Energy). The German contribution to the SEP is presently in the final phase and will be terminated in 1999.

Under the umbrella of the SEP, in 1991 NEA initiated the RPE (Rural Photovoltaic Electrification Project) as the first permanently established SHS dissemination scheme in the Philippines. Between 1991 and 1997 two phases of the RPE (I and II) were launched. The discussion about the terms of the third phase (RPE III) took almost one year and NEA finally approved it in March 1999.

The RPE is one of the few international projects in the Philippines implemented by the nation-wide network of established Electric Co-operatives (CE). There are presently other PV dissemination projects in implementation or in preparation, which are either supported by national funds or international donor agencies.

IMPLEMENTATION APPROACH AND INSTITUTIONS INVOLVED

The implementation approach is based on contracts between NEA and the Electrical Co-operatives (EC) on the one hand and between the EC and the users on the other.

The institutions involved in the RPE and their interaction at different levels is shown in graphic 2.

<u>Contract NEA – Electrical Co-operatives (ECs):</u>

NEA serves as a lender to the ECs. In 1996, about 33 million USD were released of which 64 % were provided as credits and 36 % as subsidies[59]. This amount contained funds from different sources, including grant portions from international donors.

NEA provides a credit to the ECs enabling them to buy SHS from local dealers. NEA grants a grace period of 1 year during which the ECs only pay interest rates but no debt service. The RPE scheme covers only this contractual level.

[59] National Electrification Administration, Annual Report 1996.

Contract ECs – customer (end-user)

At the implementation level, ECs act as intermediaries offering SHSs to customers in their franchise area. The customer rents (or may buy on credit) only the solar generator from its EC and buys at his own expense the BOS-components. The O&M costs for the BOS parts are covered by the customer as well.

It is important to note that the contract (lease or credit) between the EC and SHS end-users is not supported by the RPE. Therefore, it is the sole responsibility of the ECs to conclude lease (or credit) contracts with the customers which ensure that the ECs can repay the credit to NEA in a sustainable way. The EC does not pass NEA's grace period on to its customer.

Private sector involvement

Private PV dealers deliver SHS in batches to NEA and/or the ECs. Additionally, they supply spare parts and BOS components to users and ECs.

As they react only to requests by NEA and ECs, however, they have no means of actively influencing the number of SHS rented out or financed by the ECs.

FINANCIAL ARRANGEMENTS

Analysing the financial arrangements of the overall programme (RPE) three different levels of arrangements have to be considered:

(I) Donor – recipient of grants (e.g. GTZ – Government)

(II) Lending national agency – recipient of the credit (NEA – ECs)

(III) rental agency (recipient of the credit) - end users (EC – customers)

The assistance of the SEP/GTZ included mainly the contribution of 400 000 DEM (approx. 200 000 USD) to a Rotating Fund, which was established with the ECs and intended to cover initial cost of service and spare parts. While the arrangement between NEA and the ECs is a credit contract with special conditions under the RPE (see Table 3) the arrangement between the EC and its customer is a lease (or credit) contract.

After the customer has made a downpayment the EC or a PV supplier acting on behalf of ECs installs the SHS in batches of approx. 25 SHS.

During the duration of the contract the ECs collect a monthly service fee.[60]

IMPLEMENTATION EXPERIENCE

Technical problems and the consequences for financing

The *technical quality* of components (specifically fluorescent lamps, BCU and batteries) of several bulk purchases from the local market under the RPE turned out to be poor (see textbox below) resulting in shorter lifetime than allowed for in the financial calculations. Since the correlation between quality and lifetime of components was not clearly understood either by technicians

[60] This service fee includes: handling and administration, rental (or repayment) for the solar generator and maintenance of the solar generator.

or by the end-users there was also no awareness about the problems potentially involved with the system. When disappointed customers stopped payment of service fees the faulty spare parts had to be purchased by the ECs which, in turn affected their debt service for NEA. Not being aware of the quality issue, replacement components were purchased from local market again and the cycle of problems started all over again. The experience showed that looking for the cheapest components is also behaviour typical of the SHS user who has to buy the BOS components on their own before the EC installs the solar generator.

As a consequence, the earmarked share of 10 % of the monthly service fees (< 0.7 USD) was not sufficient to cover the costs of repair and maintenance. Furthermore, It turned out that applying the same flat rate service fee equally to each of the ECs is not advisable since geographical locations and economic performance of the ECs differ widely. Additionally, since maintenance was often carried out sporadically, the related costs were not monitored, and therefore, not transparent to the EC itself. In some cases, fee collection was not carried out over long periods due to the high costs of transportation to the sites.

This experience was probably one of the reasons that it took more than one year for the terms and structure of the credit scheme for the third phase of RPE to be finally approved by the NEA Board in February 1999.

External influences on programme sustainability

On the local level, the cost of BOS components was sometimes carried by local politicians instead of being paid by the end-user. Political representatives on the regional level initiated SHS dissemination projects with money from national funds which can be tapped by governors and congressmen, thus by-passing official planning procedures.

This influence of politicians, and sometimes governmental agencies jeopardised the sustainability of the SHS dissemination activities under the RPE scheme.

*In the **Philippines** in the late 1980s the GTZ project SEP initiated and promoted the local manufacture of simplified low-cost electronic components, such as ballasts and BCU's. Training and technical assistance was given to appointed manufacturers who launched the manufactured components onto the local market and which the SEP began to buy and install. After several months, however, problems began to appear on different levels. Designed as low-cost products, the electronic components could not provide the high quality that is a precondition for long lifetime and high energy-efficiency.*

It was also found that a constant product quality of the units could not be maintained. Brownouts repeatedly occurred and replacements were needed regularly. Subsequently, discussions on technical specifications and warranty terms were raised. Due to their poor quality and subsequent burning out of units the overall cost for their replacement, including O&M costs, rose unexpectedly high. Finally, it was decided not to rely on local components anymore, but to start importing those components again. As a consequence, the local company closed this production line

[61] For a batch of 25 SHS, the debt service under current credit terms amounts to only 23 000 PHP per quarter, compared to an equal quarterly amortisation for a grid extension loan in the range of 2 million PHP to 5 million PHP depending on the size on an EC.

[62] This is interestingly one of the main arguments for utilities world-wide which consider SHS dissemination programmes as pre-electrification measure in their franchise area.

Another potential thread to sustainability of SHS dissemination comes from several highly subsidised PV implementation activities NEA was also assigned to carry out under sporadic, mainly politically motivated programmes, like the '*Presidential Flagship Projects*' to equip selected villages with SHS and PV powered battery charging stations.

The role of SHS within the portfolio of the ECs

The RPE scheme of NEA was understood as a "*pre-electrification"* measure, declaring SHS as not being a final alternative to grid extension. For the NEA, the SHS dissemination programme implemented by the ECs was a suitable tool to contribute to the objective of the 5-year work plan on rural electrification.
These systems were installed in nearby areas in order to satisfy people's urgent demand for electrification. With the national grid reaching these sites the SHS were dismantled, overhauled and installed in new sites. Experience shows, however, that SHS installed under these work plans often were operational only for a limited time (between a few months and several years).

With only 1 percent of the overall credit volume SHS still play a marginal role in the ECs budgets.[61] Even a profitable solar electrification programme is only a sideline for an EC if the number of SHS-contracts cannot be increased significantly. However, SHS are often regarded as a supplementary measure by the ECs, worth considering for the fulfilment of their mandate of rural electrification.[62]

Nevertheless, ECs as well as end users seem increasingly to regard a SHS only as a temporary solution serving until grid connection is considered. This image may not change until the technical reliability of SHS is increased and the real cost of grid extension becomes apparent to ECs as well as to potential consumers.

LESSONS LEARNED FROM RPE SCHEMES

1. In 1997, an evaluation of former RPE I and II activities was initiated by SEP resulting in recommendations how to modify the RPE III scheme. There was the need not only to adjust the credit amount to the actual price structure, but also to consider the experience gained from the RPE scheme and the performance of the Electric Co-operatives in the field.

Under the RPE III the ECs would be well advised to include not only debt service and O&M costs in the service fees during the first year, but also the annual increase of O&M costs due to inflation and increased working capital requirements.

2. However, increasing rental and O&M fees do not eliminate the initial problem. The lack of quality standards, be it for local production or imported SHS components, is the main reason for the technical problems encountered. Significant efforts in quality control and application of international standards have to be taken in order to overcome the problem of poor quality components, thus breaking out of this vicious circle[63].

[63] This finding in not unique for the Philippine experience but almost universally valid for the SHS programmes reviewed in this study. It must, therefore, increasingly be one the main tasks of international assistance to build up quality control capacities, to support efforts of certification and labelling of PV components.

First corrective measures were initiated in the last phase of the involvement of GTZ in the RPE. Technicians of the Philippine FATL *(Fuel and Appliances Testing Laboratory)* were recently trained at recognised European testing laboratories in order to improve local capacities for testing and quality assurance for PV components.

3. A cash flow analysis of the RPE scheme showed high sensitivity to variation in the collection rate of rental fees, which represents the most critical variable in the model applied. Accordingly, at least 90 % of the outstanding rentals fees should be collected to avoid serious consequences for the overall implementation approach.[64]

This illustrates once more the typical difficulties of financial intermediaries: the ECs being on one hand obliged to repay the credit to NEA and, on the other one to depend on the end user's willingness and ability to pay their service fee.

4. The outcome of the RPE programme was limited due to external interference of competing programmes offering SHS either heavily subsidised (or even free of charge), or at least at more attractive financial conditions. Better co-ordination and harmonisation of rural electrification policy at governmental, regional, and local level are necessary for coherent and sustainable SHS dissemination projects. This applies especially to those SHS programmes which are presently in the planning and preparation phases.

The presented criteria for sustainable and market-based SHS finance can be used as a yardstick to measure the sustainability of future SHS projects.

LESSONS LEARNED FROM OTHER SHS PROJECTS

Beside the RPE schemes, there were more SHS project activities whose lessons learned are presented below:

- SPUG, the so-called ***Strategic Power Utility Group*** of the National Power Company (NPC), is engaged in the electrification of small islands by installing small diesel generator sets. The generated energy is sold at a highly subsidised price to local energy service companies or ECs. Therefore, SPUG/NPC is considering PV electrification as an option to avoid high running costs for installed generator sets. The danger exists that PV systems will be subsidised too, as long as these subsidies are lower than those for the generator sets, thus distorting further the market for PV systems.

- Under the so-called '***Presidential Flagship Project (PFP) 1997'***, the NPC financed PV powered Battery Charging Stations. To the same project, both NEA and DOE contributed with Solar Home Systems and Battery Charging Stations (BCS).

According to DOE, its contribution was agreed to be to "energise (selected) municipalities through the installation of individual Solar Home Systems while awaiting the construction of conventional lines." Service fees were only requested from the recipients of SHS to cover certain parts of the operational costs and were estimated to be only one third of the service fees under RPE schemes. This practise potentially jeopardised the efforts to set up realistic and sustainable service fees under the RPE III.

[64] /47/ Pertz (1998).

However, due to operational problems similar to those experienced under the RPE schemes, the intended contribution of the PFP to improve rural electrification threatens to fail, or at least, to become again a highly subsidised SHS programme further distorting the market for PV products.

- Another project with 100 SHS installed in ***Belance*** in northern Luzon, was implemented in 1993 supported by the Department of Interior and Local Government (DILG) in co-operation with Dutch suppliers. A co-operative was approved to receive a credit from the Development Bank of the Philippines (DBP) and to onlend these funds to the end-users of the systems, using the PV panel as collateral. The end-user had to pay a down payment of 205 USD for the BOS, while he was scheduled to pay 10 USD per month over four years for financing the Solar Generator. 14 local technicians were trained and a standard service fee of 1 USD per visit had to be paid by the end-user.

After three years, the project experienced difficulties. Nearly three-quarters of the systems faced technical problems with battery, BCU, and fluorescent lamps. Financial and administrative mismanagement of the co-operative made it stop payments on the DBP credit. Of the trained technicians only one remained. With the assistance of DOE, the DBP is now considering a rehabilitation programme in order to convince end-users to resume payments.

It is advisable to have a close look at the reasons for the technical problems, but more importantly to assess the financial and managerial capabilities of implementing co-operatives, otherwise similar problems might start again in short time. Once this assessment is carried out, it might give some valuable hints on the appropriateness and willingness to pay a monthly fee which, at 10 USD is twice as high as the monthly fees of the envisaged RPE III scheme.

Figure 5: Distribution of Responsibilities in the SHS projects of NEA

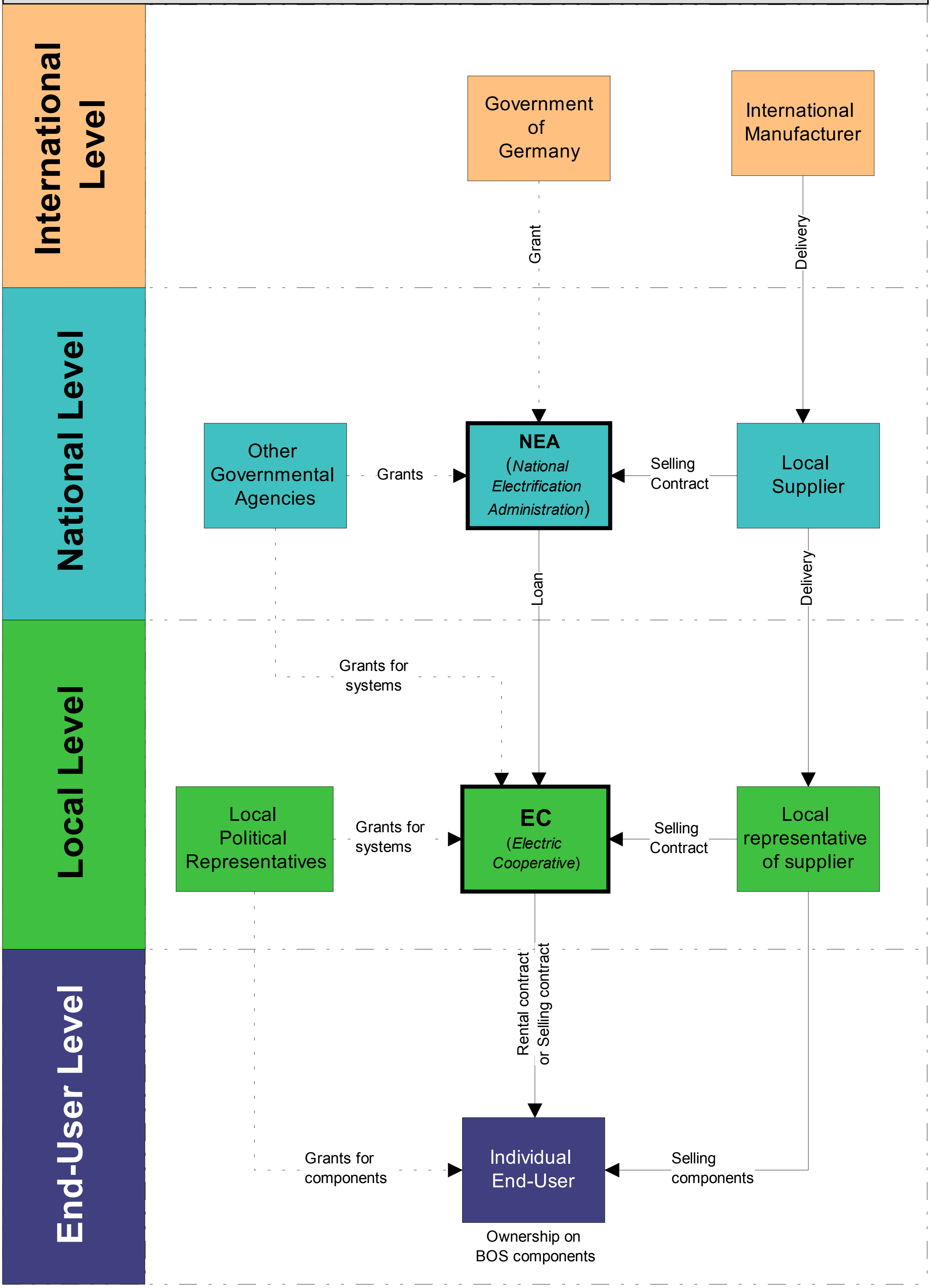


Table 5: **Design parameters of the Rural Photovoltaic Electrification (RPE)**

Parameter	**SHS dissemination approach**		
Name and duration of the programmes	**RPE I** (1992 – 1995)	**RPE II** (1996 – 1997)	**RPE III** (will start in 1999)
No. of SHS installed [65]	850	115	n. a.
	Technical parameters		
Rated power capacity [Wp] **Battery capacity [Ah]** **Type of battery** **Potential use**	50 100 imported heavy duty 2 lights, radio/ cassette, TV	75 100 local automotive 2 lights, radio/ cassette, TV	75 100 local automotive 2 lights, radio/cassette, TV
Installation	ECs	ECs	ECs
	Cost structure[66]		
Capital cost of SHS[67] **(Solar Generator and BOS, [PHP]** **incl. Handling,administration,[USD]** **and installation)**	16 000 620	16 000 – 25 000 620	30 000 750
	Financial schemes:		
	a) between NEA and EC		
National/ international funding	NEA GTZ	NEA none	NEA GTZ
Financial arrangement between NEA and EC	• NEA provides credit to ECs • ECs act as financial intermediary		
<u>Term structure:</u> **amortisation period** **amortisation type** **interest rate p.a. [%]** **grace period**	 10¼ years 41 quarterly instalments 12 1 year	 15¼ years 61 quarterly instalments 12 1 year	 20¼ years 81¼ quarterly instalments 6 (planning) 1 year
Credit disbursement procedure	▪ NEA agrees on credit contract with selected ECs and disburse credit ▪ ECs conclude rental contract with end-user and collect service fees (M&O and rental fee) ▪ ECs pay credit back to NEA		
Subsidy element	NEA received grants (until 1995) and contribution to a rotating fund as of 1997 of 400 000 DEM[68]		
	b) between EC and end user		
Financial arrangement between EC and end user	**Rental scheme**[69]: user owns BOS, EC owns Solar Generator , user pays combined service fee (O&M costs, rental fee) **Credit scheme**: user owns BOS, EC finances Solar Generator , user pays combined service fee (O&M, debt service)		

65 /47/ Pertz (1998).
66 Exchange rate in 3/1996: 1 USD = 25.2 PHP; in 3/97: 1 USD =26 PHP; in 3/98: 1 USD = 40.1 PHP.
67 Capital cost includes: cif price of complete SHS, handling fees, administration, installation.
68 Recognising that in practise, rotating funds very frequently become a 'lost contribution', and thus a subsidy element.
69 Only rental scheme is used in the RPE programme.

Selection procedure of end user		Selection of a batch of approx. 20 households, sites recommended by regional NEA office		
Credit element **[PHP]** **approximately [USD]**		Solar generator (SG) 6 000 250	Solar generator (SG) 12 000 500	solar generator (SG) 25 000 625
Subsidy element [PHP] **[USD]**		6 000 (50 % of SG and 40 % of purchase price) 250	No subsidies	indirect subsidies through lower than market interest rate or even 'zero interest financing'
Repayment Schedule	**Downpayment: (BOS) [PHP]** **[USD]**	3 000 115	5 000 125	5 000 125
	Interest rate [%]	12	12	6[71]
	Monthly payment[70] [PHP] **[USD]**	190 7.60	178 7.10	209 5.20
Market interest rate p.a. [%]		18 to 20		
Risk mitigation measures				
On behalf of NEA		▪ successful demonstration unit ▪ healthy financial situation of EC ▪ participation in customer selection through regional offices		

70 Monthly fee for O&M and repayment cost, variation due to depreciation of the Philippine Peso.
71 "Zero interest financing" (zero interest on credit) is presently under consideration.

I.III SHS Dissemination Programmes in Bolivia

The following account of the SHS dissemination programme of the Bolivian electricity utility CRE does not involve commercial funding on the end user level. The experience made with this approach represents, however, an interesting case worth analysing, it since it is an example of the utility-based SHS dissemination approach which can be increasingly used worldwide.

RURAL ELECTRIFICATION AND STATUS OF SHS DISSEMINATION

According to the last census in 1992 only 44 % of the households in Bolivia have access to electricity. There are no data available of the number of rural households without electricity. About 100 rural co-operatives operating diesel-generators or small hydropower plants provide electricity to about 30 000 rural households.

With the new electricity law of 1994 and the law about people participation, rural electrification in Bolivia gained more momentum. The regional development fund FNDR (Fondo Nacional de Desarollo Regional) is responsible for rural electrification projects.

The Rural Electric Co-operative (CRE) of the low land plains of Santa Cruz in Bolivia, with some 140 000 members, is one of the biggest private electricity utilities in Bolivia. In 1993, it had an installed capacity of 131 MW and sold 600 $GWh.yr^{-1}$.

Supported by NRECA (National Rural Electric Co-operative Association, Washington), CRE started a first field-test of 90 SHS in 1993. Since 1995, CRE increased the number of installed SHS to more than 1 400 with financial assistance of NRECA and technical assistance of the GTZ supported Project PROPER (Programa para la Difusión de Energías Renovables). Under this project only the solar panels were imported, whereas all other components came from the local market with the main components produced in the country.

Beside CRE's SHS-dissemination programme there are about 3 500 SHS which were installed by international assistance. There are local PV dealers selling SHS directly to customers. Their sales are estimated to be in the range of 1 500 to 2 000 systems per year.

Altogether, there are more than 20 000 households equipped with a SHS.[72]

SOCIO-ECONOMIC ASPECTS

In Bolivia, 3.2 million people live in rural areas representing 42.5 % of the total population. Only 32 % of these people live in villages with more than 2 000 inhabitants; the rest lives in small, dispersed villages. Basic needs like drinking water supply can not be satisfied at present.

High income disparities among the population and extreme poverty in rural areas are some of the governing socio-economic conditions in Bolivia.

Due to the limited economic resources of the rural target group for SHS, the market for PV systems is still in the initial stages. [73]

[72] /36/ Kölling (1998).
[73] Internal project documents: Rosenthal (1992); Schuberth (1996).

IMPLEMENTATION APPROACH

The NRECA/PROPER supported project of 1 300 systems was implemented by CRE based on the following approach:

- Creation of its own service department based on renewable energy technologies;
- Offer of SHS only under a rental scheme;
- Offer of two different types of SHS for residential (53 Wp) and for commercial use (2 x 53 Wp)[74] requesting different service fees;
- Extension of technical service covering the complete system, e.g. including BOS components with their technical services.

Training was given to local technicians. The staff of CRE's billing service was to collect the monthly service fee of the rented SHS. The technical service, which includes maintenance and operation services but also collection of service fees should be carried out by trained technicians, which were scheduled to attend about 200 SHS in a certain area.

FINANCIAL SCHEME PARAMETERS

Although there were customers willing to buy a SHS, CRE voted for a rental scheme. Apparently, the cost structure of the rental scheme is not monitored and therefore, not known to CRE itself, making it difficult to determine the degree of subsidies in the overall financial scheme. Since no confirmed data are available, the cost parameters have to be estimated. According to different sources, the purchase price is about 650 USD including installation and administration fees.[75]The monthly rental fee is fixed at 8.50 USD for the residential SHS, for the larger commercial system the fee is 10.30 USD. There are other financial schemes with credit components and ownership transfer applied in Bolivia. All implementing or financial institutions are faced with the problem of the weak and underdeveloped financial sector, however. Credits are generally difficult to obtain, even for small and medium enterprises due to the lack of collateral acceptable to the banks.

Private banks, in particular, only accept property situated in urban areas as a guarantee and financial institutions are not interested in helping SHS target-groups because the users are said to be not credit-worthy. [76]

There are no commercial banks in rural areas. For the main group targeted for SHS electrification this issue is even more critical. For this group, the only way to get a credit via is the informal sector (i.e. moneylenders) with extremely high interest rates and short repayment terms.

TECHNICAL ASPECTS

Field experience with SHS

An evaluation of the field test with approximately 90 SHS after 6 months revealed problems at both the technical and the institutional level. The imported deep-cycle-batteries were undersized, and a high number of them went out of operation after only half a year. Since the batteries were not properly maintained, problems with the BCU developed, causing problems with the fluorescent tube's electronic ballast and forcing some technicians or end-users to by-pass the BCU. As a consequence, fluorescent tubes had to be replaced as well after short periods of use. On the CRE level, it turned out

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[74] Commercial use of SHS in stores, small workshops etc. for lights, communication.
[75] GTZ (1998).
[76] Internal project document: Rosenthal (1992).

that the internal structure was not adequately prepared to take over responsibilities concomitant with the new task of implementing SHS. The first round of fee-collection proved difficult and, subsequently, no more collection trips were undertaken. Afterwards, a technical readjustment programme was prepared and internal organisational measures were taken in order to solve the problems.

Experience with technology transfer

As of 1994, GTZ supported in **Bolivia** the Special Energy Program (SEP) PROPER. Aware of the importance of quality assurance, the focus was on technology transfer to local manufacturers of PV components. Selected companies were given special training in the production of high-quality components accompanied by quality assurance procedures. One of these local companies was the winner of a SHS tender of the regional electric utility CRE. However, exactly at the time when quality monitoring was most needed, the process of technology transfer to this local company came to an end, resulting in a serious reduction of product quality.

These examples point out that technology transfer must not be an isolated, short-term measure, but must be seen as part of a long term strategy, carefully planned and assuring constant product quality over an extended period of time.

LESSONS LEARNED

1. PROPER was an integrated project intended to promote the use of renewable energies in rural areas in which the dissemination of SHS was an essential activity. The support of CRE's SHS programme was meant to support an innovative SHS dissemination approach in Bolivia in terms of technical and managerial aspects. Despite encountered problems, CRE's renting scheme was regarded as being an innovative and promising approach by an electric utility.

CRE's problems in setting up appropriate M&O service structure as well as with the rental fee collection is not a specific Bolivian problem but a typical one for any electricity utility entering the SHS market. The process of adapting their traditional organisational structure, not only to new target groups but also to the new challenges like technical service, tariff collection patterns, training of staff etc. requires considerable time and effort and may result in difficulties.

2. Critical issues in this approach are the lack of transparency of the cost structure within CRE in relation to both capital and operating costs, as well as in the degree of cost recovery with the service fees applied.

3. In the early stage of PROPER, the criteria for success were identified as being training, research and investigation, finance, support of private entrepreneurs and information. However, to what extent the CRE programme has been successful cannot be stated as yet.

4. The Bolivian experience strongly supports the finding of many other case studies that reliable operation of the SHS and its components is crucial to willingness to pay, irrespective of the underlying financial scheme. Quality assurance is a most crucial issue in Bolivia, too.

5. There are indications that with electricity available, the daily workload for women gets bigger. Since household work can now be postponed to the

evening hours, the daily work time in the field gets longer. Despite the belief that PV electricity supply leads to higher productivity, there is no documented evidence of this as yet.

6. There are hire purchase schemes offered in Bolivia by private PV dealers. This approach, however, is limited to an environment where the customers are well known to the dealer. After an initial down payment, the SHS credit must be paid back within a period of 24 months.

7. Although many efforts have been made to increase the awareness of target groups, financial intermediaries and PV dealers of the possibilities of SHS, after the termination of the project PROPER much remained to be done. It confirms that building up awareness is a long lasting process and often goes beyond the given time frame of a project.

8. An overall important fact is that during the duration of the CRE programme (1993 –1996) many more SHS have been implemented by private PV dealers than by the internationally supported projects. While these projects, including the CRE project installed altogether only 76 kWp (equivalent to approximately 1 000 to 1 500 SHS) about 10 000 SHS were installed by the private PV sector.[77]

[77] /36/ Kölling, GTZ (1998).

Table 6: Design parameters of the SHS Programme of CRE

Parameter		SHS dissemination approach CRE Bolivia
No. of SHS installed and duration of the programme		**> 1 400** 1993 to 1996
Technical parameters		
Rated power capacity [Wp]		50 (residential system) 100 (commercial system)
Battery capacity [Ah]		100
Type of battery		enhanced automotive
Potential use		3 fluorescent lamps (+ radio/cassette, TV, Video)
Cost structure		
Purchase price of SHS [USD]		700.00 (approximately)
Additional costs [USD] (handling, administration, installation, M&O)		50.00 (approximately)
Total cost of SHS installed and operational [USD]		750.00 (approx.)
Credit administration fees		Exact figures n. a.
Capital cost Purchase price & additional costs & credit costs		Exact figures n. a.
Financial schemes		
Financial intermediary		Utility CRE
International funding		NRECA (GTZ)
Selection procedure of recipients		Selection by CRE in the franchise area, details not available
Market interest rate		6 % p.a.
Interest rate for SHS credit		Does not apply (rental scheme)
Subsidy element		Not exact figures available, Hardware (SHS) was financed by grant of NRECA, Technical assistance by GTZ/PROPER is can be estimated to be in the range of > 50 %
Payment Schedule	Down payment	Exact terms not known, there are indications of a required down payment of approximately 20 % of the purchase price
	Monthly rental fee	8.5 USD for residential 10.3 USD for commercial (may even be higher, figures not available)

I.IV SHS Dissemination Programmes in Brazil

Another example for a utility-based SHS-programme is the case of CEMIG Brazil.

RURAL ELECTRIFICATION AND STATUS OF SHS DISSEMINATION

CEMIG is the second largest electric utility of Brazil, responsible for the electric energy supply of 98 % of the state of Minas Gears. Other private companies serve the remaining 2 %.

It is a state-owned company with a state participation of 51 % of the stocks. 98 % of the electricity-generation is based on hydropower.

With more than 250 000 km its electric distribution network is the largest of Latin America. Despite of the comparatively dense electric distribution grid, there are still almost 200 000 potential customers, mostly remote rural farms, without electricity. In remote areas, CEMIG faces load management problems in the distribution system caused by an extremely uneven load due mainly to heavy consumption in the evening hours

Based on the experience with a GTZ-assisted pilot-project with 20 SHS installed in two remote villages in 1995, CEMIG decided to spend own funds in a larger pilot-project with the implementation of 500 SHS in three different regions in the north of Minas Gerais. This is presently being implemented.

SOCIO-ECONOMIC ASPECTS

Target group for the CEMIG programme is the rural population in remote parts of the franchise area, which for economic and technical reasons are scheduled for grid connection within the next few years. For many of these potential customers, SHS are considered to be a technical and economical feasible solution at least until the connection to the conventional electric grid is economically justified.

CEMIG is considering this project as a “Pre-electrification scheme with PV“ because it intends to address the expected energy needs of many rural settlements immediately.

IMPLEMENTATION APPROACH

CEMIG applies a rental scheme. The SHS are purchased by CEMIG after international tendering on a turnkey basis with specified warranty terms (10 years on the performance of the PV-module, 1 year on the other components).

The PV-module belongs to the electric utility and will be transferred to other non-electrified customers in case the conventional electric grid reaches the site. The customers have to pay 5 USD.month^{-1} or 10 USD.month^{-1} for maintenance and repair costs into a fund, which is jointly administered by CEMIG and a local co-operative. Out of this fund, costs for replacement of components not under the CEMIG warranty scheme are to be borne.

The project is the first phase of a larger programme which is planned to be implemented until the year 1999 covering the installation of another 4 500 SHS utilising CEMIG´s own funds as well as other local government funds available from the government subsidised electrification-programme called „Luz-minas“.

INSTITUTIONAL SET UP

The SHS project is entirely managed by CEMIG, which has a widespread service structure also in remote areas. A large number of technicians work all over the country, and have a large number of vehicles and technical equipment at their disposal.

The SHS are purchased from PV dealers after competitive tendering procedure.
Basically the contract partners include CEMIG, municipalities, co-operatives, associations and end-users. CEMIG remains the owner of the Solar Generator (PV module and BCU) as it rents the Solar Generator to the Municipalities. The batteries, fluorescent lamps and installation material are owned either by the municipality or a co-operative or user-association. The end-user is responsible for the regular maintenance and has to pay only a monthly contribution to a Maintenance Fund managed by the municipality (or the responsible contract partner).

FINANCIAL SCHEME PARAMETERS

Since a purely rental scheme is applied, the user pays only a service fee, a rental fee and a fee for service, maintenance and replacement of components. The proportion paid for rental is unknown.

There are two sizes of SHS available and the fees are different accordingly. The funds for the SHS programme come from different credit and grant sources. The subsidy structure is difficult to analyse and contains cross-subsidies from CEMIG's own business as well as external subsidies. Hardware (SHS) is financed by its own funds, grants and credits of KfW and the World Bank. Technical assistance comes from GTZ.

TECHNICAL PARAMETERS

Two different types of SHS are offered, a 'simple system' with 50 Wp and a 'double system' with 100 Wp. The customers are allowed to connect 2-4 energy-saving lamps, a radio and a b/w TV-set.

LESSONS LEARNED

1. CEMIG's dissemination scheme within the "Luz-Minas" project is "centred around quality of life improvement" [78]. The project is subsidised and not a commercially oriented SHS dissemination project. As a project oriented towards improvement of living conditions it is comparable with other highly subsidised grid extension projects.

2. CEMIG is considering PV-systems as a "Pre-electrification" and not as an alternative for the extension of the conventional electric grid network. However, it is assumed that in some cases of remote customers, the PV-systems will remain perhaps as the ultimate solution.

3. Apart from the lower costs of the installation of PV-systems in comparison to grid-distribution (average cost for conventional grid connection of a rural household is approximately 3 000 USD), CEMIG applies SHS because they do not contribute to worsening of the peak-load in the evening hours, predominant in rural areas, while meeting the immediate demand for basic electrification.

4.Uncertainties in the implementation of the "Luz-Minas" PV-programme are related to:

- The correct system sizing and electricity consumption patterns of the

[78] /13/ CEMIG (1997).

end-user, who has no responsibility for the components;

- The efficient collection of the service fees in order to sustain the SHS Maintenance Fund which is directly linked to the sustainability of operation of the installed SHS;

- The willingness and ability of the concerned municipalities to guarantee a long-term local technical service infrastructure

Figure 6: Distribution of responsibilities in the SHS Project of CEMIG

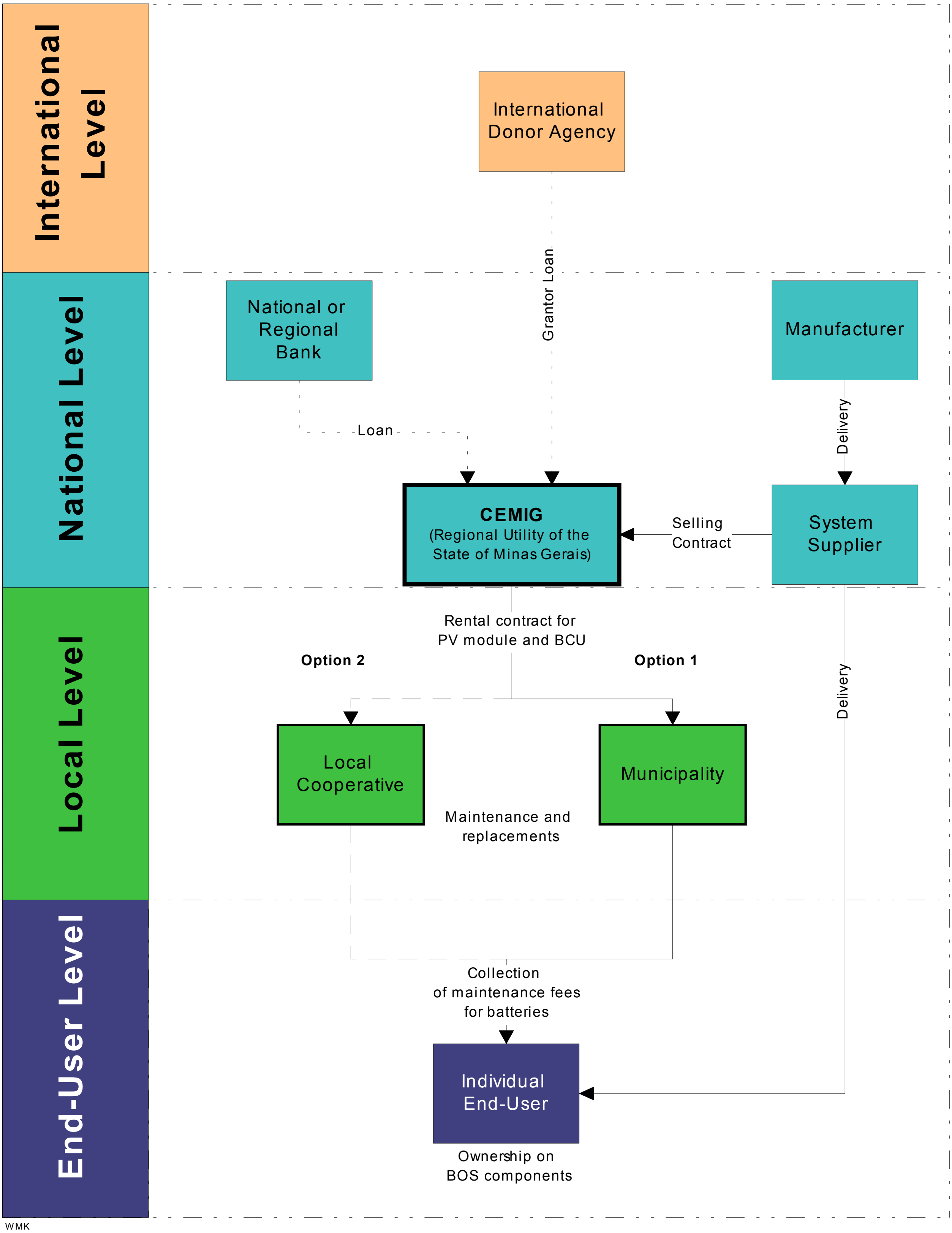


Table 7: Design parameters of the SHS Programme of CEMIG

Parameter	SHS dissemination approach CEMIG Brazil	
No. Of SHS installed and Duration of the programme	**500 (under implementation)** 1995 to 1998	
Technical parameters		
Rated power capacity [Wp]	50 (simple system)	100 (double system)
Battery capacity [Ah]	100	100
Type of battery	enhanced automotive	enhanced automotive
Potential use	2 fluorescent lamps (energy saving) (+ radio/cassette, TV, Video	4 fluorescent lamps (energy saving) (+ radio/cassette, TV, Video
Cost structure		
Purchase price of SHS USD][79]	836 (simple system)	1 368 (double system)
Additional costs [USD] (handling, administration, installation, M&O)	154	252
Total cost of SHS installed and operational [USD]	990	1 620
Administration fees [USD]	110	180
Capital cost [USD] (Purchase price & additional costs & credit costs)	1 100	1 800
Financial schemes		
Financial intermediary	Utility CEMIG	
International funding	GTZ, KfW, World Bank, BIRD and others	
Selection procedure of recipients	Determined by CEMIG in the franchise area	
Market interest rate	varied with last depreciation of the currency between 30 % to 40 %	
Interest rate for SHS credit	Does not apply	
Subsidy element	Estimates to be >30 %	
Monthly rental fee [USD]	5	10

[79] Prices in 1995.

I.V SHS Dissemination Programmes in Morocco

Morocco is one of the countries with the highest number of SHS installed. Optimal climatic conditions and a favourable rural electrification policy have lead to an established SHS market. This development was supported by numerous internationally supported PV programmes. One fact makes Morocco a very specific case: the majority of SHS are sold on cash purchase basis; special financial services for SHS are not available in the country.

The Moroccan case study reviews some aspects of the German Technical and Financial Assistance in the field of SHS dissemination. There are two main projects, which are related to each other:
Firstly, the *Special Energy Programme (SEP)* with GTZ assisting the Centre for Renewable Energy Development (CDER) since `1988. This terminated in 2000.
Secondly, starting in 1999 KfW (Kreditanstalt für Wiederaufbau) supports the national electric utility ONE with a non-reimbursable credit of approximately 6 million USD for the implementation of some 7 000 SHS as part of the rural electrification programme PERG.
Since the KfW project builds on the results of the SEP creating some innovative design elements it is worthwhile to have a closer look at both projects within the context of SHS dissemination in Morocco.

RURAL ELECTRIFICATION AND STATUS OF SHS DISSEMINATION

Through the *Special Energy Programme (SEP)* GTZ assisted CDER since 1988 in the planning and implementation of renewable energies including rural electrification projects based on SHS.

In 1994, about 400 000 consumers were served by the public utility ONE (*Office National de l'Electricité*) which operates the national grid of more than 15 000 km. However, 1.9 million rural households remain without electricity supply. The electrification rate in Morocco stands presently at only 25 %.

SHS projects in Morocco have been supported by implementing agencies mainly from Germany, France, Spain and the EC.
Since 1994 the PPER (Rural Pre-Electrification Programme), a PV project supported by the French government, has introduced different PV technologies and focused on Battery Charging Stations operated by local communities.

Morocco has a well-established and highly competitive private SHS market with a relative high number of PV dealers selling large number of SHS. In 1996, there were about 20 PV dealers offering SHS, including after sales services.

In 1995 the number of SHS installed in private households reached more than 80 000 systems. This number, however, includes the very small systems of only 11 Wp as well. The SHS in the range of 50 Wp to 100 Wp number about 15 000 systems.[80] The majority of the SHS were cash purchased.

The installed SHS capacity increased from 475 kWp in 1992 to 1.79 MWp in 1995.

[80] /37/Kublank et. al. (1997);
These figures are based on information by PV dealers in Morocco and include the very small systems of only 11 Wp as well. The number of 'typical SHS' in the range of 50 Wp to 100 Wp is about 15 000 systems.

Between 1997 and 1998 ONE completed the installation of 2 000 SHS.

Another large PV project (5 million USD) called *Photovoltaic Market Transformation Initiative* (PVMTI) financed by IFC in different countries started in 1998. It supports the private PV dealers directly.

SOCIO-ECONOMIC ASPECTS

The Moroccan Government gives high priority to rural electrification. In 1997, 1 044 villages were electrified. There are about 2 million rural households in the country of which 80 % do not have access to electricity. The majority of these households will probably not be grid-connected in the near future.

A feasibility study in a rural pilot region with an estimated potential demand for some 70 000 SHS revealed that about 50 % of the population could buy a SHS if appropriate credit facilities were provided.[81]

The yearly expenditures of rural households for conventional energy sources are about 150 USD.

IMPLEMENT-ATION APPROACH

The main component of the SEP-approach was focused on supporting the private sector, training of technicians and capacity building for technical support and after sales service structures. Given this task, SEP assisted CDER in launching pilot projects to demonstrate PV technology and quality control. This project was not trying for high numbers of PV systems installed, but concentrated more on the development, testing and improving of dissemination strategies and institutional strengthening.

The upcoming ONE-KfW project now enters the dissemination stage with 7 000 SHS to be installed. It will put much emphasis on quality control as well as on the establishment of responsive after sales service structures.

The speciality of the ONE-KfW project is the strict, and for the supplier mandatory ongoing quality tests of the system components in an internationally recognised laboratory. By imposing such a strict quality control mechanism, the technical problems with poorly designed and/or badly manufactured PV components should be avoided.

The private sector will be heavily involved; the envisaged 7 000 SHS will be installed and maintained by the private dealers/suppliers.

The ONE-KfW project will continue i SEP project, which is being phased out, considering not only the lessons learned by SEP but also those of other donor supported projects. It will provide SHS at international quality standards by trying to avoid the technical difficulties encountered in many other projects.

FINANCIAL SCHEMES

In Morocco, no SHS were financed so far by marked-priced credits from commercial banks. The reason for that is not the unwillingness of banks but the more structured problems of the banking sector. The only bank being in rural areas, *Caisse Nationale de Crédit Agricole, restricts* their credit approvals for use in the productive sector only.

In addition, potential SHS borrowers lack the necessary collateral that is required by the banks. As a consequence, they do not have access to bank credits.

[81] Internal project document: Boutaleb et.al. (1998).

The banking sector is presently in a process of re-structuring. The recent liberalisation of the interest rates might lead to some improvement in the availability of credits for PV dealers and end users.

PV dealers seem increasingly to be willing to consider leasing and rental schemes in order to improve SHS sales. However, since transaction costs as well as maintenance costs in leasing models are high and the leasing or rental fees tend to be low, no such financial schemes are presently offered by the dealers. The same considerations apply for dealer credits.

EXPERIENCE WITH ROTATING FUND (RF)

One experience with financing of SHS by a RF refers to the project SAER which project was supported by the SEP.[82]

In this project, rural credit associations founded specifically to implement SHS got a rotating fund at their disposal for initial financing of SHS for a certain number of members. Their repayments during 2 to 4 years were supposed to sustain the fund in order to finance the SHS of new members of the association. An evaluation carried out in 1995 revealed, however, that the recovery rate only reached some 50 % to 60 % which was explained by unexpectedly low earnings from agricultural production in these years. In addition to that, due to technical problems with batteries, which needed to be paid out of the rotating fund, less than the expected funds were available resulting in fewer SHS financed by the rotating fund. There are, however, also reports on misuse, lack of management and lack of proper control of funds.

LESSONS LEARNED

1. The development of SHS dissemination has accelerated tremendously. With about 3.6 MWp or 80 000 SHS installed the PV systems in Morocco can be regarded as an accepted and widely used technology for individual household electrification. There is a well-established market for SHS with a group of about 20 PV dealers serving Its needs.

There are no financial services for SHS available in Morocco; the majority of these SHS, are sold on cash purchase basis.[83]

2. The absence of financial services for SHS on one hand and the high number of cash purchased SHS on the other one, however, does not necessarily mean that SHS can be disseminated regardless of the availability of financial services. The development of the PV market in Morocco is the result of a combination of a number of factors like suitable climatic conditions, indirect subsidies (e.g. on duties), many Moroccans working in Europe and supporting their families financially and European living standards trickling down to Morocco by tourists and returning Moroccans.

All these factors contribute to the relative high degree of ability and willingness to pay in cash for a SHS.

3. It is essential to note that about 75 % (some 60 000 systems) are of the smallest size ranging from 11 Wp to 20 Wp. It is, on one hand, exactly this type of SHS being sold on cash basis. On the other hand, this type of SHS is the one often creating problems due to undersizing, poor technical design and lack of after sale services.

82 Schéma d'Approvisionnement Energétique Régional de la Province Kenitra.
83 According to interviews with PV dealers in Morocco, see /37/ Kublank et.al. (1997).

The commercialisation of typical SHS of 50 Wp and more requires some sort of credit, leasing or rental schemes provided financial services are made available. [84]

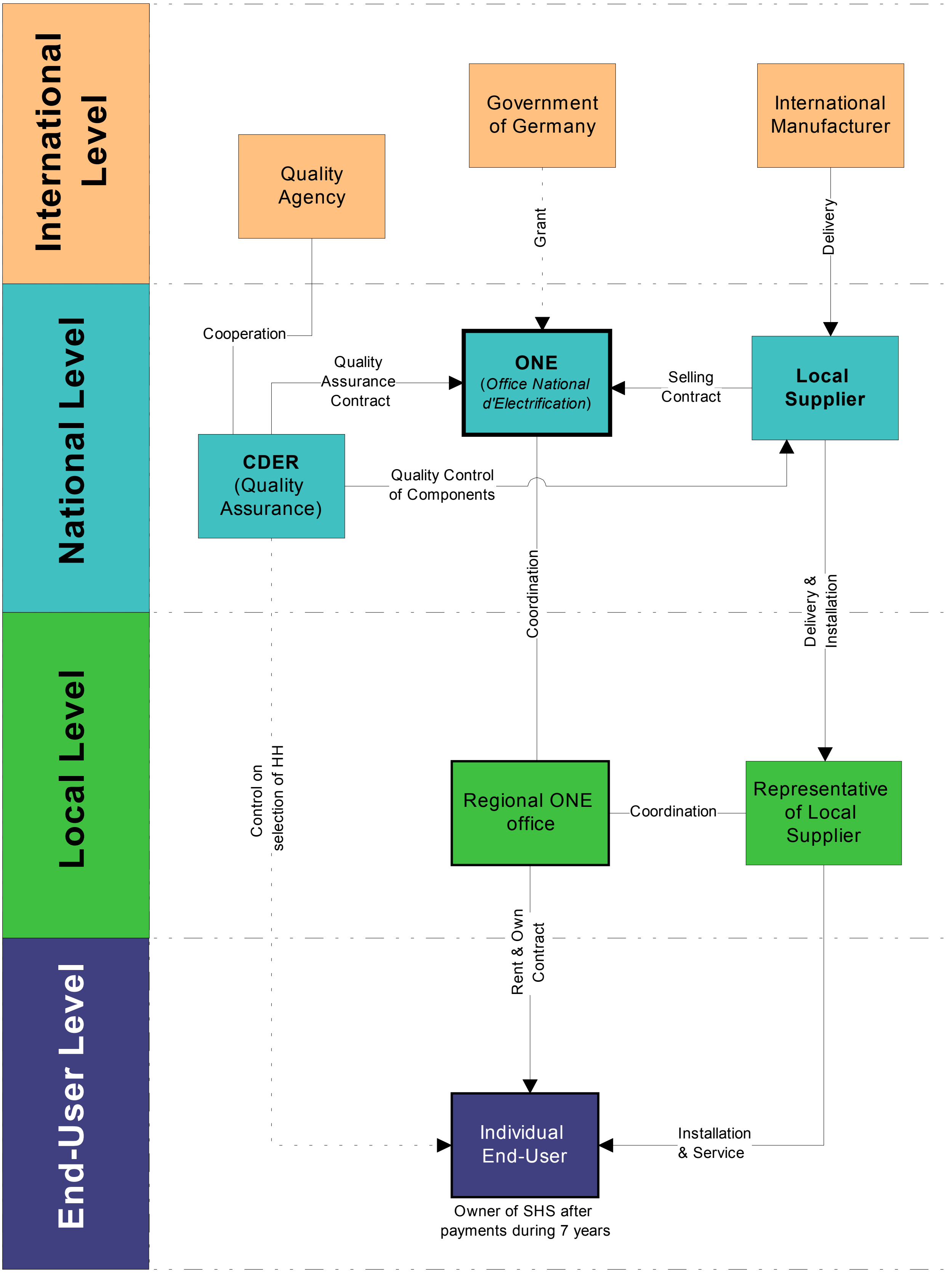
4. The analysis of subsidies in Morocco is difficult, too. Looking at the internationally supported projects, the SHS installed under these programmes are subsidised to different degrees, ranging from technical assistance to indirect subsidies on taxes and duties to direct subsidies financing pilot projects completely.

At present, the degree of subsidies given by utilities may well reach more than 50 % being borne by cross subsidies or other sources like soft loans.

5. The new ONE programme considers the experience with SHS made to date in Morocco. 2 000 SHS are already installed under this programme. The concrete measures on quality assurance and concept of creating responsive after sales service structures reflects the lessons learned from PV programmes already executed in Morocco, like the SEP and others.

[84] Different financing schemes will probably be introduced under the PVMTI Programme Morocco as well by the KfW - financed SHS programme under PERG.

Figure 7: Responsibilities in the SHS project ONE-KFW, Morocco



I.VI SHS Dissemination Programmes in Namibia

The case of Namibia is presented since the SHS programme implemented in that country is based on some lessons learned from other SHS programmes and takes new directions in the fields of information campaigns, quality assurance and consumer satisfaction. The programme, however, contains subsidy elements like most of the SHS programmes worldwide.

RURAL ELECTRIFICATION AND STATUS OF SHS DISSEMINATION

Most of the 1.6 million inhabitants or 245 000 households in Namibia are situated in rural areas. Only 9 % of them are connected to the national electricity grid. Despite the high priority rural electrification receives under the National Development Plan of the Namibian Government, financial constraints most probably will not allow it to reach an electrification rate of higher than 25 % within the next 10 years.

In 1993, a programme called “Promotion of the Use of Renewable Energy Sources in Namibia” was launched by the Ministry of Mines and Energy with support of GTZ to improve the energy supply in rural areas. Among other project components, the use of solar energy for individual households (SHS) was envisaged to replace traditional energy sources.

In 1996, a SHS dissemination programme called ***Home Power!*** was launched. During the pilot phase of this programme, 96 SHS have been installed in 5 regions. Based on the encouraging results of the pilot phase in 1996/97, a second phase was launched with the objective of establishing a local SHS market to extend the programme activities to other regions. [85]

Beside the *Home Power!* programme, there are apparently furniture shops offering SHS. These seem to be of doubtful quality.[86]

SOCIO-ECONOMIC AND ECOLOGICAL ASPECTS

Rural electrification is one measure to improve socio-economic living conditions of the rural population. The reduction of pollution, health risks, deforestation and desertification are desired side effects of the programme. Traditional energy sources of the non-electrified rural households are fuel wood, kerosene, candles and paraffin. Dry cells are commonly used for radio/cassette players and flashlights.

IMPLEMENTATION APPROACH

Since no basic data on SHS dissemination were available, a pilot phase with approximately 100 installed SHS provided the background information for the design of the implementation approach. Drawing from GTZ experience with SHS dissemination programmes, the approach is based on the assumption that “local availability of skilled manpower together with a well established solar business sector as well as private ownership independent from any direct government subsidies are crucial issues for the sustainable dissemination of SHS in rural areas.”[87]

Subsequently, there are mainly three elements constituting the Namibian implementation approach:

- ***Awareness programme***
- ***Training programme (for installation and maintenance)***
- ***Financial scheme***

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[85] Internal project document: Müller; Siepker 1998 (2)
[86] Internal project document: Wamukonya (1998).
[87] Internal project document: Müller; Siepker 1998 (1).

The target group is limited to creditworthy people who can afford the down payment and monthly payments for a SHS.

FINANCIAL SCHEME PARAMETERS

SHS financing within this programme is based on a credit scheme administered by the National Development Corporation (NDC).

The credit is provided by the ***Peri-Urban and Rural Solar Electrification Revolving Fund*** which was established by the Ministry of Mines and Energy and jointly fed by national and regional funds and donor contributions of US-AID and NORAD. The total contributions to the Fund amounted in March 1998 to approximately 4 million NAD (715 000 USD) of which a small portion (150 000 NAD) is being used for a credit guarantee fund.[88]

Interest earned on investing part of the Revolving Fund in the local capital market will sustain a Contingency Fund, which then is used to finance the aftersales service during the one-year guarantee period of the SHS.

Successful applicants have to make a down payment of 20 % of the purchase price of a SHS which is approximately 5 000 NAD (892 USD) for the 50 Wp system and 10 600 NAD (1 700 USD) for the 100 Wp system including all fees for handling, administration, transport, installation and, an insurance over 5 years.[89]

80 % is given as a credit with 5 % annual interest rate and to be paid back over a maximum period of 5 years. Monthly payments depending on the repayment schedule vary between 70 NAD (12.50 USD) and 250 NAD (45 USD).[90] In order to consider the specific financial situation and income patterns of the customers, the debt service can be made in monthly, quarterly or, annual instalments.

INSTITUTIONAL SET UP

NDC with its regional offices is the central financial and administrative intermediary promoting the credit programme, processing and approving the credit applications.

Four Authorised PV dealers deliver the SHS while trained technicians install the systems at site.

TECHNICAL ASPECTS

An interesting element of the approach is the combined offer of SHS and LPG cooking systems aimed at compensating one of the main disadvantages of a SHS: its limited power generating capacity, which is not sufficient for thermal applications like cooking and ironing.

Consequently, the *Home Power! Programme* offers a PV-LPG system covering the most urgent energy needs of rural households.

The potential customer can choose different types of equipment (5 Wp Solar Lantern, 50 Wp and 100 Wp SHS, two types of LPG cooking stoves) as well as different modes of repaying the credit. In order to better suit the customer’s needs it is intended to offer a 20 Wp system as well.

The relatively low number of systems installed and the short operation time

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88 Internal project document: Müller, Siepker (1998/1).
89 Insurance covers damages resulting from Acts of God only.
90 Internal project document: Wamukonya (1998).

to date do not allow for a technical appraisal of the installed systems.

There are, however, obviously considerable efforts in providing high quality SHS components. The quality of SHS installed under the Home Power! Programme seems to be better in comparison to the ones supplied by some furniture shops.[91]

LEGAL ASPECTS

The customer physically owns the SHS from the beginning with NDC, however, reserving property rights until the credit is repaid. Up to now, there is a surprisingly high repayment rate of 100 %.[92]

Therefore, no SHS has been claimed with credits in arrears; enforcement strategies by NDC are not known.

FINANCIAL SUSTAINABILITY OF THE REVOLVING FUND

Although, the programme claims not to require any direct government subsidies, a closer look at the financial scheme and the funding mechanism reveals that the future of the Revolving Fund will most probably be critical and may well be in urgent need of some form of subsidies.

With only 5 % interest rate for the SHS credit and about 13 % to 15 % inflation rate, the purchasing power of the Revolving Fund will be half in about 7 to 8 years. Since commercial market rates are in the range of some 20 %, the average credit (5 %, 5 years) of about 4 000 NAD (715 USD) for the 50 Wp system contains a subsidy element of approximately 31 %. [93]Additionally, it is very doubtful that the claimed administration fee of 10 % of the credit amount is sufficient to ensure Operational Self-sufficiency of the Revolving Fund after 3 to 7 years, (which is commonly established as a benchmark for sustainability). There are also considerations going on to subsidise transport cost, which are very high. Summarising, subsidies on different levels can be estimated to reach 30 % to 40 %.

LESSONS LEARNED

1. The *Home Power! Programme* tries to avoid errors and pitfalls of other SHS programmes by addressing critical issues like the training of technicians, comprehensive information of potential customers, ensuring high quality components and offering an affordable and flexible financial scheme.

2. A detailed evaluation of the 1-year-pilot phase of the programme showed a surprising high recovery rate of 100 % indicating the high satisfaction of the majority of the participating customers.

3. This evaluation also confirmed that private ownership and the successful development of a SHS market with a responsive service structure would be essential for the sustainable SHS dissemination in Namibia. The private PV sector must be more involved in the programme allowing them to build up a SHS clientele to serve the growing market.

4. There is still lack of information and/or ignorance on the side of the customers concerning the limitations of a SHS.

5. There is also a lack of knowledge of the programme and the credit scheme offered and how to access the scheme.

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[91] dto.

[92] Internal project document: Müller, Siepker, 1998 (2).

[93] This calculation considers compensation of inflation only; in real terms the subsidies are even higher.

6. The term structure of the credit scheme is attractive from the customer's perspective. There exist, however, doubts about the sustainability of the Revolving Fund.

7. The Programme shows conformity with the financial sector using the existing financial institutions and structures thus avoiding the establishment of parallel structures. It excludes, however the less wealthy customers.

Table 8: Design parameters of the SHS Programme Home Power! Namibia

Parameter	SHS dissemination approach Home Power! Programme	
No. of SHS installed	171	
Duration of the programme	1996/97 (first phase) since 1998 (second phase, ongoing)	
Technical parameters		
Type of system	**small system**	**large system**
Rated power capacity [Wp]	50	100
Battery capacity [Ah]	100	100
Type of battery	lead acid (no further information)	
Potential use	4 fluorescent lamps (+ radio/cassette, TV, Video)	8 fluorescent lamps (+ radio/cassette, TV, Video)
Cost structure		
Total cost of SHS installed and operational[94] [NAD] [USD]	5 000 890	10 600 1 700
Administration fee (included in total cost) [USD]	89 (10 %)	170 (10 %)
Installation cost (included in total cost) [USD]	130	200
Financial schemes		
Financial intermediary	National Development Corporation (NDC) managing Revolving Fund	
International funding	GTZ, NORAD, REFAD-US-AID	
Subsidy element	at least 35 % (estimated)	
Interest rate and payback period	5 %, 5 years	
Monthly instalment [NAD] [USD]	70 to 252 12 to 45	243 43
Appraisal of credit-worthiness of customers	employment, annual income, age, credit track record,	

[94] Prices from 1998, included are 10 % costs for handling, administration, installation, M&O.

I.VII SHS Dissemination Programmes in Lesotho

The case study evaluates two recent approaches in implementing market oriented SHS dissemination strategies in Lesotho. The first one – SELS, a special SHS credit programme intended to be established within the formal rural finance sector – was stopped over concerns regarding sustainability before it actually took off.
A recent development of hire purchase schemes seems to be more promising. This development, based on a commercial approach driven by so-called furniture shops, is not subsidised and has the potential to be widely applied in neighbouring countries in the Southern African Region.[95] There is not a high number of SHS sold commercially, making the Lesotho case an interesting one, but the dissemination approach represents a well-known marketing concept in Southern Africa. This makes it worthwhile to have a closer look at the mechanism.
Interestingly, similar experience is reported from Sri Lanka, where a chain of commercial shops (sewing machine shops = ”Singer” shops) entered the SHS business.

RURAL ELECTRIFICATION AND STATUS OF SHS DISSEMINATION

In 1993 only approx. 9 000 of the total of 375 000 households (2.4 %) were grid-connected, 200 of them in rural areas. Over 80 % of the population (equivalent to 300 000 households) live in rural areas, resulting in a rural grid-connection rate of 0.07 %. These figures indicate a significant theoretical potential market for SHS, although, a market study was never undertaken.

According to the documentation there are about 4 000 SHS installed in Lesotho.[96] The PV market is mainly served by three private local PV-dealers and by imported do-it-your-self-kits from the Republic of South Africa.

SOCIO-ECONOMIC ASPECTS

Target group for SHS is 110 000 rural households in the middle income segment representing 36 % of the rural population. Only 6 % of this group are in the position to pay cash; the remaining households are in need of Hire purchase facilities.

64 % of rural households, however, cannot afford the cost for a SHS. They cannot access commercial lending. Even highly subsidised dissemination approaches of international donors will not be viable because the majority of the poorer population is not able to bear the long run operating and maintenance costs.

The biggest challenge for a sustainable dissemination approach for SHS in Lesotho is certainly how to meet the financial requirements of those 30 % of rural households with a comparatively low income but a strong demand for SHS. For them, the price of a PV-system is between half a years salary (teacher, nurse etc.) and two years income (peasant farmer). In spite of their relative low incomes, precluding cash sales, a SHS is highly desirable amenity for this group if credit services are available.

People are well aware that the costs of traditional energy sources (e.g. kerosene, candles) may be higher than that of financing a SHS. People in Lesotho – and this applies to other Southern African countries like Zimbabwe as well – show a considerable degree of discipline in repaying consumer credits based on hire purchase schemes. If poor quality

[95] There are reports on hire purchase schemes to be used for SHS financing in Kenya, see: /24/ Gregory et.al. 1997
[96] This high number of SHS may lead to the impression that SHS in Lesotho has experienced a large dissemination. However, the Lesotho programmes are not mentioned in international studies on SHS dissemination.

components do not effect the operation of the SHS, a high willingness to pay for SHS can be expected.

IMPLEMENTATION APPROACHES

In the middle of the 1990s a special credit programme for SHS (Solar Energy Credit Scheme - SELS) was designed. The objective of this dissemination initiative was to facilitate access to SHS for the low-income rural population using the Lesotho Agricultural Development Bank (LADB) as a financial intermediary. This programme was supported by Technical Assistance provided by GTZ. Details on the design parameters of the financial model are given in the table below.

Before the project took off, however, in 1996 the overall economic situation of LADB had deteriorated to such an extent that the Ministry of Finance ordered a re-organisation and re-structuring of the Bank. As a result, the LADB was no longer a candidate for a partnership in implementing special financial facilities for SHS. Discussions with other potential partners such as commercial banks revealed that they are not interested in providing loans to finance SHS, firstly because they do not have an adequate network in rural areas, and secondly, because they are not prepared to bear the risk of making long-term consumption credits to rural households.

Only the Lesotho Bank expressed some interest in setting up a special credit programme, a prerequisite being a credit guarantee fund at least partly subsidised by international donors.

Credit unions or informal savings and credit associations were identified as other possible partners but for several reasons they could not qualify for an active role in financial intermediation.

An alternative and market-oriented approach in disseminating SHS comes from the established commercial sector e.g. furniture shops and consumer electronic outlets, which increasingly serve as market channels for the existing PV dealers in Lesotho.

A number of these dealers have a close network of outlets and offer durable consumer goods either for cash or on hire purchase basis. Credit is advanced if real security and regular income are evident. Products are sold on hire purchase plans where the end-user makes a down payment followed by monthly instalments.

In spite of high interest rates, in Lesotho as well as in other Southern African countries, hire purchase plans seem to be a highly accepted financial arrangement.

INSTITUTIONAL SET UP

The institutional set up of this promising market-oriented dissemination approach reflects the developed commercial structure in rural and semi-urban Lesotho, shows an interesting distribution of responsibilities among the involved players and represents an example of appropriate incentives for win-win options in SHS dissemination.

It must be noted, however, that some crucial issues for sustainable dissemination may not adequately be addressed by the hire purchase scheme applied. Do the incentives and shares of responsibility of the different players create the responsive commercial structure required for a sustainable ”SHS- culture?”

WIN-WIN OPTIONS IN AN INCENTIVE-COMPATIBLE ENVIRONMENT

→ ***PV DEALERS***

- sell SHS to furniture shops
- advise them in handling and technical specifications;
- install and maintain SHS on customer’s or furniture shop’s request
- provide spare parts and replacements
- provide a ½ year guarantee period

→ ***FURNITURE SHOPS & ELECTRONIC SHOPS***

- offer SHS like any other durable consumer good to customers on cash or hire purchase basis
- receive repayment (delivered and not collected) by the customers
- enforce payment or repossess SHS in case of customers’ default
- claim life insurance of customers if required

→ ***COMMERCIAL BANKS***

- refinance the furniture shop’s operation by wholesale credits

→ **LIFE INSURANCE COMPANIES**

- offer their service to the furniture shops enabling them to mitigate the default risk (e.g. death of customer)
- offer life insurance to SHS customers

→ **CUSTOMERS**

- take advantage of affordable hire-purchase schemes provided by well established intermediaries (commercial shops)
- conclude life insurance contract and transfer it to the furniture shop as collateral

FINANCIAL ASPECTS

The design parameters and repayment schedules of the two presented financing schemes are summarised in the Table below.

Credit approach (SELS)

Apart from the reservation of proprietary rights in favour of the financing institution (LADB), it was planned to secure the credit by a guarantee fund. The client, however, would not have been informed about the existence and functioning of this guarantee fund.

This arrangement was meant to help prevent moral hazard, i.e. customers defaulting and banks not pursuing repayment based on the existence of a guarantee scheme.

However, the envisaged procedures for credit approval, for guarantee as well as for the recovery of outstanding instalments was in no way responsive the requirements of SHS customers. These procedures originated from LADB’s unsuitable standard procedures, which contributed finally to the collapse of the Bank. Summarising, the envisaged financial model SELS was in danger of failing from the very beginning.

Hire Purchase Scheme

A hire purchase plan is a consumer credit with a downpayment of 20 % - 30 % and a credit component, which is to be repaid by a maximum of 24 monthly instalments. The advantage for the customer is to know from the very beginning the overall cost of the SHS including the cost for financial service. In the past, a hire purchase scheme tended to be 50 % to 100 % more expensive than a cash purchase.

Presently, the overall cost for the acquisition of a consumer good through a hire purchase scheme including SHS is 20 % to 80 % above the cash price, which usually is known to the customer. This credit conditions are competitive compared with usual bank credit conditions in Lesotho.

TECHNICAL ASPECTS

Technical parameters

The SHS offered in Lesotho differ mainly in their capacity ranging from very small systems of only 20 Wp for the operation of a lamp and a radio to the more typical systems of some 50 Wp suitable for fluorescent lamps, radio and a small b/w TV.

Quality Aspects

Problems with poor quality SHS are known in Lesotho. Experience from earlier dissemination programmes reveals deficient dissemination due to

- *Technical problems*
- *Insufficient training*
- *Financial problems*
- *Lack of information*

There are reports about very small and low quality SHS with capacities of only 12 Wp to 14 Wp sold as being capable of powering lights, colour TV and radio. The resulting operational problems and the danger to the image of PV-technology caused SESSA (Solar Society of Southern Africa) to publish a notice to furniture shops warning them not to market these doubtful SHS.[97]

As a result, the marketing efforts of the three national PV dealers were heavily affected by these low quality SHS imported from South Africa.

LEGAL ASPECTS

Ownership of SHS

The user physically possesses the SHS but the financial institution (in case of hire purchase schemes the furniture shops) reserves ownership of the SHS until the credit is completely paid back.

There is, however, no legal basis for the recovery of the SHS once a customer is not able or willing to repay his credit. Therefore, risk mitigation measures of the furniture shops include requesting detailed information not only about the economic situation of a customer but

97 Information leaflet from SESSA directed to furniture stores in Lesotho, Nov. 1997.

also about his social and family environment etc. in order to be able to put economic and social pressure on a customer whose credit is in arrears.

Recovery of an SHS

The physical recovery of a SHS or components once it is installed, however, is not an easy task. There is no reliable information available about this practise and the results. In the SELS concept the recovery of a SHS would have required a court order and the assistance of the local police. It would also have needed the basic technical skills of a technician. Even if components could be recovered it remains doubtful whether the resale value would compensate for the outstanding instalments.

LESSONS LEARNED

Weak performance of a formal financial intermediary

From the failure of the planned SELS in Lesotho the GTZ drew the following conclusions**:**

- *Rather than developing SHS-specific financial schemes it would be preferable to integrate SHS financing into existing market-based mechanisms such as hire purchase schemes.*
- *Potential PV dealers and shop owners should be encouraged to invest in SHSs.*
- *GTZ should restrict its role to supporting the development of management capabilities, monitoring instruments, quality control and training facilities*.

Commercial approach by semi-formal financial intermediaries

Established commercial structures offering hire purchase plans may be an alternative option for the dissemination of SHSs in Lesotho because the dealers are able to interact with the customer, resulting in low transaction costs and short and attractive credit terms.

However, commercial distribution strategies and financial schemes such as hire purchase plans are not free of criticism.

As mentioned above, unscrupulous retailers may offer low quality and low priced SHSs to unsuspecting end-users. Due to careless technical design and use of poor quality components, system failures will most probably result after a short period of operation. Hence, the behaviour of these retailers results in end-user dissatisfaction, poor credit recovery and projects an overall negative image of PV technology.

Marketing practices of dishonest manufacturers and wholesalers serve as a warning to dealers not to sell low quality SHSs on hire purchase because severe problems in collecting instalments will occur after a few months.

Such experiences in Lesotho confirm the necessity of internationally recognised quality standards and control mechanisms for market based approaches.

Lack of consistent electrification policy

There is no consistent policy on the part of the responsible government organisations on how to exploit the development potential that PV technology offers for rural electrification. As consequence, there are reports that there was no systematic follow up on already completed executed demonstration projects, which generated requests for SHS.

<u>Lack of quality, technical standards</u>

The impact of poor quality SHS components on user satisfaction is widely known among donor agencies. However, this knowledge is not always and/or not sufficiently being transferred into dissemination strategies.

In non-subsidised hire purchase schemes like practised in Lesotho, the consequences of poor quality and technical failures are felt immediately by dealers and retailers involved. There are no quality standards in Lesotho, resulting in clear field for low priced and poor quality solar systems.

Table 9: Design parameters of intended Credit Finance Scheme and existing Hire Purchase Schemes in Lesotho[1]

Parameter	**SHS dissemination approach**				
	Solar Energy Loan Scheme (SELS) of LADB (planned but not implemented)			**Hire Purchase Scheme (e.g. Furniture Shops)**	
Technical parameters					
Type of SHS	Type A (PV-SRL-A)	Type B (PV-SRL-B)	Type C (PV-SHS-C)	Different types and sizes Available	
Potential Use	1 fluorescent lamp + Radio/ Cassette	2 fluorescent lamps + Radio/ Cassette	3 fluorescent lamps + Radio/ Cassette + TV + Video	Similar to SHS type B	
Cost structure					
(1) Cash price[98] of SHS [LSL][99] (USD)	1 300/ (221)	2 500,-- (425)	4 300 (731)	2 400 (408)	
(2)Handling fee [LSL] (USD)	25 (4.25)	50 (8.5)	75 (12.75)	None	None
(3) Additional costs [LSL], (USD)	Depending on cost of handling, transport, installation (figures not n.a.)			(handling, transport, installation) 650 (110)	
(4) Total cost for SHS installed, operational [LSL], (USD)	Cash price (1) handling fee (2) additional costs (3)			3 050 (518)	
(5) Credit administration fees [LSL], (USD)	Interests & administration fee (figures not n.a.)			650 (110)	1 380 (235)
(6) Capital cost (total initial investment cost) [LSL], (USD)	Total cost (4) & credit administration fees (5)			3 700 (628)	4 430 (753)

[98] Prices: 1996.
[99] Exchange rates (June 1998): 1.00 LSL (Maloti) = 0.28 DEM = 0.17 USD.

<table>
<tr><th colspan="4">Financing scheme</th></tr>
<tr><td>Financial intermediary</td><td>LADB</td><td colspan="2">Dealer (furniture & electronic shops, PV-dealer)</td></tr>
<tr><td>Credit Appraisal procedure</td><td>1. Pre-selection by LADB's loan department
2. Final decision by SELS-Loan-Committee</td><td colspan="2">Dealer (furniture & electronic shops, PV-dealer)</td></tr>
<tr><td>Commodity Interest rate (1996)</td><td>17 % p.a. over 36 months</td><td colspan="2">33 % p.a. over max. 24 months</td></tr>
<tr><td>Subsidy element[100]</td><td>= difference between market and commodity interest rate</td><td colspan="2">No subsidies</td></tr>
<tr><td rowspan="2">Payment Schedule</td><td rowspan="2">Downpayment of 25 %, 75 % in 36 monthly instalments to 17 % interest</td><td>12- months schemes</td><td>24- months scheme</td></tr>
<tr><td>Downpayment 20 %; remaining 80 % in 11 monthly instalments</td><td>Downpayment 20 %; remaining 80 % in 23 monthly instalments</td></tr>
<tr><td>Difference between cash purchase and credit finance</td><td>+ 25 % to 30 %</td><td>+ 18 % (w/o Installation)
35 % (with installation)</td><td>+ 45 % (w/o Installation)
54 % (with installation)</td></tr>
<tr><th colspan="4">Risk mitigation measures</th></tr>
<tr><td>Guarantee</td><td>Reservation of ownership by LADB or Authorised Dealer</td><td colspan="2">Reservation of ownership by dealer for technical faults, life insurance of the borrower</td></tr>
<tr><td>Late payment fee</td><td>1 % p.m.</td><td colspan="2">n. a.</td></tr>
<tr><td>Cancellation of Credit agreement</td><td>After 3 consecutive months of non-payment LADB announces cancellation of credit agreement if due amount is not paid within 15 days. After this delay LADB demands immediate repayment of outstanding instalments.</td><td colspan="2">No legal standard procedure; legal vacuum since there is no hire purchase law,
▪ Informal measures, black list for defaulting customers,
▪ Social pressure based on information in credit application</td></tr>
<tr><td>Collateral enforcement</td><td>Repossession of SHS by „Court Order“ (if necessary with police assistance); authorised Dealer supposed to be obliged to re-purchase SHS, compensation of outstanding amounts by guarantee fund</td><td colspan="2">Recovery of SHS by dealer and resale of components,
if possible: legal measures to recover outstanding instalments</td></tr>
</table>

[100] Estimate, subsidy difficult to quantify.

II. SHS Programmes in other Countries

II.I Mexico

A government programme on rural electrification through PV systems started in the early 1990s. Financed by the National Solidarity Programme, more than 24 000 x 50 W_p-SHS were installed up to 1996. The programme is based on the government's commitment to "improving the quality of life of the less privileged population". The Federal government is providing 50 % of the total project cost, while State Governments contribute 30 %. The remaining 20 % comes from a combined effort between the Local Government and the end-user. The national utility CFE is involved in the technical design, training and monitoring. Experience shows that despite the strong involvement of the technical departments of the utility, problems with the technical quality of system components jeopardised the sustainability of the installations.

II.II China

A new project on the installation of 200 000 SHS of the Chinese Government is under consideration to be co-financed by World Bank/GEF. Using a "market-driven approach" for implementation in rural areas of four provinces, it is aimed to catalyse development of commercial companies that will offer customers high quality products and effective sales and service arrangements, as well as affordable payment mechanisms.
As an important project component it is planned to establish technical standards for PV systems and components and to strengthen a National Solar PV Testing and Certification Centre following present international trends and efforts directed towards quality assurance.

II.III Vietnam

Since 1994, with the financial and technical support of Rockefeller Brothers Fund (RBF) through the Solar Electric Light Fund (SELF), the Vietnam Women's Union (VWU) has been implementing the project "Solar electrification supporting women in remote areas". The project's focus is on SHS dissemination. As of 1998, 340 systems have been installed in 5 communities. The equipment was completely supplied by SELF, the Union carried out distribution, while the Institute of Energy (the national utility's research institute) and SOLARLAB (a semi-commercial research department) provided technical support and training.

The hardware costs, i.e. total on-site costs excluding administration, training and other costs, are borne by the end user on a credit basis. The financial services are predicated on:

- 20 % down payment of hardware costs;
- Repayment of credit in monthly or quarterly instalments over 3-4 years;
- Users organised in groups of 10-30 members with each group head responsible for credit collection;
- Establishment of a revolving fund for purchase of additional systems.

In February 1998, VWU signed an agreement with the Solar Electric Light Company (the international holding of SELF) for the "National Solar Project for Women and People without Access to the National Grid". The project planned to install 4 000 SHS in 1998 and another 8 000 in 1999.

III. Selected Examples for Credit Programmes and International PV Initiatives

III.I Agreements between Commercial Banks and SHS Sales/ Service Centres

In **India**, the US-based non-profit organisation Solar Electric Light Fund (SELF) has created a commercial company called Solar Electric Light Company (SELCO). This company sells, installs and maintains solar home systems through a network of five service centres in the southern states of Karnataka and Andhra Pradesh. SELCO has entered into a partnership agreement with the Syndicate Bank in India that provides credits. The credit scheme is comprised of a down payment of 54 USD and monthly instalments of 11 USD over 48 months. The crucial factor that seems to make this mechanism work is the fact that SELCO provides a special guarantee on the SHS. Every person who purchases a SHS (and borrows money from the Syndicate Bank) can stop paying his monthly instalments and return it to the bank's branch office if the system doesn't work. In this case, SELCO would cover the credit.

III.II Consumer Credit Programmes organised by SHS Providers

Sudimara in **Indonesia**

The Indonesian government started a programme called Banpres to install 3 000 solar systems through village co-operatives in 1979. By 1992, the programme was completed and the Dutch manufacturer withdrew from the market. However, the former managing director of the Dutch manufacturer established his own company, Sudimara, which purchases solar modules from Italy and assembles them into solar home systems in Indonesia.
Sudimara sells SHS through a network of 50 service centres that provide marketing, installation, maintenance services and credit. About 10 %-15 % of Sudimara's sales are in cash; the rest is purchased through various credit schemes that cover periods between one and four years, one credit plan for example requires a 110 USD down payment and monthly instalments of 12 USD over four years. By October 1995, Sudimara had a total of 5 000 outstanding credits amounting to 1.4 million USD.

Soluz in the **Dominican Republic**

In the mid-eighties, an American engineer and six Dominican partners founded a SHS equipment business called Industria Eléctrica Bella Vista (IEBV). In June 1993, a new leasing company called Soluz was created as a US-based commercial affiliate of IEBV, whose start-up capital was partially provided by the Rockefeller Foundation. The rationale for leasing was to make SHS more affordable for low-income families by eliminating the down payment. Since Soluz started its operations in 1994, it installed 750 SHS in 40 communities that are served by IEBV. The monthly payment is 20 USD for a 50-watt-system and less for smaller systems (average monthly income is 110 USD). Soluz applies an interesting methodology to handle the small financial transactions. In order to provide SHS under a leasing contract, a minimum number of families per community must register. When there is a sufficient number of families on the waiting list, Soluz delivers the SHS and sets up a collection point for payments. Each household signs its own contract with Soluz and makes the monthly instalments at the local collection point. If there is a problem with the system, the families can leave a message at the collection point.

IV. Examples for International PV Initiatives

In the three cases of ***India, Indonesia and the Dominican Republic*** access to refunding facilities was a serious obstacle to expansion of financial operations.
Therefore, intelligent second-tier financial mechanisms need to be in place to stimulate commercial banks to provide direct credits to SHS purchasers or to wholesalers that will onlend these funds. The following ideas throw some light on how these second-tier mechanisms could work:

The former president of the US-based United Power Systems promotes a solar-finance initiative called **SolarBank**. The basic idea is to convert millions of small retail credits into aggregate blocks of debt securities that can be financed in capital markets. In other words, financial institutions will sell their portfolio of small solar credits to the Solar Bank, which uses these credits as collateral for a security (securitisation).
The benefits are the following: First, the financial institution that sells its portfolio gets instant cash and continues to receive a considerable administration fee for the portfolio it just sold. Second, these financial institutions can increase their leverage as securitisation allows them to add portfolio to their books without raising their equity. Third, since securitisation operations involve a very large scale (25 million USD transactions for the SolarBank would still be small) this can contribute to lowering interest rates. Though securitisation involves a lot of risks and pitfalls (transaction size, foreign exchange risk, political risk, up-front costs etc.), it might be an interesting option to improve refunding conditions for institutions that provide SHS finance.

The **Dutch Investment Bank Triodos** provides funds to SHS credit retailers such as solar-service companies, financial institutions and village co-operatives. After having started with two pilot credits in Uganda (52 000 USD) and Swaziland (390 000 USD), Triodos created a Solar Investment Fund in 1996 that handles 10 solar credit funds in Africa, Asia and Latin America.

Solar Development Capital (SDC): The World Bank Group and several charitable foundations initiated the Solar Development program. Management is carried out by Triodos PV Partners, formed by Triodos Bank Group, Environmental Enterprises, and Global Transition Consulting. Solar Development Capital does engage in direct financing of the final customer but invests in PV businesses in developing countries. SDC endeavours to achieve capital appreciation for its shareholders and to create model businesses able to attract outside financing for future expansion. SDC provides debt and equity to companies involved in distribution, consumer financing, leasing, manufacturing, or other aspects related to accelerated PV use in rural areas. Some senior debt may be placed with micro-credit institutions. Equity investments will be structured so the entrepreneur retains majority ownership. SDC's initial capitalisation was around 29 million USD but that, once self-sustainability is demonstrated, it could be handling much more PV financing per year." [101]

Photovoltaic Market Transformation Initiative (PVMTI):
Implemented by the International Finance Corporation (IFC) this programme started in 1997 and aims "to significantly accelerate the commercialisation, market penetration and financial viability of PV technology in the developing world".
It is based on the premise that private sector project design and management will stimulate more sustainable ventures than government or donor financed PV procurements alone. During the implementation phase, a total of 25 million USD of the GEF funds are available for direct investment by IFC in India (15 million USD), Kenya and Morocco (5 million USD each). Additional IFC co-investment is under consideration. Leverage achieved with the GEF funds is expected to result in total investments of around 100 million USD. "In terms of market

[101] IT Power (1997).

development, PVMTI is anticipated to increase the number of PV household systems from approximately 80 000 per year to over 125 000 per year".

The majority of funds will be 'invested as concessional debt in corporate entities aiming to execute ambitious, innovative business plans in the PV sector.' Potential investee companies will be selected based on a solicitation procedure. Participating companies are required to co-finance the PVMTI investment, they also have to submit proposals of financial models to be applied. The disbursement schedule of funds will individually be agreed between the respective Investee Company and the IFC according to the presented business plan.

PVMTI claims to aim 'at near commercial investments of financing that will assist in market development and overcome barriers to PV dissemination'.[102] Suggestions are to make 5 % to 10 % of the funds available as grants, e.g. for training, quality control and certification. If carefully allocated, these indirect subsidies may reasonably contribute to building up the necessary infrastructures and management capacities in the participating countries.

Finally, efforts were made in the late eighties with the **FINESSE** programme that was initiated in 1989 by the World Bank. In various countries of South East Asia market studies identified not only a big market but also proposed projects in order to push market-driven developments (including a credit of about 295 million USD to NEA). After several years of basic adjustments it was not until 1998 that the FINESSE programme started to move in the Philippines. This modified programme is assisting the Development Bank of the Philippines (DBP) during the next three years and will offer specific training programmes to DBP officers as well as upgrade an already existing credit scheme of DBP for renewable energy projects ("Windows III"). FINESSE activities were subsequently undertaken in southern Africa.

[102] IMPAX/IT Power (1998).

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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.