Report IEA PVPS T9-01:2002

Financing Mechanisms for Solar Home Systems in Developing Countries

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.

Focused 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.

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.

Report IEA PVPS T9-02:2003

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

Part 1

Executive Summary

Small Solar Home Systems (SHS) using photovoltaic (PV) technology offer one of the first and most appropriate opportunities for many households in rural and remote communities of developing countries to gain access to simple electrical energy services (basic lighting, radio, TV, etc.). However, the high capital cost of PV systems, coupled to social, cultural and financial variations within and between different locations, has created the need for a range of new and innovative implementation models in order to make SHS energy services more widely accessible to such communities.

This Recommended Practice Guide attempts to describe, simply and concisely, a variety of implementation models, and is intended to serve as a tool for SHS energy services delivery decision making.

The Guide consists of two parts:

- Part 1 (this document) is a summary of three generic implementation approaches that have been used in developing countries to support energy services delivery based on SHS.
- Part 2 is a stand-alone document, which presents Case Studies of the various implementation models from a series of real project experiences. This includes overviews of the key issues and lessons learnt in each case.

Within Part 1, three broad approaches are considered: direct sales; credit sales; to a fee-for-service. Credit Sales are further sub-divided as indicated below. The report provides a general description of each model, and discusses the applicability or conditions under which such a model might be appropriate. The key stakeholders and their respective roles/responsibilities are identified in each case, as well as the associated advantages and disadvantages and risks. Critically, the Guide also attempts to identify the key factors that govern the success or failure of the various models.

A summary of considerations – key questions that policy makers and project designers need to consider during the decision-making process - is provided to assist with selection of an appropriate SHS implementation model.

Summary of Models

Model 1, Cash Sales: A PV system is sold directly or via a dealer to the end-user. This is perhaps the ‘cleanest’ arrangement, with ownership, and generally also maintenance responsibilities, transferring immediately to the end-user. It is, however, limited by the purchasing power of the end user, so is likely to have limited accessibility and/or necessitate smaller/cheaper systems.

Model 2, Credit Sales: The end-user acquires the PV system on credit, addressing the initial investment barrier that affects Cash Sales and enabling more widespread accessibility to SHS. Credit sales are divided into three categories:

- **2A Dealer Credit**, the PV supplier/dealer sells the PV system to the end-user over an extended period, the user enters into a credit arrangement with the dealer. Depending on the arrangements, the end-user immediately becomes the owner of the system, or becomes the owner when all payments are made. This model has broad applicability and can be effectively operated by the commercial sector alone. However, it is reliant on the development of a sustainable credit facilities and the credit management skills of PV businesses, which may be limited.

- **2B End-user Credit**, the PV supplier/dealer sells the PV system to the end-user, who obtains consumer credit from a third party credit institution. Usually the end-user becomes the owner of the system immediately, but this can be delayed until all payments are made. The PV system can be used as collateral against the loan. The model relies on credit institutions that may be better positioned to manage finance than PV businesses. However, such institutions do not always exist, and may have more stringent credit review processes; while stricter credit control may improve the sustainability it may also limit accessibility.

- **2C Lease / Hire purchase**, the PV supplier/dealer or a financial intermediary leases the PV system to the end-user: At the end of the lease period, ownership may or may not be transferred to the end-user, depending on the arrangements. During the lease period, the lessor remains owner of the system and is responsible for its maintenance and repair. There is limited experience of and scope for this model, requiring a strong commitment and sound business plan for the PV company providing the credit. However, it has potential for more widespread accessibility due to opportunity for longer repayment periods and smaller initial payments.

Model 3, Fee for service: An energy service company (ESCO) owns the system, and provides an energy service to the end-user, who pays a periodic fee (e.g. monthly) to the ESCO. The end-user is not responsible for the maintenance of the system and never becomes the owner. This has the potential for greatest accessibility. However it poses a high risk for the energy service company, requiring their long-term commitment and strong financial backing.

Implementation Model Selection Considerations

While the Guide describes a number of generic implementation models, local conditions are likely to demand a degree of tailoring or combinations of elements from the various approaches. A sound understanding of the locality and its energy market are fundamental to the choice of model and the prospects for successful PV SHS implementation. Key issues that need to be carefully considered are:

1. What is the status of the energy sector in the country, and what are the policies relating to non-electrified areas and to electrification and development?
2. Who are the end-users? What are their electricity (and energy service) needs and expectations? What is their economic activity and source of income (farming, livestock, services, craft)?
3. What are the competing/conventional practices to cover domestic energy needs and what is the household expenditure for it?
4. How can the end-users be reached? Who are the stakeholders?
5. What is the potential for productive use of electricity?

The Guide delves deeper into these issues and provides a series of questions intended to give direction to policy makers and project designers in their deliberations over implementation model selection.

Table 1: Summary of success factors for each implementation model

MODEL	Cash Sales	Dealer credit	End-user credit	Hire purchase	Fee-for-service
Clear advice to end-users on system limitations	●	●	●	●	●
Good installation and proper manuals	●	●	●	●	●
Good maintenance and after-sales structure	●	●	●	●	●
Evaluation of creditworthiness		●	●	●	
Clear arrangement of payment and penalties		●	●	●	●
Clear boundaries of ownership		●	●	●	●
Able to issue penalties		●	●	●	●
Payment designed to fit income cycle of client		●	●	●	
Warranty period must equal or exceed the contract period		●	●	●	●
Sound financial institute with rural outlets			●		
Relatively stable country/economy					●
Sparsely populated areas	●				
Government policy					●
Existence of rural credit		●	●	●	
Access to capital		●		●	●

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

Part 2

Executive Summary

This document is the second part of a Recommended Practice Guide that outlines various models for the implementation of small domestic photovoltaic (PV) systems (Solar Home Systems, or SHS) in developing countries. The Guide, which has been developed by PVSDC (Photovoltaic Services for Developing Countries of the International Energy Agency's PV Power Systems Programme), is intended to serve as a tool for SHS energy services delivery decision making.

PV SHS offer one of the first and most appropriate opportunities for many households in rural and remote communities of developing countries to gain access to simple electrical energy services (basic lighting, radio, TV, etc.). However, the high capital cost of PV systems, coupled to social, cultural and financial variations within and between different locations, has created the need for a range of new and innovative implementation models in order to make SHS energy services more widely accessible to such communities.

Part 1 of the Guide summarises a number of generic implementation models and describes the conditions under which each model might be appropriate. The key stakeholders and their respective roles/responsibilities are identified in each case, as well as the associated advantages and disadvantages and risks. The key factors that govern the success or failure of the various models are also highlighted.

Part 2 presents a series of Case Studies of the various implementation models in use in the field, based on real project experiences. This includes overviews of the key issues and lessons learnt in each case. Note though that the case studies are not a critical evaluation of the implementation models, but seek to give the reader an idea of the realities of using the models in practice.

8 Case studies are presented, all but one of which describe more than one implementation model:

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

SELCO Solar Lanka Limited, Sri Lanka

In Sri Lanka, over 50 % of the 18 million population do not have access to the electricity grid. To help achieve the vision of 75% electrification by 2007, the Sri Lankan government is promoting sustainable market-based provision of rural energy services. This includes initiatives to develop commercial sales models for Solar Home Systems (SHS).

SELCO Solar Lanka Limited (SSL), a subsidiary of Solar Electric Light Company, sells, installs, services and helps to finance solar PV lighting and power systems in rural Sri Lanka. SSL has two sales models: cash or credit, the latter in partnership with the micro-finance agency SEEDS (Sarvodaya Economic Enterprise Development Services). Under the World Bank Energy Services Delivery Project, a grant of 100 USD is available to buy-down the cost to the end-user. About 5% of rural households can afford to pay the remaining 300-350 USD in cash for an SHS; the credit facility extends the SHS opportunity to a further 45% of the rural population, who make equal repayments over a term of 1 to 5 years for their system.

SSL uses village demonstrations to raise general awareness of the systems, with door-to-door approaches to reinforce the message and build closer links to the customers. SEEDS trains SSL’s marketing officers to be better able to identify credit-worthy customers. Reliability and quality are key features of the sales agreement, with customers guaranteed four free service calls within 24 hours in the first year and three in the second year. Installation is undertaken by SSL technicians who also train the customers as to how to use their system. The customer is also given a user manual, and a clear explanation of what to expect of the system.

The repayment rate is high, on average over 90 %. SEEDS undertakes loan collections. The approach of field officers visiting the customers’ homes rather than requiring the customer to visit the bank is found to be very effective.

Solar Energy Supplies, Zimbabwe

Around 95% of rural Zimbabweans, who account for 65% of the total population, have no electricity. Solar Energy Supplies (SES) sells standard 3, 4, 5 and 6 light PV SHS kits to customers in these areas for cash or on credit. The PV systems are available in credit stores, directly from the producer’s shop and from other solar suppliers. Demonstrations in villages have proven to be very effective advertising measures. The credit store network provides around 120 branches nation-wide, each covering a radius of about 100 km.

Learning from problems encountered with early cash sales, the SES standard kits are now pre-engineered packages that include the lights, complete with switches, wiring, a charge regulator, a battery and a solar module. The module size depends on whether or not the customer wishes to run a monochrome TV. This ensures a correctly sized and engineered system, with all wires of adequate cross section and length. Different high quality plug-in connectors for the positive and negative terminals are used to remove potential for mistakes with polarity and to ensure reliable connections. Warranties are given on the balance of system components (five years), on the module (usually 10 to 20 years) and on the battery (one year). This product focus is felt by the company to be sufficient to enable them to transfer installation, operation and maintenance responsibilities entirely to the end-user. An illustrated manual is supplied with each kit, detailing both installation and maintenance procedures. The kits and manual have been refined to account for feedback from customers to make the instructions and processes as foolproof as possible.

The 4 light system costs around 300 USD cash, depending on the module supplied. The credit arrangement requires 25% downpayment, followed by equal monthly payments over 6 to 24 months. Interest is at the commercial bank rate, currently around 30%. Around 70% of the systems are sold on credit, and 30% for cash. In the event of a problem, the owner contacts the retailer who in turn contacts the supplier, if necessary. SES believes that as with every other commercial product, the selling points for SHS are cost and performance.

PT. Sudimara, Indonesia

From 1993 to 1998, PT. Sudimara installed SHSs on a hire purchase and cash sale basis in the Indonesian provinces of Middle-Java, West Java, Lampung and Jambi. The economic crisis that hit Indonesia in 1997 and 1998 coupled with the government's pretence to electrify rural villages by putting up electrification poles (which they took back after the elections), destroyed the SHS market and forced the company to stop operations. Prior to this, however, some useful lessons and experience were gained.

The company had 5 regional offices, and 65 branches, each branch having three to four employees. 50 % of the 260 staff were in sales, 20 % in technology development, 20 % in manufacturing, and 10% in administration. Technicians undertook installation and user training and also monthly visits to collect payment. There was a maximum of about 250 systems per technician. Repayment rates were around 90-95%, with people generally willing to honour payment as long as the system worked. System and component quality was identified as critical for avoiding user abuse and premature system failure. One drawback was that complaints were dealt with in an ad hoc manner because technicians did not have the skills to perform a solid diagnosis. A better, more user-friendly design of the systems and better technician training are seen as solutions to these problems.

Additionally, as the business expanded, credit management became problematic and time-consuming. The company also experienced cash-flow problems as a result, while the banks were unwilling to offer business development loans due to lack of acceptable collateral.

Mambruk Energy International, Indonesia

Mambruk also offer SHS in Indonesia on cash or credit via its franchised Sales and Service Centres (S&SC). These centres are based in small regional cities and are obliged to open service points or appoint sales agents in the rural areas. Installation is generally undertaken by the technician of the S&SC, or by the service point technician; all must pass a training course.

A number of marketing approaches are used, dependent upon the area / ethnic sensitivities. This includes newspapers, radio, village demonstrations and billboards.

Standard contracts are used for cash as well as hire-purchase sales. Initial credit evaluation is undertaken by the S&SC staff who complete a credit request form for pre-screened applicants that is sent for final approval by the credit manager at the head-office. In some regions, a government credit assurance organisation decides credit-worthiness.

In every case Mambruk provides a warranty and customer training. The end-users are jointly responsible with the S&SC technicians for operation and maintenance, with technicians undertaking regular maintenance visits every second month for the first three years. In the event of failure during this period, the S&SC, which has full complement of spare parts, rectifies the problem. Service thereafter may be offered by the service points. End-users are asked to maintain the system and not to attach other batteries or loads, though there is no written regulation to this effect.

Modules (10 year warranty) and charge-controllers are imported. All other components are manufactured locally and have a one-year warranty. The cash price (2001) is around $320. On credit terms, 25% down payment is required, with the balance payable over 30 months at 12.2 USD/month, with ownership transferring to the customer after the final payment.

Solar Home Systems, Swaziland

In 1997, a Solar Home Systems scheme was established in Swaziland, with the opportunity for SHS to be bought through cash sales or leasing. A loan from Triodos Bank initially established the customer credit-line, and a loan from the World Bank provided general market development support. It is estimated that 1-2% of all rural households are reached through this approach, restricted to the wealthier population.

A wide variety of promotional measures are used, with radio, newspaper adverts and professional sales advice reportedly the most effective for generating sales. Word of mouth is also important. Initially the project had just one central outlet, but subsequently this was extended to a network of rural hardware stores. Despite training and provision of promotional material, the use of general hardware stores was not successful – SHS sales were found to require well trained staff that could inform customers of the SHS benefits and limitations.

An arrangement was initially made with a local bank for payment collection for lease systems, but this also proved problematic; the bank did not provide the company with customer payment details, customers did not like to go to the bank, and repayment discipline deteriorated, particularly due to failing batteries after approximately 2 years operation. People do not always have the money to replace the battery instantly and often have to wait for some time before they have saved enough for replacement. If this happens with a system sold on leasing terms, this may result in non-payment. This and other socio-economic factors are cited as reasons for limiting the SHS financing period to no longer than two years.

Soluz Honduras

Soluz Honduras provides PV sales and services to rural customers in one of the poorest countries in Central America. Almost 70% of PV systems supplied are provided on a fee-for-service basis, the remainder sold for cash or on credit.

The fee-for-service approach allows Soluz to provide SHS electricity at affordable monthly prices, ranging from USD 10 to USD 20 per month. This is equivalent to typical costs of kerosene, dry cell batteries, and the re-charging of car batteries for TV usage. The service arrangement includes a guaranteed service response within a specified time. The customer is responsible for simple maintenance tasks such as adding distilled water to the battery. Service calls occur in the event of failure; visits are not made for preventative maintenance. The company owns all components, except for the battery, which the customer must purchase. When the battery reaches the end of its life, the customer purchases a new one, typically from Soluz Honduras on a payment plan.

Payments are made at rural collection points - normally an existing country store – to agents contracted by the company. Soluz zone managers, who are typically responsible for 250 to 1000 customers, in turn collect the payments from the collection points. Collection rates for the service scheme are essentially 100%. Non-payment results in the rapid removal of the system.

Ongoing staff training is provided, and periodic quality reviews are made of installation quality and customer satisfaction using standardised quality checklists.

Sunlight Power Maroc, Morocco

In Morocco, the Rural Electrification General Programme (PERG) is targeting provision of power to some 1500 rural villages each year to 2006. Some 200,000 households will be electrified with SHSs; the Moroccan State Utility, ONE, co-operates with the private sector and subsidises the investment cost of the SHS, particularly to offer PV electricity on a fee-for-service approach.

Sunlight Power Maroc supplies a range of systems of varying module and battery capacities to meet the various lighting and audio-visual service needs of its customers; between 2 and 10 lamps plus a TV outlet can be catered for. SPM's core business – accounting for approximately 80% of its clients – is off-grid solar-based electricity on a fee-for-service plan. The company has a permanent presence in the medium-sized rural towns of Taza, Sefrou and Taounate, in north-eastern Morocco, as well as regular presence at rural markets (souks), which allows it to meet and offer continuous technical support and follow-up to its customers. The souks are central to the business, allowing sales staff to build a relationship with customers and gauge their intention to meet the payment schedule over a longer period. They are also where most payments are made. No contracts are signed on the first meeting. Additionally, two instalments must be made before installation will be undertaken.

Installation is done by SPM's trained technicians on an agreed date. Instructions on operation and simple maintenance responsibilities and a manual are then handed over to the household. The customer commits to allow technicians to undertake periodic maintenance visits and six monthly inspections. The company is responsible for maintenance and replacements of components, except for tubes and fuses and customer damage, which have to be replaced by the customer, and generally aims to complete remedial work within 48 hours of notification. Technicians must log all service calls, and there is a rigorous reporting and controlling system, particularly focusing on follow-up and customer satisfaction.

One problem remains the difficulty to raise capital in the traditional finance sector, which has required the company to refer to private capital.

Gansu PV Company, China

The Gansu PV Company has been manufacturing, installing and servicing solar home systems of up to 120 W and small 6 W portable solar lighting systems in the Gansu province of western China since 1994. About 1 000 systems are sold for cash each year, with half of the system price paid in advance, and the remainder on satisfactory installation. The small lighting systems cost around 12 USD, including 5-year service fee.

An earlier attempt to provide systems on credit failed because the community had no concept of credit facilities and so did not feel obliged to meet repayments. Subsequently a trade-up exchange facility has been introduced to allow customers to increase the size of their system if their demand increases and they have sufficient savings.

The company's 100 strong staff undertake regular training every three months to allow them to sell, install and service the systems. They also provide user training. Each branch has a motorbike, which allows the sales staff to increase their installation rate to 30 systems per month, compared to perhaps 3 per month otherwise.

Warranties are passed on to the customer, though customers still have to pay some of the costs (proportional to the expired warranty term) if replacements are needed within the warranty period.

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PV for Rural Electrification in Developing Countries – A Guide to Capacity Building Requirements

Scope and Objectives

This document identifies capacity building measures that should be undertaken as an integral component of a PV based rural electrification implementation programme. It addresses issues relating to capacity building within the following sectors and groups:

- Government Bodies (Ministries responsible for Agriculture, Education, Energy, Environment, Finance, Health, Industry, Public Works, Water).
- Utility Sector.
- Financial Community.
- NGOs.
- Service Delivery Chain.
- End-users.

Many of the measures outlined could be adapted to any other off-grid or dispersed renewable energy technology. However, as the mandate of IEA PVPS Task 9 is to consider only photovoltaics, other technologies are not explicitly addressed.

The objective of this document is to provide guidance to those project developers who are interested in implementing or improving support programmes for the deployment of photovoltaic systems for rural electrification. In particular it is targeted at bilateral donor agencies, at international, national and regional financing organisations, development agencies and project developers.

Executive Summary

Capacity building relates to the development of an organisation's (or individual's) knowledge, skills and capabilities to better enable them to successfully perform their work and improve their effectiveness. This often implies simple awareness raising, but can also include the creation of an enabling environment through appropriate policy and legal frameworks, institutional and human resources development and strengthening of managerial systems. These are usually achieved through ongoing provision of technical support activities, training, specific technical assistance and resource networking.

PV and other renewable energy technologies have wide ranging potential for meeting basic domestic electricity needs, as well as for supporting improved services across the health, education, agriculture and commercial sectors, particularly in the context of rural development of developing countries. Extending PV energy solutions to support rural development involves many stakeholder organisations, and yet many enabling and implementing agencies do not have adequate knowledge, skills or resources to successfully manage or deliver the intended programmes. The cross-sectoral relevance of PV energy services is particularly poorly understood.

This Recommended Practice Guide (RPG) considers the typical capacity requirements of key agencies and organisations involved in PV based rural development projects and programmes. The Guide identifies a variety of specific capacity building measures that may be needed within these stakeholder groups to ensure more effective and sustainable PV energy services delivery, at the same time emphasising that capacity building needs to be considered from a holistic programme view to achieve maximum benefits with often limited resources.

The justification for the costs of capacity building in PV has been demonstrated in a number of PV projects, where training has had a direct impact on the sustainability of a project and on future programmes. The costs for capacity building can be as little as a few percent of the project budget, but may determine whether the project is a success or not.

Assessing the Need for Capacity Building

Clearly, decisions about capacity building requirements can only be made in the context of the existing skills and knowledge base and in view of an understanding of the needs and opportunity for PV within the local development priorities. This demands an appreciation that capacity building should ideally strengthen and integrate with existing infrastructure, rather than imposing entirely new initiatives and procedures.

A general capacity building programme therefore begins with an attempt to understand sectoral and cross-sectoral issues, and how PV may support these priorities. From here, an appraisal of the existing knowledge base and working practices within the stakeholder organisations is possible and shortfalls in knowledge, skills and supporting tools can be identified. Training programmes and additional resourcing measures should then be developed, tailoring these to a format that will be familiar and best acceptable to the stakeholders. The 'final' stage is implementation – delivery of the identified capacity strengthening measures, though this requires a long-term ongoing view and a degree of flexibility to adapt or extend capacity building measures to integrate field experience gained during the project or programme.

Specific Capacity Building Needs

Successful programme delivery will be dependent upon the preparation, planning, management and delivery strengths of several organisations potentially including a number of government ministries, through the utility and finance sectors, to NGOs and the service delivery chain (suppliers, installers and maintainers). Overall, the ongoing success of the initiative also depends on the successful engagement of the end-users. The Guide identifies a wide range of capacity building needs and measures that may be required to add to or enhance existing knowledge and skills of each of these stakeholder groups. These are broadly summarised in Table (i).

Table i: Summary of capacity building measures for the main target groups.

	Rural electrification policy development and contribution of energy to sector	Fiscal policy impacts	Awareness raising, promotional and educational activities	Evaluation and choice of technology options	Resource assessments	Technical advisory services	Financial and least cost analysis	Co-ordination	Impact assessments	Business plan development	Development of quality standards.
Ministry of Energy	●	●	●	●	●	●	●	●	●		
Ministry of Education	●		●	●			●	●			
Ministry of Health	●		●	●			●	●			
Ministry of Water/Agriculture	●		●	●			●	●			
Ministry of (Rural) Development	●		●				●	●			
Ministry of Public works			●	●			●	●			
Ministry of Environment	●		●		●		●	●	●		
Ministry of Trade and Industry	●	●	●	●						●	●
Office for Small Business			●	●						●	●
Ministry of Finance	●	●	●								
Financiers & Lending Institutions			●				●			●	●
Training Organisations			●								●
NGOs			●							●	
Utilities	●		●	●	●	●	●			●	
Service Delivery Chain			●	●	●	●	●			●	

Government Ministries

The multi-sectoral relevance of PV energy services is still not widely known within critical government departments and will generally require an awareness campaign to familiarise staff to the various applications of PV and how they can assist in meeting sectoral priorities. Strengthening may also be required to enable staff to make appropriate comparative costing decisions, for instance on the basis of life-cycle costs.

Synergies can often be found between ministries, which implies there are likely to be benefits from inter-departmental knowledge sharing and coordination of programmes, as well as from resource networking. Energy technology awareness need not be a core skills requirement for each department, but should be accessible by all relevant departments, possibly via an external agency. Common skills, knowledge and tools that would be required and which may need to be addressed through specific training, seminars or workshops or appropriately targeted factsheets, booklets or manuals include:

- Cross-sectoral opportunities and requirement for energy, particularly for health education and water provision;
- Value and role of electricity services for rural community development, including, for example, income generation;
- Energy use surveys and life-cycle costing of energy services;
- Socio-economic and environmental impact assessments of energy options;
- Understanding of PV cost structures, including impact of local taxes, tariffs and duties;
- Awareness of (project or program) the financing sources and models for supporting PV energy services dissemination;
- Understanding of existing local PV sector capacity (including private sector businesses and NGOs);
- Awareness of system/components together with implications of component, installation and service quality;
- Ability to undertake community-focused promotional and educational activities

Additional specific capacity building measures may be needed within relevant departments, particularly in relation to integrating opportunities for PV and other renewable energy technologies within ministerial policies and understanding how policy decisions can positively or adversely affect the sustainability of PV energy services delivery.

Utility Sector

Despite ongoing deregulation and privatisation of the electricity sector in many countries, electricity and the supply of energy are still generally viewed by consumers as a “community service” and the rural electrification policies of the government are often implemented by the utility sector. Utilities continue to have a critical role to play in the viability and sustainability of off-grid PV-based rural electrification. If the electricity utility does not understand that PV can be a viable technology for meeting rural electricity needs, it can - perhaps inadvertently - undermine any initiative to introduce PV based systems into rural areas, even though there may be no firm plans to extend the grid to those areas.

Capacity building activities that may be required for the utility sector, include:

- General awareness raising seminars on the various applications of PV systems and situations where PV might be an appropriate alternative to grid extension;
- Technical training courses for engineers and technicians to provide an appreciation of the potential and limitations of PV;
- Support to allow true life-cycle cost analyses of alternatives for rural community electricity supply and to increase familiarity with energy expenditure and energy needs of rural people;
- Training in socio-economic and environmental impact assessments;
- Information and skills to allow investigation of alternative off-grid business models for supplying basic electricity services to remote communities, together with business and possibly sales and marketing training if appropriate;
- Stronger awareness of energy provision in the context of government rural development strategy and the sectoral priorities in health, education, water and agriculture.

Financial Community

Engaging the finance sector in PV energy services delivery for rural development is critical, both in terms of assisting end-user purchase through credit and savings facilities, and for supporting business and project development.
In relation to the end-users, a variety of financiers including smaller rural banks and cooperatives could potentially facilitate PV system purchases, though this may be outside their core business / lending focus. Such micro-finance has inherent risks, but a number of international experiences do exist to demonstrate that small-scale PV lending can be successful if appropriately structured, particularly in view of the opportunities for social and economic development.

Capacity building requirements for the finance sector again includes targeted seminars, workshops and specific training to improve general awareness both of the demand and potential down-stream benefits of PV for rural households and communities. International experience on alternative finance models, risk mitigation and changes in customer energy expenditure as well as information on national rural development priorities will also be extremely relevant.

From the business and project development perspective, capacity strengthening would tend to involve working closely with the local PV industry and relevant government bodies, again with the primary objective of understanding and being able to mitigate lending risks. This would include general education on PV business operations, capital demands and cash flows, together with demonstration of existing profitable business models based on similar experiences overseas. Training would be required to enable financial institutions to evaluate PV business proposals, and in particular to understand the implications of quality standards on the sustainability of the proposals.

Non Governmental Organisations

NGOs often have an intimate knowledge of local community needs, activities, social and financial structures, as well as strong community standing. They can therefore be pivotal for information and technology dissemination, installation, service and rural financing.
Aside from general awareness raising on the various applications of PV systems and improving understanding how PV can be used to help with income generation activities within a community, specific capacity building measures for the NGO sector might include:

- Training on how to identify the energy needs of the local population
- Technical training courses for engineers and technicians to design and plan projects for the communities in which they are working.
- Training on the operation and maintenance requirements for PV and how to advise end-users on the limitations of their systems and basic maintenance requirements.
- Providing material and training staff to enable them to give seminars in the communities on the potential of PV in meeting some of the community needs.

Service Delivery Chain

A critical failing in many previous PV rural electrification programmes has been a focus of the programme planners on delivering hardware without adequate provision for long-term support. Such long-term support generally requires some private sector business involvement, implicit in which is a viable local market to sustain that business.
The service delivery chain refers to:

- Manufacturers/assemblers of equipment and/or companies importing the required products.
- Engineers/technicians who can design systems based on equipment that is easy to obtain locally and which meet international or national standards.
- Sales staff that can explain the systems to potential end-users.
- Technicians who can install and maintain systems.
- Entrepreneurs that can create new businesses to service this market and who have the skills to ensure the business is viable and sustainable.

These stakeholders, once alerted to the PV opportunity, may require a variety of general business management and specific technical PV training. Business management skills, such as materials sourcing, quality assurance, stores management and logistics, customer management, business planning, and accessing finance may be addressed in existing business training schools and will only require small modifications to suit the PV sector.

More specific training – including system design, installation and maintenance, end-user training and operation of PV-relevant business models such as energy service companies, may require development of new courses based on international experiences, to be delivered through existing training centres.

The establishment of an industry association, drawing from international experience as well as adaptation of similar local structures where they exist, may be appropriate in order to better co-ordinate broad industry interests and possibly deliver or oversee long-term training and accreditation for the industry.

End Users

End-user preparation and training has been found to be a factor in PV service satisfaction levels; familiarising customers with appropriate applications of PV and, of at least equal importance, its limitations are fundamental to programme success. This would typically include a range of broad awareness raising activities by village groups, NGOs, PV service businesses or government, to address:

- energy expenditure and likely changes with the introduction of PV;
- the importance and long-term cost implications of quality PV products, installation and maintenance;
- energy management and energy efficient appliances;
- ongoing costs such as the replacement of batteries and other components;
- ownership responsibilities / conditions of service

Training by the installation company or system supplier on system operation and simple user maintenance procedures to ensure the system continues to operate satisfactorily is also essential.

Training Organisations

Embedding PV sector training within the mainstream education and training sector will be a longer-term ambition to ensure ongoing local development of a vibrant and competent industry. In this respect, the ministry of education has an important role to ensure that training centres and universities are adequately resourced to accommodate PV training needs. At the same time, the training courses themselves can only be sustainable if training leads to employment (i.e. if there is a sustainable PV market). The PV industry and training community therefore have a common interest to see appropriate training courses develop.

As in other capacity building areas, the capabilities of existing training organisations first need to be assessed, to identify opportunities for including PV within existing vocational training and to decide what additional skills the trainers themselves may require.

Specific capacity building measures for the education and skills sector include:

- Training to survey current and future training requirements for the PV industry (if it exists) within that country;
- Training to study additional teaching resource needs (both staff and equipment) to meet the needs of the industry;
- Information on the skills requirements for the PV industry, in order to develop appropriate training programmes for technical personnel within the industry;
- Information on the benefits of independent accreditation of training providers and training courses.

This last point will stimulate the quality systems approach that underpins sustainable PV sector development. Training of technicians should ideally be undertaken by a nationally or internationally accredited institution that has been audited by a third party. This not only ensures that technicians are trained to a high standard by a qualified institute, but helps to ensure that systems are installed to a high standard, thereby addressing several key sustainability concerns of donor agencies, governments and other stakeholders.

IEA PVPS Report T9-04:2003

The Role of Quality Management, Hardware Certification and Accredited Training in PV Programmes in Developing Countries

Executive Summary

With the increased emphasis on the role of electricity in rural development and poverty alleviation, it is very important that future PV-based rural electrification programmes are seen to bring real benefits to rural communities in developing countries. Many previous projects have not met with the degree of success they might have because of a lack of quality at some point in the delivery chain. This lack of quality has been seen at all levels in the implementation process – be it a lack of competent personnel within an implementing agency, a lack of well trained installation and maintenance technicians or poor hardware quality.

By imposing a quality remit on an implementation programme, the likelihood of a project's success can be substantially enhanced. It is generally acknowledged that recognised standards lead to increased quality of a given product. However, the issue of quality assurance goes beyond compliance with technical standards. In order for a PV implementation programme to be successful, it needs to be designed with quality assurance in mind throughout the implementation process, not just when hardware is procured. Programme design, selection of equipment and supplier, checking compliance of systems/components, installation and commissioning, ongoing maintenance, and training of personnel at various levels should all be subject to appropriate quality control.

For a PV implementation programme, or indeed any rural electrification programme, there are three important areas of quality control:

- quality management – which covers the operational procedures of the organisations involved – from PV system installers and hardware suppliers to technical consultants, financiers and service providers.
- technical standards – compliance with technical standards provides a degree of assurance that components and systems meet agreed performance criteria
- quality of training – ensures that system design, installation, commissioning and maintenance personnel have been trained to an agreed level of competence.

A requirement that recognised levels of quality are maintained in each of these three areas will help to ensure the success of a programme. Furthermore, the use of quality management systems, certified components and practitioners and accredited training programmes is of direct benefit to all the stakeholders in a rural electrification programme. This benefit primarily arises from the improved reliability and performance of the PV system and in particular the reduced maintenance requirements and costs, though there are additional benefits from the creation of local, sustainable jobs.

Quality Management Systems

A quality management system (QMS) relates to an organisation's operating procedures. In itself, it is no guarantee of high-quality products or services, but it does provide a strong documented framework against which operational performance and processes can be monitored, measured, reviewed and improved.

In general, a quality management system involves:

- documenting working procedures (e.g. a Quality Manual) and ensuring that these are understood by everyone involved, from senior management to new employees;
- establishing a system for documenting development efforts, work procedures, work performed, testing, modifications, customer feedback, etc.;
- regular reviews and evaluation of critical aspects of the organisation and the quality management system itself (internal audits);
- using results of reviews and customer feedback, and a commitment to staff training to improve the quality of the organisation's work.

Implementing a QMS demands the active involvement of all staff, initially to clarify or confirm existing working practices that will form the backbone of the documented procedures, and eventually to implement any new policies, procedures and documentation practices that may be identified. Crucially, the QMS development and implementation process requires a ‘champion’ with appropriate skills and level of authority to take responsibility for driving the process.

Organisations may chose to have their QMS certified by an external auditor to add further credibility.

Hardware Quality

One of the most effective ways of reducing technical risk is through the use of nationally or internationally recognised standards. The use of PV modules certified to international standards IEC 61215/61646 is increasingly commonplace. At the same time, the lack of such standards on balance-of-system components - batteries, charge controllers, inverters etc. - makes their specification and selection more problematic. There are a number of activities underway to address this deficiency, through IEC Technical Committee 82 and the Global Approval Programme for PV (PV GAP). In the meantime, a number of organisations are developing ‘interim standards’, while a number of national programmes are also developing national or regional standards.

Appropriate technical specifications and tender documents can also provide important quality control functions, particularly for larger projects or programmes. Linked to this, should be a requirement for and implementation of independent testing prior to acceptance of hardware.

Product quality marks and certification do provide potentially valuable indications of component quality. Likewise, independent certification of random product samples against third-party standards is an effective tool for determining likely durability and reliability. However, gaining recognised standards can be an expensive process, so it may be necessary to consider requirements for such indicators in the context of local manufacture. Project implementers may need to explore provision of assistance for local firms to undergo the approvals process, be that through a direct technical budget line, or via support for appropriate local standards development and testing via local test facilities.

In the complete absence of accepted standards and certified products, performance guarantees and warranties are the only legal option for end-users and financing institutions to enforce their right for a functioning, high quality PV-system. The terms of these warranties and guarantees, for both components and for entire systems, should be stipulated in tender specifications and also in supply contracts.

Training and Practitioner Quality

PV energy services for developing countries are predominately focused at the remote home or rural community level. The result is many small systems requiring a dispersed resource of installation and maintenance technicians and businesses to serve this decentralised market. Often, such infrastructure is non-existant, and where it does exist there are generally few controls to ensure installation and service staff have the appropriate technical skills and level of competency for service-delivery sustainability.

Rural energy service programme planners must therefore consider appropriate technician training alongside hardware standards as a means of strengthening prospects for programme success. Training accreditation and practitioner certification underpins this objective.

For a training accreditation and practitioner certification programme to succeed, it must:

- have the support of the industry it represents and be credible to funding, government, and member groups (in this respect, accreditation of training organisations should be steered by an independent non-profit organisation);
- provide a benefit to its users and stakeholders that outweighs its costs;
- be based on valid standards of knowledge and skills competency and on auditable measures of capability and process;
- have a chain of responsibility that extends from the national and/or international standards and oversight group to the participating organisations and individuals.

At the same time, any such initiative will only be sustainable where there is a viable market that provides adequate work for certified practitioners.

Beneficiaries of Quality Management and Compliance with Standards

For the risk-averse finance community who generally have limited experience of PV sector lending, quality management systems provide an important basis for conventional risk analysis in evaluating loans and investment opportunities for PV equipment and PV implementation projects. An appropriate qualifying framework, be that through licensing or certification of hardware, training, and practitioners allows the finance sector to better evaluate the qualifications of organisations or individuals requesting funds, receiving funds, or installing the equipment and systems provided with the funds, and gives some measure of confidence on which to base lending decisions.

Similarly, government ministries who are often answerable both to primary financiers (such as the international development community) and to the public (including the end-users) can have greater confidence that they are making sound use of funds and are addressing important programme sustainability concerns. This gives strong justification for government investment to help establish the necessary local quality infrastructure, a vital segment of the ‘virtuous sustainability circle’: quality supports reliability, which builds confidence in the technology and businesses, stimulating jobs, which in turn are quality-focused to continue the cycle.

From the perspective of the service delivery organisations, particularly private sector businesses, the use of quality products and certified skilled staff, while imposing some additional costs, has significant impacts on system performance and reliability. This in turn leads to reduced maintenance costs and higher levels of customer satisfaction. This reduces the likelihood of non-payment for systems purchased on credit or under an energy service agreement, and in localities where word-of-mouth is the primary marketing tool, happy customers can be strong business advocates.

Demonstration of a quality management approach for companies in the service delivery chain is increasingly also a prerequisite for participation in large donor/government backed programmes, for the reasons outlined above.

Ultimately the end-users are the major beneficiaries of systems that deliver reliable energy services in line with their expectations.

IEA PVPS Report T9-05:2003

PV for Rural Electrification in Developing Countries – Programme Design, Planning and Implementation

Executive Summary

Photovoltaic (PV) technology can supply reliable, cost-effective solar electricity for basic needs in many remote and developing areas, bringing better lighting to homes or schools, running medical refrigerators, powering small businesses, and pumping or purifying water. As a result, decentralised PV-based energy services are gaining increasing interest among the international development community and national governments as an important tool for sustainable rural development.

However, PV programmes for rural development have been far from universally successful. Invariably this reflects poorly on the technology, though frequently the underlying problems are not technological. The likelihood of PV programme success or failure - as for projects of any description - is determined to a large extent at the planning and design stages.

This Recommended Practice Guide (RPG) is intended to provide input to programme developers considering implementing or improving support programmes based on PV energy systems for rural electrification. It sets out to highlight critical factors that must be given due attention during project preparation and design as well as practical suggestions for carrying the plan through to implementation. It also addresses monitoring and evaluation considerations for assessing performance and impact throughout and after completing the programme, lessons from which can be invaluable for future project development.

Preparation

The initial preparation phase requires both a view of the big picture, in terms of what the programme is aiming to achieve, and how it fits within the broad national policy framework, while at the same time demanding extensive micro-level analysis to ensure that the real needs of stakeholders will be best met through the proposed technological solution. It is also at this stage that the skills and resources needed to see the project through to completion are identified.

Meeting Stakeholder Needs

Rural electrification is not simply about supplying power, but rather should be seen as a means of fulfilling the needs and aspirations of rural communities. A needs assessment should initially seek to answer what the recipients will gain by the completion of the programme, how those gains will be measured and what justifies the input of the resources that will be required to undertake the programme?

Extensive consultation with the intended users and their representatives is essential to provide a clear understanding of village and household structures and functions, and the development priorities. This should serve to identify what energy services are needed, which should directly inform the project design, including most appropriate energy source to cost-effectively satisfy these services to the required degree of reliability and availability.

At the same time, a variety of other stakeholders other than the intended beneficiaries may be affected by the proposed programme or project, and it is vital that these groups are also given an opportunity to shape planning decisions at the preparatory stage. Additional consultation may be needed with local industry, small business owners, consumers of small business goods, non-government organisations, trainers, local government and state government among others. The assumption that introducing renewable energy will yield only benefits is not necessarily correct. The preparation phase of programme planning needs to take potential costs, challenges, or negative reactions to the programme into account. Stakeholder consultation should seek to identify the economic, social, and cultural costs and benefits of a particular programme, in addition to the direct programme results.

This is a costly and time-consuming process, but is essential to help identify potential social disruptions and resultant challenges or costs in mitigating these. Ignoring stakeholders or not involving them at the earliest opportunity will often ensure the quick failure of the programme.

Capacity Building and Technical Assistance

The issue of ensuring that government ministries, implementing agencies, local businesses and technicians, the utility and finance sector and end-users have the appropriate skills and resources needed to ensure the successful completion of the programme and ongoing sustainability of the energy services post-implementation is dealt with extensively in a separate RPG. Clearly though, it is essential that existing capacity and any additional capacity building needs are identified during the preparatory phase. This will also serve to identify technical assistance (TA) needs, which may require the involvement of international expertise.

Where TA is required, the work should be competitively tendered against clear Terms of Reference (ToR). In particular, key staff should be able to demonstrate they possess appropriate expertise and have past experience of similar work.

Supply Options

Detailed system design occurs in the next phase of the project, but technology options for providing the energy services identified during the stakeholder consultation will be proposed during project preparation. This is dependent among others upon the local energy resources and the requirements for reliability and availability, though factors such as accessibility (terrain) and environmental constraints will also have a bearing on decisions.

Given a finite programme budget, cost is certainly a critical concern. Detailed costing is impossible at the preparatory phase as the final technical solutions will not be known until later in the project. Some reasonably accurate indicative costing is nevertheless important. Project sustainability dictates that this should be based on life-cycle analysis, while externality effects (such as environmental impacts, local job creation, etc.) should also be accounted for as far as possible.

Budgeting for Sustainability

In addition to the hardware costs, programme planners also need to make sufficient allowance within budgets for:

- planning and project development, including stakeholder assessment;
- capacity building and training;
- transportation and installation;
- operating and maintenance, replacement component costs (e.g., batteries) and,
- monitoring and evaluation costs.

Defining how these costs will be met and by whom is fundamental to the project delivery. Effective planning of financing should take into consideration the costs end-users can realistically be expected to bear, and which costs should be absorbed in the broader funding package.

Long-term sustainability of PV energy service projects needs an element of cost recovery from the project outset. Grants or donations should never be used to cover operating costs and should only contribute to alleviating the initial high cost of purchasing equipment. The financing should be set up in such a way that it creates revenue that will at a minimum cover the cost of operation and maintenance of the systems.

Design

The design phase covers the detailed project planning including scheduling and milestones, defining measures of performance and monitoring systems, clarifying organisational roles, relationships and responsibilities together with addressing any awareness, skills or resource shortfalls as well as the specifics of system design, delivery and ongoing maintenance. Underpinning all of these is a focus on quality – not only relating to hardware, but also to the management systems as well as human resource development. (Capacity Building, Financial Delivery Mechanisms and Quality Assurance are covered extensively in other RPGs.) Much of this phase will require close collaboration between programme planners and appropriate technical experts.

Goals, Objectives, Schedules and Milestones

Building on the policy context analysis and needs assessments undertaken during the preparatory phase, more specific goals should be established against which ongoing progress and final project evaluation can be measured. This may include for instance, simple quantitative targets such as number of customers served or number of systems installed, but other appropriate indicators might be the success of income generating activities arising from better evening illumination, or improvements in students' performance at school. Additionally, programme sustainability indicators should also be incorporated to assess performance beyond the term of the implementation phase.

With the goals established, planners can identify the activities needed to achieve these, and develop the detailed work plan. The schedule of activities should incorporate appropriate milestones to enable the programme administrators to monitor ongoing performance, to accommodate rescheduling or refinement of objectives if necessary.

Logistics and Budgets

Logistical planning takes the time plan and schedules and adds the fine detail needed to ensure that all jobs are done correctly. Planning for contingencies is essential, and a degree of flexibility should be built into the plan to allow for re-assessment and corrections if unforeseen circumstances require certain logistics to be reworked. Logistical planning takes into account "what if" scenarios and then does what it can to eliminate potential setbacks. It should address key questions relating to staffing needs, tooling and equipment, communications, security, end users, management systems and budget, among others.

Programme expenditures should be estimated and tied to programme milestones. Separate accounts should be set-up for core budget items such as materials, transportation, wages, training costs, installation costs, communication and administration, public outreach, and programme evaluation and adjustment, among others. The budget should be reviewed on a regular basis throughout the programme to alert administrators of unexpected expenditures which may affect the expected programme outcomes.

Staffing – roles, responsibilities and training

Successful project implementation is heavily reliant upon the skills and abilities of project staff and other stakeholders to undertake the activities expected of them. Job functions and the associated skills needed must be clearly defined. Management structures, reporting and feedback roles must be mapped out. Areas of responsibility must be clearly delineated and the functions and inter-relationships of team members identified as the precursor to identifying individual project staff. Training may be required at this early stage, and should continue throughout the duration of the project, particularly if field experience dictates that additional skills are required.

Financial Delivery Mechanisms

The options and implications of alternative financial delivery mechanisms are addressed thoroughly in other Guides. The project design phase will consider factors such as:

- traditional energy usage costs and prices;
- accessibility of financing services to the stakeholders;
- levels of capital savings available at end-user, stakeholder, and regional or national levels;
- means of generating and accessing domestic savings; and
- Means of accessing international and donor funding

The impact of the financial approach should be evaluated both in terms of its implications for the end user and other stakeholders. A macro-economic impact analysis in respect of potential impacts on the national or regional economy should also be undertaken.

Technical Specification and Procurement

Energy service requirements and local environmental constraints identified earlier provide the basis for the technical system specification. Often equipment will be selected through a tender process. This requires a clear tender specification and penalties should be built in to contracts for failure to meet the specifications and deliverables once the tender is awarded. Procedures may be required for component or system testing, for installation or for commissioning.

Other technical issues that must be considered prior to implementation are negative environmental impacts and security against theft and vandalism. A range of technical and social measures may need to be established to mitigate such effects, for instance recycling schemes to prevent dumping of batteries or community involvement to engender a greater sense of local ownership as a deterrent to theft.

Information Management

For most programmes, some form of information management system (IMS) will be invaluable, to help monitor ongoing progress against milestones, record information relating to problems, details of contractors, stakeholders etc. The form of IMS will depend on the nature and structure of the programme, and the option to expand an IMS should be kept open to accommodate emerging information needs, but it is advisable to design the system at an early stage. This will allow pre-implementation data, for instance from the needs assessment, to be incorporated.

Maintenance Provision

Programme planning also needs to address the issue of maintenance responsibilities, including monitoring of satisfactory system operation and the financial provision for maintenance or replacements.

As far as possible, on-going maintenance and monitoring should be the responsibility of local personnel who will have a natural interest in the proper performance and maintenance of the equipment. This can also serve to create local jobs and develop an infrastructure that will support further renewable energy and social development.

Implementation, Monitoring and Evaluation

With the programme plan clearly defined, the main requirement of the implementation phase is to provide supervision and ensure quality controls are adhered to, and any ongoing capacity requirements are addressed.

A recognised project authority must exercise specific time and budget control. In addition, on-site monitoring of installation quality by persons with technical expertise is important. Programme administrators might plan a technical inspection by an expert at various key phases of installation. Enforcement of programme time plans, milestones, budgets, and quality guidelines should carry clear consequences. Personnel need to know in advance what is expected of them, and then need to know that they will be held to that expectation.

Continual programme evaluation should be used to identify areas where expectations may not have been in line with reality, and steps should be taken to adjust the plan. The IMS should be kept continually updated and used to assist with monitoring and evaluation against the programme plan. Regular reports, which may be required by financing or national authorities, can also help capture progress.

Detailed programme planning in the design phase will help reduce the need for major deviations from the plan during the implementation phase. Regular supervision and evaluation will help ensure quality and will prevent the programme from straying too far from its objectives.

Post-implementation evaluation

Re-assessing the programme after its completion can allow for unforeseen or unintended consequences to be identified and addressed. The programme should be revisited, not just to evaluate its performance and quality, but also to look at how it has affected the lives of the stakeholders, over a time frame of at least a year following its implementation. Similarly, the environmental impact of the programme should be measured during implementation and post-implementation. The social and environmental evaluation should determine whether follow-up training or remediation may be necessary.

The programme should be evaluated against its projected targets and milestones as the project proceeds. A separate technical evaluation may be required if technical problems are experienced during or after the programme. Programme evaluation will give a historical perspective on the results of the programme that will not only benefit the specific stakeholders of the programme, but also will aid administrators in planning future programmes.

Final evaluation should make judgements on programme significance and efficiency. Significance should be measured against the society's values and priorities in achieving economic growth and social development. Efficiency assessment relates to the relationship between the costs of the programme and the final significance of the programme's outcome.

IEA PVPS Report T9-06:2003

Executive Summary

Photovoltaic (PV) systems represent an interesting option for supplying electricity to dispersed rural communities. However, the emergence of PV as a technology has, in itself, not been enough to ensure its widespread diffusion amongst those who desire electricity. Whilst market forces and government programmes have both played a part in promoting PV uptake to date, widespread opinion across a broad range of actors recognises a clear need to strengthen the institutional framework. The focus of this effort should be on developing appropriate market rules and incentives which can underpin long-term *self-sustaining* markets. This Recommended Practice Guide (RPG) aims to define the key components and mechanisms of just such a framework.

Institutional Infrastructure Framework

The specific framework requirements depend to a certain extent on the PV deployment model (direct sales or rural development ‘service’), and are clearly also dependent upon local political, cultural and economic factors among others. However, generically a sustainable institutional framework will adopt a lifecycle approach as well as emphasising the provision of a continuous, reliable, quality-focused service.

Under a direct sales model the institutional framework will generally be less rigid to allow for the influence of natural market forces. Nevertheless, the framework should address: ensuring adequate quality throughout the delivery chain; supporting access to and actively disseminating information to end-users to allow them to make better-informed choices; establishing appropriate after-sales services; and ensuring that financing mechanisms are in place so as to attract a wider range of potential end-users.

Government led rural electrification and development programmes on the other hand will require a stronger framework coupled to capacity building activities at all levels (capacity building is covered extensively in a separate RPG). Additionally, special attention should be given to ensuring that government measures will not stifle the market growth of PV direct sales.

The fundamental infrastructure functions and the respective agents with primary responsibility for these can be effectively grouped into five main categories, as shown below:

Fundamental Function:	Agent:
End-User Education	Service Provider and/or Public Authority.
Regulation and Planning	Public Authority and also possibly an independent body contracted by the Public Authority to carry out regulatory functions including evaluation and feedback.
Installation and Maintenance	Energy Service Provider (private, public, local, NGO, …). The service provider will provide a service over an agreed period of time and geographic region.
Operation and Use	End-users federated in a form of loose or tight end-user association (cooperative, local council, etc.).
Facilitation of Implementation	A private entity contracted by the regulator or the public authority (with or without delegation of some regulatory responsibility) to oversee programme development. The function can also be carried out by staff from the regulation office itself..

Main Agent Functions

Public Authority

The Public Authority is the overarching (governmental) body that establishes the policy and regulatory environment in which PV-based energy services will be delivered. A vital requirement of the Authority in relation to sustainability of such services is that it demonstrates a commitment to rural electrification and accepts PV on merit amongst a number of technical options for meeting energy needs across a range of development sectors (particularly health, education and communications).

In relation to **planning**, the Public Authority would have responsibility for energy sector strategy as well as co-operation with other key development agencies. The Authority should be in a position to decide appropriate technical and economically justifiable approaches for rural electrification, and should make such planning (e.g. grid-extension limits) available to potential users and investors. It should also establish the framework and foster the appropriate business environment for private sector participation in the services delivery.

The public **regulator** is emerging as a significant role for formulating, monitoring and, where necessary, enforcing the contractual obligations of the various participants in the energy services supply framework. Ideally the regulator would be independent of the Planning Authority, and specific rural electrification, RE or PV responsibilities. The regulatory function should incorporate customer protection and arbitration mechanisms and is critical to ensuring quality control throughout the delivery chain.

The Public Authority also has responsibility for ensuring that unbiased information is disseminated to all other stakeholders and for initiating any capacity building at all levels of the delivery chain.

Service Provider

The service provider(s) may be a utility or equipment supplier, end user organisation, NGO or other appropriate body and may deliver a variety of functions ranging from installation and ongoing maintenance to ensuring customer satisfaction and collection of payments. In any event the service will be delivered for a fee and as such requires that the provider has an understanding of running a (profitable) business. Effort should be placed in training the service provider on all aspects (technical, administrative and managerial) that are required to run a business of this kind.

The service provider has a central role in creating a sound contractual framework which delineates the terms of service and ongoing arrangements for payment, maintenance, and so forth. This is designed to safeguard both the rights of the service provider and those of their customers. The regulator will also figure to a greater or lesser extent in the contract framework definition depending upon the implementation/delivery model. An energy service concession model will arguably require a more complex contractual framework and greater participation of the regulator notably to assuage the greater inherent risks for the provider (particularly in respect of their financial exposure), but also to ensure appropriate continuing service levels for the customer.

End-User Organisations / NGOs

Similarly, the role and structure of the end-user organisation depends to some extent on the delivery model, but responsibilities may include consultative input during scheme definition and feedback during implementation, payment collection and administration, ongoing systems operation and maintenance and user training provision.

Non-Governmental Organisations with good local standing may provide valuable support to the beneficiary community, either directly assisting with the structuring of the end-user organisation, or by providing training / awareness building, in particular to ensure users have appropriate levels of understanding to engage in contractual negotiations with service providers.

Facilitator

The facilitator is the linchpin of the institutional framework, providing intermediary linkages as appropriate between the Public Authority (Planner/Regulator), Service Provider and End-User Group. This may cover some regulatory functions, or predominately advice and support. The facilitator will be critical for setting and enforcing standards and for ongoing monitoring and feedback during implementation.

By nature, the facilitator can be a private sector based organisation, a full public sector agency, a local institution or NGO. The latter two may also play a major role in service provision. Every effort should be made to identify such competent and experienced organisations in energy, community development or rural finance which are essential in facilitating intermediation.

Financial Instruments and Subsidies

The broad range of finance sources potentially available for PV-based energy services delivery are discussed at length in the RPG '*Sources of Financing for PV Based Rural Electrification in Developing Countries*'. One contentious issue which that report does not address is the potential for judicious use of subsidies to support rural infrastructure investment. The chief concerns relate to their use, the methods in which they are set-up and their impact on existing PV markets and competition.

The cost of rural electrification in general and even more so for basic services and the poorer rural people cannot be covered through charges alone. Without subsidies there is little potential business in remote areas. However, poorly targeted subsidies have often failed to meet their stated objectives of making services more affordable to the poorest. Subsidies should be directed at encouraging access to services rather than subsidising the operating costs of providing the services.

Throughout the world, rural electrification has been substantially subsidised, at least regarding investment costs. Investment subsidies to rural electrification projects have two main roles in Rural Electrification strategies:

- By reducing the financial cost, which the utility must recover through its tariff revenue, the average tariff is reduced, expanding access to more of the population. The impact of the subsidy on the connection rate is maximised if service providers are required to use the subsidy revenue to reduce the fixed monthly tariffs and connection charges for lifeline consumers.
- The other main function is to facilitate “financial closure” (equity + loans + subsidies + consumer contributions). An upfront investment subsidy reduces the required equity contribution and the size of the investment loan. If the objective is to facilitate locally based investors, the upfront investment subsidy is an important tool

In general, demand side subsidies which are disbursed to the service provider upon achievement of service targets work better than supply side subsidies because they provide stronger incentives for expanding coverage and sustaining services.

Output-Based Aid (OBA), as developed by the World Bank (WB) group, adopts a similar target-based approach to subsidies: it ties *payment* to *outputs* or *services* actually delivered. Payments may replace or complement user-fees, possibly funded from taxes or donors, including WB loans or grants.

Mobilising the Private Sector

Private institutional investors tend to view PV projects as too small and too risky. Existing instruments for infrastructure financing in this context have to evolve. The World Bank and IFC are, in this context, promoting *partial risk guarantee and partial credit guarantee schemes*, to encourage private sector banks and investors to accept higher risk levels and longer term exposures.

Partial risk coverage can, for instance, be designed to cover the risk of the service provider defaulting on debt service. For projects of a smaller size, a form of project bundling, wherein a single partial credit risk guarantee could cover a series of projects has also been envisioned. This would go a long way to encourage “large” investors / service providers to get involved in a series of clustered rural electrification projects.