



Solar Photovoltaics in Africa

EXPERIENCES
WITH FINANCING
AND DELIVERY
MODELS



United Nations
Development
Programme



Global
Environment
Facility

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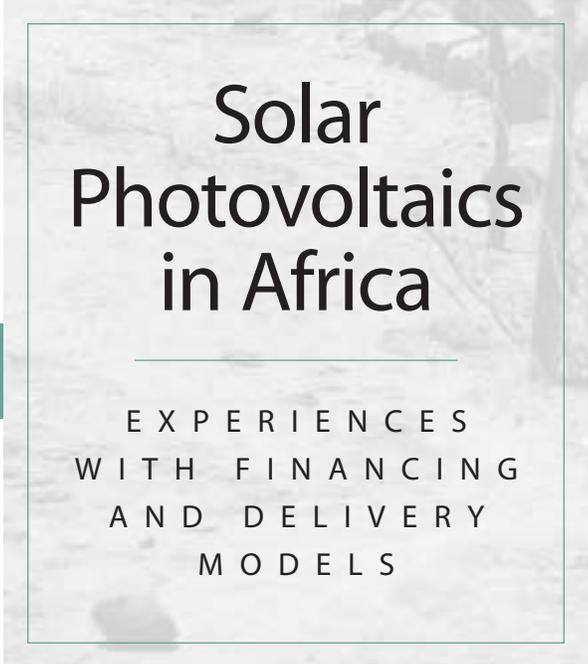
The GEF can succeed in its global environmental mission only as part of a worldwide movement towards sustainable development. GEF brings together 166 member governments, leading development institutions, the scientific community, and a wide spectrum of private sector and non-governmental organizations on behalf of a common global environmental agenda.

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This is the second in the *Monitoring and Evaluation Report Series*¹ published under the Lessons for the Future series to present results of analytical work carried around the Global Environment Facility (GEF) portfolio of the United Nations Development Programme (UNDP). The purpose of the series is to disseminate findings of studies based on experiences gained from UNDP-GEF's own projects and programmes, or from activities of our partners and other concerned organizations working in areas relevant to the GEF operations. The publications have various objectives and target groups. First and foremost, it is our intent to make available lessons and good practice from past and ongoing operations to project proponents, designers and implementers, the executing agencies of UNDP-GEF projects, and UNDP staff. Secondly, the monitoring and evaluation (M&E) series is aimed at highlighting key issues and results related to UNDP-GEF work for our principal constituencies, including the GEF Council and global environmental Conventions. Finally, we hope that the reports will equally serve to spread the word of our work to other interested parties, including academic and research institutions, non-governmental organizations (NGOs) and civil society, and the public at large. The reports are published at irregular intervals when relevant materials and studies are completed and become available.

The second issue of this series focuses on solar photovoltaics (PV). After nearly 20 years of supporting PV for use in Africa, the development community needs to take time to carefully take stock of achievements; systematically collect lessons learned; and thoughtfully re-shape policies and activities designed to support the dissemination of PV-based electrification. This publication seeks to contribute to this learning process, hoping to make the lessons learned and experiences gained in the African context more widely available to development practitioners, government departments, consultants, PV suppliers, researchers and experts. In particular, the publication explores questions about the best ways to make PV systems accessible, affordable and sustainable to rural people in developing countries, keeping in mind the constraints, opportunities, and risks prevailing in each region and country.

¹ The first report published in November 2003 was entitled *Conserving Forest Biodiversity: Threats, Solutions and Experiences*.

This report springs from a UNDP-GEF sponsored workshop on "Financing Mechanisms and Business Models for Photovoltaic Systems in Africa" held in Pretoria, Republic of South Africa, in May of 2003. Representatives of 15 PV programmes in Africa were present at the workshop, and their experiences provided a rich fuel for the ensuing discussion. The goal of the report is to share some of that richness to a much wider audience.

Financial support for the workshop and this publication came from UNDP's Global Cooperation Framework, through the Sustainable Energy Programme of the UNDP Energy and Environment Group, as well as from UNDP-GEF. We acknowledge gratefully this support.

In addition, we would like to thank Martin Krause, UNDP-GEF Regional Coordinator in Climate Change for Eastern and Southern Africa, who conceived of the idea for the learning network of PV projects, and Sara Nordström, UNDP-GEF consultant to the M&E and climate change teams, who worked closely with Martin to bring the workshop and this publication about. We are also greatly indebted to the principal authors, Mark Hankins and Douglas Banks, who shared from their years of experience in producing these papers. We would also like to acknowledge Farid Mohamed, Nikhil Desai, and Ashington Ngigi for their insightful comments on the various drafts of the publication. Finally, all of the participants at the original PV workshop held in Pretoria in May of 2003 deserve a vote of gratitude – we hope that this final product and the experience of the workshop justify their time and effort.

We sincerely hope that the research presented in this report will be of use to everyone concerned with solar PV development in Africa and beyond. Your comments on the present study, and the Lessons for the Future/M&E Report Series in general, will be most appreciated.



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Abbreviations and Acronyms

AFC	Agricultural Finance Corporation	PSF	Private Sector Foundation
Ah	Ampere hour: amount of electrical charge that is stored in a battery	PV	Photovoltaic or solar electric
BBS	Battery-based systems	PVMTI	Photovoltaic Market Transformation Initiative
DANIDA	Danish International Development Agency	REF	Rural energy fund
ERT	Energy for Rural Transformation	RET	Renewable energy technology
ESCO	Energy service company	SACCO	Savings and credit cooperative
ESMAP	Energy Sector Management Assistance Program	SDG	Solar Development Group
GEF	Global Environment Facility	SHS	Solar home system
GHG	Greenhouse gas	SIDA	Swedish International Development Cooperation Agency
IEA PVPS	International Energy Agency Photovoltaic Power Systems Programme	SME	Small and medium-sized enterprises
IFC	International Finance Corporation	SWH	Solar water heater
HP	Hire purchase	UNDP	United Nations Development Programme
kW	Kilowatt: Unit of power	UNEP	United Nations Environment Programme
kWh	Kilowatt hour: Unit of electrical energy	UNOPS	United Nations Office for Project Service
LPG	Liquefied petroleum gas	UPPRE	Uganda Pilot Photovoltaic Project for Rural Electrification
MDGs	Millennium Development Goals	V	Volts: A measurement of the 'strength' of electricity.
MFI	Micro-finance institution	VAT	Value-added tax
MW	Megawatt: Unit of power	WB	World Bank
NGO	Non-governmental organization	Wh	Watt hours: Measure of electrical energy
Nuon RAPS	A joint venture between Nuon, the largest Dutch utility, and Rural Areas Power Solutions	Wp	Peak watts rating
ODA	Official Development Assistance	12VDC	Twelve volts direct current electricity
PMU	Project management unit	240VAC	Two hundred and forty volts alternating current electricity
PPP	Public-private partnership		

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Executive Summary

Since 1991, the GEF has provided grant financing of more than US\$200 million towards the total cost of nearly US\$1.4 billion of the photovoltaic (PV) projects in its portfolio. Nearly half of these projects are based in Africa, making PV the primary focus of GEF support in the climate change focal area in Africa. While the GEF supports PV projects in order to help households and businesses to obtain modern energy supply, namely electricity, without increasing greenhouse gas emissions, it must be acknowledged that the quantity of greenhouse gases reduced through PV projects is quite small. Most of the PV projects supported by the GEF are designed to stimulate the market for PVs by removing barriers to their expanded use in hopes that a thriving market will develop to supply with electricity the population in Africa currently without electricity at zero net greenhouse gas emissions.

Based upon the experiences in PV markets under GEF projects, projects of other donors, and purely private-sector initiatives, there appear to be three critical questions that have to be answered before a sustainable market for PVs can be stimulated in the rural areas of a developing country.

First, what are the appropriate uses of PVs in rural areas of developing countries and, therefore, what is their priority among the target markets? Many projects in the past have over-stated both the importance and potential of PVs for energy supply in developing countries. Photovoltaics provide a limited amount of expensive electric power that can be used for operating light bulbs, radios, TVs, and other low-load electrical appliances. They generally do not supply sufficient electricity to operate stoves, ovens, other major appliances, welding machines, grinding mills, and many other productive uses that can typically be operated with grid electricity. Thus, it is important to bear in mind that PVs provided a limited, but expensive form of electricity for households in developing countries. As a result, they may not be a priority for all households in developing countries. The poorer inhabitants of rural areas will generally not be able to afford even the maintenance costs of most PV systems, let alone the capital costs. The alternatives to PV systems may be grid electricity in some cases; dry cells and kerosene in others; and auto-battery based systems (BBSs) in others. Local circumstances will determine which of these options is the most desirable: PVs are

not a universal choice. Yet PV does fill an important niche in supplying the rural energy needs in developing countries. However, the size of that niche can be easily overestimated.

Second, how can financing be constructively used to grow the market for PVs in the rural areas of developing countries? In simplest terms, financing should help to expand the market of PVs by helping consumers, communities, businesses, and suppliers to afford the high capital costs associated with PVs. Before jumping to the conclusion that financing will stimulate growth of all nascent PV markets, both the status of the financial sector and the maturity of the PV market must be analysed. With respect to the latter, PV markets can be classified into four categories: pre-commercial; pioneer; emerging; and mature markets. Financing should be tailored differently to fit the state of the PV market under examination. With respect to the former, the level of sophistication of the financial sector and its financial institutions will vary by country. To grow a PV market through financing, attention should be paid to leveraging finance at all stages of the supply chain, not just to the financing of final consumers. Micro-finance entities, national development funds and banks, and commercial banks can all be enlisted to grow a young PV market. Each of these institutions will have certain advantages and disadvantages when operating at a different stage of the supply chain and in a PV market of a given level of maturity. Care must be taken to match the financial institution and instrument with the agent in the market with which it will be most effective – mismatches have been frequent and costly. Six lessons bear repeating in the context of PV projects and financing. One, project objectives should be kept realistic. Two, vary the types of finance depending upon the local situation. Three, use finance all along the supply chain. Four, be flexible, but keep it simple. Five, leave finance scheme design and management to the experts. Six, use finance as a “carrot” to ensure quality installations and after-sales service.

Finally, what institutional structures should projects rely upon to get the PV systems in place; to continue growing in line with the expanding market; and to continue to provide operational and maintenance support to these systems once they are installed and are operating? In other words, what is the best method or approach to delivering PV systems?

Four distinct PV delivery models have been identified, and these, in turn, may give rise to many hybrid combinations. The first of these models is referred to as the *commercially led model*. This model typically operates on the basis of cash sales and relies upon merchants that may be dealing in many other commodities. As a result, quality control may be an issue and the consumer will largely be responsible for long-term maintenance, or perhaps the dealer will provide maintenance on a cost-recovery basis. The second type of delivery model is the *multi-stakeholder programmatic model*. Under this type of model, a project management unit is typically charged with reaching rural customers, perhaps extending consumer credit to them. The project management unit will frequently engage in bulk procurement and will only buy systems that meet national standards. But they tend to sell to limited geographic areas and consumers frequently encounter maintenance difficulties after installation. The third delivery model is the *utility model* which is typically operated on a fee-for-service basis. In these cases, the utility or rural energy service company seeks to establish a long-term relationship with the rural consumers, but retains ownership and maintenance

responsibilities for the systems installed. As a result, the consumer pays only a monthly fee, but the utility or rural energy service company (RESCO) must carry the debt service associated with the capital cost of the PV systems. Bulk purchase arrangements will be used to purchase systems that meet a national standard, but again, this model will place a premium on serving dense geographic markets. The fourth delivery model is a *grant-based model* and applies typically to institutions. Under these situations – used for schools, clinics, and missions – bulk procurement will typically occur at a national level. The systems will then be delivered and installed locally, leaving the operation and maintenance in the hands of the local institution. If the local institution is committed to the use of the PV systems and sets aside sufficient resources for maintenance, this model can work well.

Each of these models has its own strengths and weaknesses, and its appropriateness will depend upon local conditions. All of them have a role to play if PV is ever to reach its potential in supplying the electricity needs of the large share of the population in developing countries currently without access to electricity.



Difficulties of transport for maintenance, KwaZulu-Natal, South Africa.

INTRODUCTION TO AND LIMITATIONS OF SOLAR PHOTOVOLTAIC POWER

1 INTRODUCTION

Development projects and programmes have disseminated solar photovoltaic² (PV) systems in Africa since the early 1980s. Pioneer projects introduced community-based PV pumping systems, vaccine refrigerators for remote clinics, and power systems for communications, schools and institutions. These projects were important because Africa has the lowest rural access to electricity of any continent and, with the exception of South Africa, the highest costs for delivering electricity to rural people. The technical success of such projects, particularly the World Health Organization's Expanded Programme on Immunization,³ helped to establish PV as a reliable technology for rural development. Missionaries, non-governmental organizations and projects funded by official development assistance began to systematically use PV systems as an off-grid power source.

Virtually all of these early community development-type PV systems for health, education or water supply were provided to communities or governments through grants. Little systematic consideration was given to how end users or communities would cover the long-term costs of the PV systems, except for those provided in the context of multi-lateral loans. In short, during the 1980s and early 1990s, the question of financing PV systems was considered less important than gaining experience with the technology.

In spite of this support and Africa's huge need for off-grid power, PV has not been an unqualified success for the continent. Africa's share of the PV market is less than 5 percent of the global market and has been decreasing.⁴ Nevertheless, interest in developing Africa's PV capacity is warranted. As this report will show, where grid electricity is not cost effective, PV (or battery-based) systems often provide a cost-effective alternative to less efficient forms of energy, such as kerosene and lead-based batteries. But more successful finance and implementation models are needed. Some of the GEF-supported PV projects in Africa – both those completed and those under implementation – provide a number of lessons for project planners and commercial initiatives. Other commercial, government and bilaterally funded initiatives, which are also discussed in this report, provide excellent learning opportunities as well.⁴

1.1 A convergence of interests

Several factors contributed to the early enthusiasm for PV, including the drop in prices of PV technology in the late 1980s, the success of demonstration projects and the invention of the solar home system.⁵ The PV solar home system (typically a 50 Wp⁶ power system that can power several lights, a black-and-white television and a radio) was immediately recognized as a tool for rural electrification worthy of support. Pilot projects (most of them bilateral) for disseminating solar home systems were initiated around the world (mainly in Indonesia, the Philippines, Sri Lanka and Latin America). For a variety of reasons, PV became a donor 'flavour of the month'. The different interests of various groups looking for a rural electrification 'fix' to meet their respective interests⁷ converged:

- Rural development groups were looking for a product that could alleviate poverty and bring benefits to rural people.
- The GEF was committed to allocating resources to renewable energy projects worldwide.
- Environmentalists were looking to promote renewable energy technologies.
- PV companies were looking to build markets for their technology.
- Governments wanted to provide rural electrification, since less than 10 percent of the rural African population has electricity.
- Rural people wanted power for the appliances they owned or aspired to own.

2 Term used to describe devices that convert light energy to electrical energy.

3 A global programme to increase child immunization, including in remote and off-grid areas.

4 See the GEF bilateral and commercial projects referenced in the Annex.

5 Basic small PV system for rural household use.

6 Term used to describe the size of solar electric systems.

7 Whether PV was indeed the best vehicle to accomplish what these various interests were attempting to do was not much discussed.

TABLE 1

Rural Electrification in Selected East African Countries

Country	Number of rural households without electricity (millions)	Grid capacity (MW)	Rural electrification penetration (% of households electrified)
Kenya	> 4	1160	<3
Uganda	>3.5	240	<1
Tanzania	>3	863	<1
Ethiopia	<7	450	<3
Eritrea	<0.5	60	<3

Source: *Energy for Sustainable Development 2003*

Even as the first projects were being developed, it became clear to project planners that the solar home systems being promoted were far too expensive for the impoverished market to which they were supposed to be bringing benefits. Investment costs for an installed 50 Wp solar home system are between \$500 and \$1,000⁸ – and the average annual income per capita in most of the countries served is less than \$400. At current incomes, less than 3 percent of rural Africans without electricity can afford the investment cost of a standard PV solar home system. Consequently, a major challenge – the ‘holy grail’ of PV projects – has been making standard-sized PV solar home systems affordable for low-income groups.

But what does affordable mean? To whom should they be affordable? And who would give a PV system priority over other pressing requirements of rural life? These questions are discussed more closely in the following chapter.

1.2 The limitations of PV

While PV has its niche, it also has serious limitations. First, PV electricity is expensive,⁹ particularly in Africa.¹⁰ And ordinary solar home system energy outputs are low: they cannot provide power for cooking, heating or productive purposes such as welding, grinding maize or charging batteries commercially. They can provide limited power for lighting, radio, TV, communication, and relatively small-scale pumping and refrigeration, as well as other small-scale end uses.

Second, support for PV energy should be weighed against other rural priorities. Where people lack energy for cooking, heating or commercial activities, solar home systems will not be the best option. In fact, some non-energy technologies may be more urgently needed: a farmer, for instance, might consider a pump a higher priority than household electrification.

Third, the Millennium Development Goals emphasize poverty alleviation and focus on those most in need. While these are the people least likely to be able to afford PV technologies, PV projects can target whole communities, including poorer individuals, by providing electricity for public uses, such as school lighting and power, information and communications, community pumping and vaccine refrigeration.

Finally, PV programmes need to be integrated with other rural energy programmes, particularly grid extensions. Virtually all consumers would prefer grid connections to PV power. In South Africa, provision of PV systems has become politicized, and many remote PV beneficiaries have mobilized against the technology because they want to receive grid-based power. In Kenya, on the other hand, rural people are selecting PV and battery-based systems by the thousands, as they have lost faith that the power grid will reach them. Electricity companies need to make rural people aware of plans for grid extension and of the energy options that will be available to them.

1.3 Need to share experiences

Given these constraints on the development of PV markets in Africa, one might ask, “Why continue to support PV systems at all?” It is a fair question given the other technologies that also need support.

⁸ All prices are in US dollars unless otherwise noted.

⁹ For a 50 Wp solar home system with an installment cost of \$500 and 20-year lifetime, the cost of electricity provided (including battery replacement and maintenance costs) is over \$0.50 per kWh. The cost of grid electricity from hydro and thermal sources is lower, but is also expensive to distribute to rural households.

¹⁰ PV systems are less expensive in Asia than Africa. For example, a PV system in Sri Lanka costs less than half of what it costs in Uganda.

The answer is that huge numbers of African households and communities are without electricity, and few will have their energy needs met by grid extension in the next five to ten years. Photovoltaic systems are a viable option where electricity is a priority, where per capita demand is low and where end users are widely dispersed. However, unless the commercial availability of PV is supported, its prices will remain high and beyond the reach of many communities.

Nevertheless, establishing sustainable markets for PV technology, especially in rural areas of Africa, has been challenging. Given the limited success even with relatively strong support, governments, donors and policy makers are right to question whether PV projects are contributing significantly to rural electrification. The decision as to whether a poor country should subsidize PV systems needs to be carefully evaluated based on evidence demonstrating the technology's contribution to the rural development priorities of the country, such as improved access to water, better health or improved literacy. Strategies for PV projects must include concrete outcomes, and not be technology-driven, as many past projects have been.

As of 2003, the GEF supported 46 projects that dealt primarily with PV dissemination. As shown in Table 2, GEF funding to African PV-only projects is almost as high as that for African projects that combine PV with other renewable energy technologies. More than one third of GEF investments in PV globally are to programmes that focus only on PV. This level of commitment underlines the priority that the GEF has given to PV. In addition, scores of bilateral and foundation-supported PV projects are attempting to provide electrification to rural communities around the world.

TABLE 2
Total GEF Investments in PV

Type of technology focus (GEF project)	GEF energy project funding (millions of US\$)	Total number of projects	Funding for Africa (millions of US\$)	Number of projects in Africa
PV with other technologies such as solar water heaters, wind, hydro, biomass	224.5	29	49.9	10
PV only	119.4	17	43.2	11
Total	343.9	46	93.1	21

Source: GEF 2003

2 PREREQUISITES FOR SOLAR RURAL ELECTRIFICATION

Next we turn to a discussion of the energy needs, perspectives and aspirations of rural people and how these shape PV markets and affect commercial initiatives. We will also discuss the energy alternatives that are typically available to rural dwellers, and their relative merits in terms of meeting energy needs.

Clearly the poorest of the poor in rural Africa cannot afford a \$600 PV system, nor would this be a priority when needs for food, clothing and shelter are not met. But rural Africa is not homogeneous. It includes economically marginalized people as well as those who are much more economically active. Some can afford modern forms of energy, whether from the grid, a micro-hydro plant, liquid petroleum gas cylinders, generators or PV modules. This group is of particular interest to designers of PV solar home system projects. For those who are already paying more than \$10 dollar per month to buy dry cells and kerosene and to charge lead-acid batteries, PV systems are a good investment. Indeed, this is why hundreds of thousands have already bought them.

2.1 What is the priority and whose priority is it?

The energy priorities of rural households and communities depend on one's perspective. Poverty alleviation, lowered greenhouse gas emissions¹¹ and 'productive' power¹² rank high on donors' agendas. Community priorities, on the other hand, often include energy for pumping water (for drinking, livestock and irrigation), health services, schools, public lighting systems, communications or gov-

ernment services. Then there are household and consumer priorities, which may be different altogether. Priorities often vary by gender as well – women may want electric lighting so the house is well illuminated and the children can study, whereas men often prefer electricity for entertainment, be it music from stereos and radios or television. For some, better cooking options may be a higher priority than lighting. Priorities of development agencies (for instance, greenhouse gas reductions) need to be balanced against national priorities (such as poverty alleviation), and these in turn need to be balanced against community and household aspirations for a better quality of life.

Project design must consider the driving forces behind market interventions. For example, in Kenya, the desire for television drives the demand for PV. Virtually all PV solar home system owners in Kenya have a TV, which is why they bought the PV system. While television might not be considered an important development tool, it is a high priority for 800,000 rural households, or 15 percent of the Kenyan population.

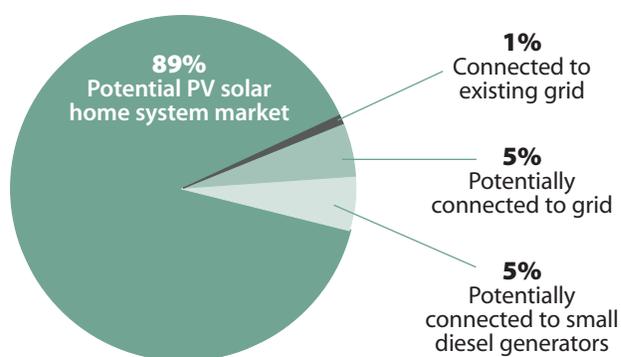
In Kenya, Uganda and the United Republic of Tanzania, the market for cell phones has increased dramatically. People in rural areas – those within coverage of the network – have bought a considerable portion of them. This enormous demand for cell phones has surprised many but, together with the demand for TVs in Kenya and elsewhere, demonstrates how important being connected with the country and the outside world is to rural people. The point is that project designers need to recognize that different stakeholders have different priorities, and to be realistic in trying to balance them. For example, a project designed to establish a market for PV solar home systems might not have a direct effect on poverty, but like the cell phone market, it might help to meet the agendas of a variety of rural groups.

2.2 Demand for electricity and appliances: What does the consumer want?

The first tasks of PV projects and commercial initiatives are to gauge the size of the market, identify the characteristics of beneficiaries or consumers (for example, location, income level and occupation), and establish what they really want. As can be seen in Figure 1, the potential

PV market in Uganda is 89 percent of the rural population, because 1 percent is already grid connected, 5 percent aspire to grid power and 5 percent aspire to being connected to isolated grids powered by small diesel generators. However, many of these households – perhaps over half are unable to afford a PV system.

FIGURE 1
Potential PV Solar Home System Market, Uganda¹³



So what is the true market potential? The starting point to look at what appliances people already have and how much they are already spending on energy for them. This helps to establish who would want a PV system and how much they might be able to pay for it. The list of appliances includes:

- **Lighting.** Off-grid families generally use paraffin (kerosene) for lighting at night. Although paraffin costs at most several dollars per month, the quality of the light is poor, and the fuel produces fumes. The biggest improvement in switching to PV or the grid is in convenience and lighting quality rather than cost.

¹¹ Renewable energy technologies do not contribute to global warming because they do not increase greenhouse gas (such as carbon dioxide and methane) concentrations in the atmosphere.

¹² 'Productive power' is power that enables people to engage in economically productive activities. Milling machines, irrigation pumps, crop dryers and welding machines are some examples of productive uses of power. Because of the low output of PV systems, PV power is not generally considered to be a 'productive' power source, though many PV applications do enable people to increase their incomes.

¹³ Source: Author's notes.

- **Radio/cassette player.** Radios do not use very much power, and a pair of battery cells can last a month in a small radio. However, if the system is larger than 20 watts, the cost of dry cell batteries becomes prohibitive.
- **Cell phones.** In Kenya, Uganda and the United Republic of Tanzania, millions of consumers use cell phones and a significant portion of these live in off-grid areas, which is creating demand for PV.
- **Television.** Demand for television is driving demand for PV in Kenya, Morocco and Sri Lanka. Television requires a 12VDC PV or battery-based system, a generator or a grid connection. Charging battery-based systems costs \$5–\$10 per month. The user of a small diesel generator (genset) will have to spend several times this amount. However, the investment cost of PV systems (and their complexity) may cause consumers to choose gensets to power larger colour TVs.
- **Refrigerators, electric kettles, irons and microwave ovens.** For all but a tiny fraction of enthusiasts and rich consumers, PV is not a viable choice to power these appliances. In East Africa, very few rural people aspire to own appliances such as refrigerators. However, in southern Africa, many people with PV systems have been greatly disappointed because the systems typically power only a limited number and type of appliances.¹⁴

Monthly energy expenditures provide benchmarks for the establishment of finance or fee-for-service payment schemes. Energy expenditures can be estimated based on the appliances owned. Very poor rural households may spend less than \$1 per month on kerosene and dry cells. Those who are better off – such as teachers, small- and medium-sized entrepreneurs and farmers – may spend between \$5 and \$15 per month. As incomes rise, energy expenditures (and aspirations) also rise quite quickly. National and other surveys can track these expenditures.



TV and video with PV, Eastern Province, Zambia.

Rural people will be quick to see whether the improved service that a PV system provides matches the monthly costs – or the investment.

Electricity is not an end in itself: consumers want power for their appliances and light for their households. And they would choose grid power if it were available. Nonetheless, in rural areas beyond the electricity grids, solar home systems (or battery-based systems) offer considerable improvements over dry cells and kerosene, and greater flexibility. Photovoltaic systems offer a convenient power source for the appliances they own or hope to own. Whether consumers are prepared to pay for PV (whether with cash or financing) will depend on whether the system meets the needs of the appliances owned (or desired) and whether it costs less than what they are spending on power already.

2.3 Technology alternatives available

Project designers should be realistic about the limits of PV power: It will not run household refrigerators or maize mills cheaply, and will not, without serious technical and price improvements, replace grid electrification. Thus, PV systems should be seen as one choice among many, and rural people – given the proper information – should be encouraged to choose the technologies that best meet their needs and finance capabilities. In many countries (such as Indonesia, the Philippines and South Africa), PV electrification is used as an interim solution before the grid connections are possible, and consumers are made aware of this when provided with PV systems.

Consumer aspirations and outlooks affect their choice of power systems. If consumers aspire to owning refrigerators or other electric appliances that cannot be powered by PV or battery-based systems, then they will not choose PV. If PV is seen by a community to be substandard or second-class, then the demand in that community will be reduced. Finance systems for rural energy supply should cover the range of viable options.

Assuming that virtually all rural people would like to move away from kerosene and dry cells, available alternatives include:

- **Solar home system PV packages.** These standard 50 W_p PV solar home systems, the ones used most often in development projects, provide enough power to light three to six rooms and power a black-and-white TV each night. Ideally suited to charge a 75 Ah battery, these systems supply 10–15 Ah per day and cost between \$500 and \$1,000. Less expensive lanterns and smaller systems are perfectly functional and widely available, though they provide fewer hours of power.
- **Battery-based system.** The battery-based system is simply a lead-acid battery used to power 12VDC appliances (usually TVs and music systems), and carried back and forth to a charging station (usually grid-based). Consumers often must pay to transport the battery to and from the charging station, where they pay a fee of about \$1 per charge (\$5–\$10 per month). Inevitably, the battery will have a short life (often less than two years) because of the number of deep discharge cycles it is subjected to. PV companies often encourage consumers to upgrade from battery-based to PV systems. There are probably ten times as many battery-based systems in use in rural and peri-urban African households as there are PV systems. PV modules, in fact, are just one way to charge 12VDC batteries. Although PV systems offer far better performance, they are unlikely to replace them.¹⁴
- **Grid/220VAC power.** Grid power (including mini-grids from micro-hydro) is clearly superior to PV and battery-based power. Where there is a chance – or even an unsubstantiated hope – that communities will

¹⁴ Although it is possible to enlarge PV systems, beyond a certain point the incremental cost of expanding a household PV system to power more appliances is expensive. A household might, for example, add a module and battery (and inverter) to make it possible to run a colour TV. However, the cost of adding enough module and storage capacity to power a refrigerator or an electric iron would be well beyond the budget of most of the rural people that GEF-type PV projects target.

¹⁵ In Kenya, rural people managed over 800,000 battery-based systems in 2003 (Energy for Sustainable Development 2003).

receive grid power, PV sales drop dramatically. But very few countries in Africa have rural electrification programmes that have reached more than 10 percent of the rural population. In countries with little movement toward rural electrification, customers often choose PV.¹⁶

- **Generators.** For small loads in households (lighting and entertainment), generators are more expensive (even on a first cost basis) than PV. They generally do not compete in this market. However, in some countries (Somalia, United Republic of Tanzania), upper-income people still chose gensets because of their versatility and their 240VAC¹⁷ power output.

Table 3 show the differences that consumers face between grid power, PV and battery-based power, and dry cell and kerosene. Essentially they provide three different levels of access to electricity.

Dry cells and kerosene provide the lowest level of power for an extremely high cost per unit. In the case of dry cells, consumers are paying well over \$50 per kilowatt hour. With this form of power, however, there is little upfront investment cost, and the incremental weekly costs are low. With dry cells or kerosene, consumers can buy extremely small amounts of energy that can fit within their budgets.

Twelve volt DC systems in the table include both PV solar home and battery-based systems because they provide a similar level of power and can run the same 12VDC appliances.¹⁸ The battery-based system has a much lower investment cost (just the cost of the lead-acid battery), but has high maintenance and recurrent costs. PV systems are more convenient (since the consumer does not have to move the battery) and have a much longer battery life. However, PVs have much higher upfront costs. As can be seen in Table 3, the monthly costs of 12VDC systems are comparable to those of the dry cell and kerosene system, but the amount of energy provided is more than ten times higher.

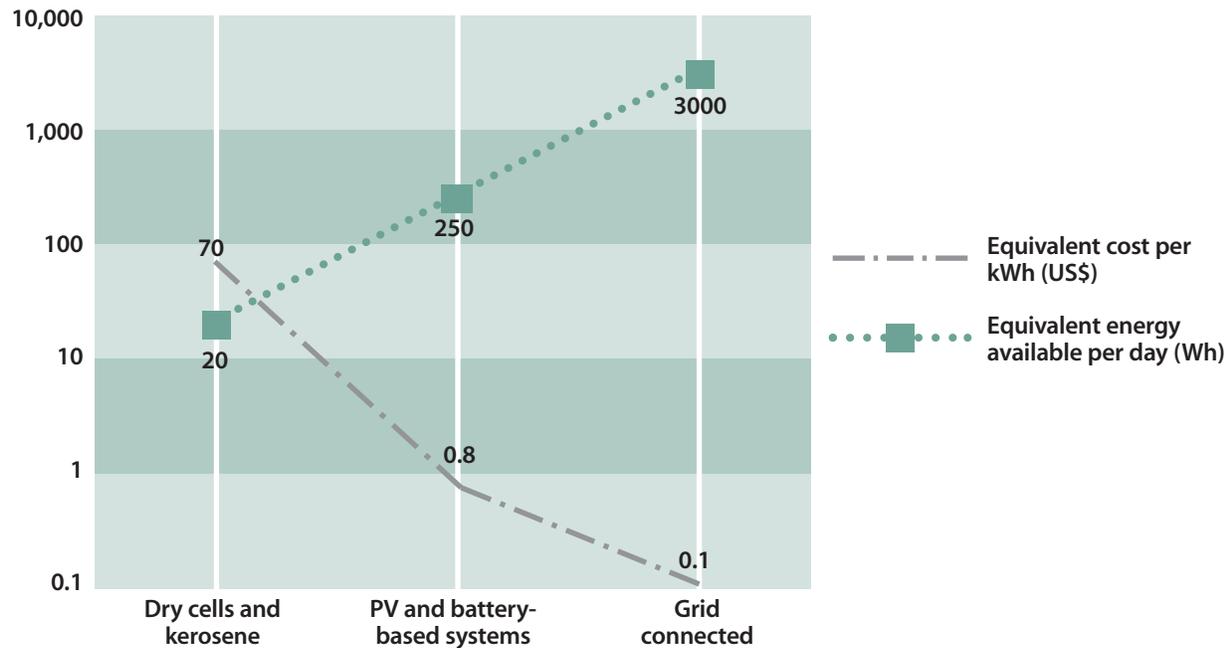
TABLE 3

Comparing the Potential Power Providers

Parameter	Grid electricity	12VDC systems: PV solar home systems and battery-based systems	Dry cell and kerosene
Power delivery capacity	0–100s kWh/month	<6 kWh/month	>0.5 kWh/month
Appliances	Capacity to power most appliances (although rural people usually cannot afford to cook with electricity or to run heavy appliances)	Lights, TV, radio, cell phone, small motors	Kerosene lamp, radio
kWh equivalent cost to consumer	Low (less than \$0.10/kWh)	High (±\$0.50/kWh)	Extremely high (>\$40/kWh)
Real monthly costs paid by consumers	\$5–\$20/month	> \$2 (very low maintenance) \$5–\$15 in fee-for-service	\$5–\$15
Investment cost	Depends on proximity of grid. Usually \$250–\$1,500 per connection (\$430 per connection in South Africa)	> \$500	None
Desirability to consumer	High	Depends on access to grid and aspiration of consumer	Low
Desirability to environmentalists	Medium	High	Low
Convenience	High	Moderate	Low

FIGURE 2

Comparing the Alternatives: Cost of Energy and Amount Provided by Grid Power, PV and Dry Cell/Kerosene



As Table 3 shows, grid-based power offers a huge improvement over 12VDC power systems. It can power any appliance – though most rural people cannot afford to cook with electricity. And it can provide about ten times the power (or more) of a solar home system for about one-tenth the cost. As shown in the logarithmic graph in Figure 2, dry cells and kerosene provide the equivalent of 20 Wh per day, while, for a similar monthly cost, battery-based systems and solar home systems provide 250 Wh per day. Grid power can provide 3,000 Wh per day, an improvement that is about ten times better than either 12VDC or PV power. The gray line in the figure above clearly shows why grid power is so attractive: once installed, it is very inexpensive.

But it is costly to extend the grid to rural areas – on the order of \$10,000 per kilometre. PV solar home systems and battery-based systems offer an intermediate, low-cost solution, providing a better option than dry cells or kerosene that is more affordable than grid extension. In general, once consumers switch to PV from dry cells, their aspirations rise quickly and they immediately desire even more power.



Battery box, Eastern Province, Zambia.

- ¹⁶ Over 50 percent of Kenyan PV systems are located within 5 km of the nearest grid lines.
- ¹⁷ Power from the grid is usually 240 (or 110) volts alternating current.
- ¹⁸ Batteries are often the first step to converting to PV systems, as discussed in Chapter 2.

1 SOLAR PV FOR RURAL AREAS AND THE NEED FOR FINANCING

If it is agreed that solar PV is an appropriate technology for supplying some rural energy needs, and that the current upfront costs of systems are too high for consumers and traders, it is important to find ways to make the technology affordable. Years of experience have shown that that is not so simple. Planners need to ask how finance can best help PV projects and what the role of finance is in the big picture of PV market development. In fact, many types of financial tools directed to different players in the PV market are available. All may be appropriate under some circumstances, depending on the stage of development of the PV market, the financial institutions in place, conditions within the particular country and the overall project goals.

The issues are complex even before one gets into the design of programme finance. Project planners therefore need to be clear about their goals. As the next section will show, financing is just one component of PV projects, one that is often expensive in terms of time and resources. Financing PV systems or companies increases the cost of the technology considerably. Consumers or traders will eventually have to cover the interest and fees for finance experts. The costs of stimulating the finance sector to get into the PV market – raising awareness, developing grant packages, etc. – and the cost of setting up finance infrastructure for PV also need to be taken into account. Donors have often subsidized such costs in the past. To maintain long-term markets, however, these costs eventually must be borne by the consumers, or by sustainable subsidies.¹⁹

1.1 Types of finance for PV projects

Consumer finance. Many rural PV projects rely heavily on credit financing for consumers so that payments can be made as low as possible and more people can be served (Box 1). Consumer credit is expensive to administer, however, and maintaining low interest rates and long payback periods can be difficult. Also, consumer financing depends on the existence of a rural finance network, which in many countries simply does not exist.

Moreover, given the high price of PV technology in Africa, a more prudent approach may be to invest scarce resources in lowering prices for consumers before building financing programmes for them. In addition, consumer loans do little to extend the PV market beyond the reach of affluent rural consumers. It is therefore important to determine whether the market – in terms of PV demand/awareness and finance sector development – is ready for consumer finance intervention. If not, it is important to ask whether the intervention will still be successful and a productive investment of scarce funds.

Market development finance. A supply chain must be in place before financing PV solar home systems is considered. Therefore, the most reasonable targets for early-stage PV markets, which are described below, are often the companies themselves rather than the consumers. To stimulate the market, finance can sometimes be directed to companies and associated players in the supply chain. Early stage markets, and PV consumers, may be better served in this way. For example, if a PV system in Uganda is several times the price of a similar system in Indonesia (because of high duties and taxes, a lack of competition and poor market infrastructure), one might question whether a project should attempt to finance consumers to pay that price. A more effective approach might be to try to lower the price through market development.

BOX 1

Monthly payments on a loan for a 50 Wp solar home system sponsored by the SolarBank Programme shows that it costs \$15/watt, with 10 percent system efficiency. In the base case, it is financed with a seven-year, 18 percent interest loan. Payments are \$16.40/month. Increasing system efficiency from 10 percent to 15 percent through research programmes only reduces monthly payments to \$10.93/month. Cutting system costs by half through manufacturing scale-up only reduces monthly payments to \$8.20/month. However, improving financing to a 20-year, 5 percent interest loan by itself reduces monthly payments to \$6.37/month. Of course, the best result is attained when all three avenues of cost improvement are implemented, but the immediate impact of lower-cost financing is apparent. (Michael Eckhart, SolarBank)



A technician connecting user appliances (TV and radio) and providing customer education, northern KwaZulu-Natal (Nuon RAPS), South Africa.

Public sector (poverty alleviation) finance. Even with lower prices, well-established sales networks and consumer financing, the poorer segments of the population will still not be able to afford PV solar home systems. They are simply too expensive and there is no way to make them affordable to that segment. Questions then arise as to why donor funding is being used to help the upper quartile of the population access PV systems and what is being done for low-income groups.

Where poverty alleviation is a primary objective, these questions must be asked. In such cases, public funding may be best used to increase access to electricity in an equitable way. Instead of attempting to put a light bulb in every house, for example, such projects could aim to use public funds to put electricity where it serves the most people: to light schoolrooms, to power community water supply services or to provide electricity for clinics.

All three types of finance described above are important. Because household consumers make up a large part of the potential market for PV, establishing appropriate consumer financing packages will be a key part of setting up the market. However, a PV industry does not develop

overnight without attention being paid to the various players. Finance packages may need to be developed to help the companies, technicians and the agencies that deliver the product to the consumer. And, because international development focuses on alleviating poverty, PV projects should strive to serve as wide a group of people as possible.

1.2 Tailoring PV finance to the needs of the country

Finance programmes should complement the state of the industry and develop as the industry does. Therefore, when planning finance interventions, project or commercial planners need to understand the other market parameters and design a set of financing tools that match market needs:

- **Demand for electricity and appliances.** What do consumers want? What can they afford? (Chapter 1, section 1)
- **Technology alternatives.** What power systems are available and within reach for consumers? What are the alternatives and competing products on the market? (Chapter 1, section 2.3)
- **State of the PV and 12VDC market delivery system.** What is the state of PV market development? Do consumers know about the technology? How well developed are the existing PV companies? (Chapter 2, section 3)
- **Maturity/stability of the finance sector and the policy environment.** How well developed is the local finance sector? Does it reach rural areas through micro-finance institutions? Is the currency stable? What are interest rates in the country? Do policies favour businesses targeting off-grid rural areas or those dealing with PV technologies? (Chapter 2, section 4)

All of the above factor into the design of a finance programme. Because of the unique situation of each country, there is no 'one-size-fits-all' PV finance programme.

¹⁹ Rural electrification is often cross-subsidized from other sectors. Special low-interest rates for rural PV systems could also be an opportunity for cross-subsidization.

This would seem self-evident. However, despite scores of projects and various attempted finance models, there has been relatively limited success in the deployment of sustainable PV markets or finance schemes. This report revisits how finance has been applied to PV programmes and commercial ventures and also includes financing methods that have not previously been considered.

2 CATEGORIES OF FINANCE: THE TOOLS²⁰

The three general groups of finance tools for PV markets include *financing for consumers* to help them purchase or rent PV systems; *financing for companies* to help them expand their import, distribution, retail or other operations and to offer credit to downstream consumers or companies; and *assistance to finance organizations* themselves to help them play a role in the development of the market – either as micro-finance institutions to deal with consumers directly or as rural energy funds/banks to offer financing to companies. This section provides short working definitions for various types of finance, which are described in more detail elsewhere (see, for example, Liebenberg and Stander 2003). There are more financing methods than are readily apparent, and not all of them require a finance organization to implement.

An important lesson from the last decade is that financial players should be encouraged to do what they do best. Providing loans to rural consumers, for example, is best handled by micro-finance institutions and hire purchase organizations (Chapter 2, section 2.1). Company financing and loan guarantees are best organized by formal finance institutions.

Although it would seem an obvious mistake, funds have sometimes been allocated to groups that were not ready to use them in the most appropriate ways, or that did not fully understand the PV market. If finance organizations, whatever their sophistication or reach, are not prepared to deal with PV financing, they should be given time to adjust. The banking industry in Africa is understandably cautious about adopting new ideas and products.

2.1 Financing the consumers

Consumer finance is the obvious way to make PV more accessible. While the vast majority of rural people will never be able to buy upfront a 50 Wp PV solar home system,²¹ they have several options:

- Continue living with the lower energy service
- Buy a smaller system and build up the system in a modular way
- Seek financing

Experience has shown that rural finance programmes, particularly revolving credit schemes, are risky and expensive to set up and administer. From the point of view of financiers, rural people are difficult customers. However, recent experience also shows that, given the right terms and conditions, rural consumers can be good credit risks,²² particularly when they are supported in income-generating activities. The major problem is that coverage of banks (usually based in towns and urban centres) does not extend to many off-grid areas where PV is generally demanded.

Rural people tend to be conservative in the types of loans they take out (when they can get them), and a PV solar home system might not be their highest priority. Children's education, business expenses and farm expansions, for example, may be higher on the list. Rural dwellers may also be reluctant to put up what is often their only tangible asset – the land they own – as collateral for the purchase of PV systems.

Table 4 lists twelve distinct types of consumer financing methods, and the following discussion summarizes important successes or failures. Short case studies of some of these are included in boxes.

²⁰ Not to be confused with delivery models, a closely related topic covered in Chapter 3.

²¹ A majority of consumers in most countries will not be able to afford a colour TV either.

²² This is the experience from micro-finance organizations, such as the Kenya Rural Enterprise Programme, Pride Africa, Uganda Women's Finance Trust, Grameen Bank and others.

TABLE 4

Consumer Financing Tools

Financing method	Description	Experience
Cash purchase	<i>Purchase of the entire PV system using one payment. The most common method of payment in pioneer markets. For a \$600 PV system, this is out of the question for most rural families.</i>	Many successful experiences. Most systems sold are small.
Modular cash purchase	<i>Purchase of system components over time. With this method, the quality of the system suffers, but the consumer is able to purchase components incrementally, often with units of less than \$50.</i>	Many successful experiences. This method of purchase is common in Kenya and Zimbabwe.
Layaway	<i>The consumer makes a price agreement with the supplier, and makes monthly payments to the supplier, who holds the consumer's money and maintains the price. Agreements are often done informally, with no interest charged or accrued.</i>	This method is not very common, but has been used by a number of stores.
Hire purchase/ salary withhold-ing schemes	<i>The consumer, a civil servant or member of a company that has a credit agreement with the supplier, enters into an agreement to have a monthly deduction from his or her salary. The deduction occurs automatically, and the loan period typically lasts from 6 to 18 months. Interest rates are very high.</i>	Many successful experiences. Kenya has a large hire purchase market as does the United Republic of Tanzania. It is also common among miners in Mozambique. Because of high interest rates, a consumer typically pays more than double the initial price of a solar home system by the end of the period.
Commercial consumer loans	<i>The consumer takes a loan with a commercial bank to buy a PV system. Normally this involves some type of security of equal value to the PV system and a relatively high interest rate.</i>	Little experience. Has been piloted but not offered widely. The method is not easily accessible to rural dwellers, and is often considered unattractive because rural farmers are not usually willing to mortgage their land for a PV system.
Loans through savings and credit cooperatives	<i>Standard loan offered by cooperative membership organizations to teachers, civil servants, farmers and others. Savings and credit cooperatives are the most common credit agency used by rural people because they can gain access to them easily in many countries. There are also lower requirements for security. These loans typically have lower interest rates than commercial loans.</i>	Some successful experiences in Uganda, Kenya, Zimbabwe, but no wide-scale uptake.
Rural Grameen Bank/ village bank/ micro-finance institution-type loans	<i>A group of people come together with the purpose of purchasing PV systems. They each pay a nominal amount into a savings fund that is used as security for the entire group. This approach is effective where the loan recipients are small businesses generating a return. The loans are not generally successful for financing consumer goods.</i>	Some experiences. This approach has been used for many micro-enterprise loans in Kenya and elsewhere; Uganda has an active village bank approach.
Fee-for-service	<i>With fee-for-service, the customer does not own the system, but instead pays a monthly fee for use of the system. The system is owned by the company that installs it. This method requires the company implementing it to install thousands of systems (and possibly to have a concession that grants it exclusivity to a region).</i>	Experience in South Africa and Zambia. South African experience is heavily subsidized, and thousands of systems have been installed.
Dealer credit (large-scale)	<i>Like standard loans, but offered by the PV company/dealer directly to the consumer. PV companies must take all the risk and make all of the outlays.</i>	Experience in Sri Lanka and Indonesia, but none in Africa.

(continued on page 20)

TABLE 4 (continued)

Consumer Financing Tools

Financing method	Description	Experience
Informal credit/small-scale dealer credit	<i>Loans for PV systems offered on an informal basis from the local dealer to the consumer. Although not immediately obvious in the overall picture, this method is important. It enables small dealers to break up payments in ways that are convenient to them and the customer (for example, down payment, payment upon completion, payment after three months).</i>	Common.
Subsidy to consumer	<i>Subsidies enable the consumer to get a straight discount on the system.</i>	Consumer subsidies are offered in Germany, Japan and the US state of California. A World Bank-GEF Energy for Rural Transformation project in Uganda (ERT) ²³ and similar World Bank-GEF efforts in Ethiopia and Mozambique are introducing consumer subsidies. Poorly managed subsidy programmes can have negative effects on regional markets, and are also vulnerable to corruption.
Full-value grant	<i>Grants are in the form of free equipment that is provided without charge.</i>	A large portion of the PV systems in Africa have come as grants. Many of the markets in Africa have been adversely affected by grant programmes, because the grant equipment often enters and distorts commercial markets.

2.1.1 Cash purchase and modular system purchase

Every market includes a group of high-income people who can afford PV systems and will pay for them with cash. There are (or have been) large numbers of cash purchasers in Botswana, Kenya, South Africa, Uganda, Zimbabwe²⁴ and elsewhere, and they generally outnumber credit buyers. These consumers, often called technology ‘early adopters’, are crucial to market development because they demonstrate the benefits of PV systems and convince others to buy them, stimulating demand. It should be the objective of any project to encourage this market (perhaps by encouraging the private sector to provide smaller systems), in addition to financed systems.

Modular cash purchase is the most common form of financing PV systems. Through this method, rural people purchase the appliance and/or the battery first, and then add the PV system components later. Although the method has its technical problems, it does meet the needs of the rural farmer with seasonal cash availability. When cash is available, the consumer buys a battery-

based system, and with low outlays is able to keep it charged through a charging station. In a subsequent season, the consumer buys a solar module and affixes it to the battery. Later, the consumer may purchase another module, lights and a charge regulator.

Many consumers in Kenya, Uganda, the United Republic of Tanzania and Zimbabwe use this method. In these countries, 5 percent to 15 percent of the rural population already owns battery-based systems, and uses them to power lights, radio and TV. In Kenya and Zimbabwe, they upgrade to PV power in considerable numbers, typically by purchasing a 12 Wp amorphous module²⁵ over the counter at a shop. This practice has been driving local PV industries. Because such systems are poorly sized, self-installed and usually do not include charge regulators, their performance is poor, and their battery life is short. But the consumers are used to managing battery-based systems, and they upgrade to PV systems to eliminate the cost and inconvenience of regularly charging batteries.

BOX 2

Case study: Cash purchases in Zimbabwe

A 1993 project in Zimbabwe implemented by UNDP called Photovoltaics for Household and Community Use was the GEF's first experience promoting PV systems. The \$7 million project included efforts to develop indigenous PV businesses, a cooperative electrification programme with ZESA (the national utility), awareness and technical training campaigns and a pilot loan programme with the Agricultural Finance Corporation (the national agricultural bank).

The project had a relatively solid foundation to build upon, established by several pioneer companies that were manufacturing modules or selling and installing PV systems. At least 2,400, and perhaps as many as 10,000 or more [ESMAP 2000] solar home systems were already in place before the project began – in telecommunications services, bottle stores (bars) and institutions.

The increased demand for PV enticed traders from Botswana and South Africa to increase their activities in Zimbabwe.²⁶ While their low-cost 12 Wp amorphous systems were often improperly installed and seen as a negative influence by the project, in the long term they may have been healthy for the industry. Their entrance in the market encouraged competition, and by 1998, over 80,000 PV solar home systems – more than nine times the number that had been installed by the project – were in place. Most of these systems were purchased with cash through non-project entities and about 40 percent of these were self-installed (ESMAP 2000). By 1998, 4.6 percent of rural households, almost 1 percent of urban households owned PV systems and nearly 14 percent of the total population used battery-based systems (ESMAP 2000).

Note: the GEF project was not the only group offering PV solar home system credit; Solarcomm sold hundreds of systems through a special credit system that it introduced during the project.

BOX 3

Case study: Modular cash purchases in Kenya

By 1995, consumer awareness of PV in Kenya was over 60 percent. Purchases of PV systems exceeded 400 kWp per year (more than 20,000 modules), and hundreds of retail outlets had sprung up all over the country. There was a solid base of knowledge about PV among rural technicians.

Modular cash purchases to upgrade from battery-based systems to PV systems were common, and more than 120,000 systems have been built up in this way. Consumers, often already familiar with battery-based systems, simply buy small 12 Wp modules and batteries to power TVs. Lights, extra modules and charge regulators are often added later. In the late 1980s, the average size of PV systems was over 40 Wp. However, as demand for PV solar home systems increased, consumers sought ways to build systems without having to pay the \$700 or more that a full solar home system would cost. As a result, there was a trend away from the full PV solar home system 'kit' to component purchases made over the counter.

Today, the purchase price for a typical Kenyan PV system (battery and a 12–20 Wp module) is less than \$200. Key to their operational success are full-year warranties from three solar battery manufacturers and the fact that PV consumers still occasionally charge their batteries at grid-based charging stations.

²³ Rural energy programme being implemented by the World Bank in a number of African countries.

²⁴ Cash purchases in Zimbabwe outnumbered the UNDP-GEF project financed systems by more than 15 to 1 (ESMAP 2000).

²⁵ Amorphous silicon (a-Si) is a type of PV material that normally costs less than crystalline silicon (x-Si). Some a-Si modules are lower in quality than crystalline modules.

²⁶ All five sites with PV systems visited by the project evaluator in 1997 were installed outside the GEF project (Majero and Chetse 1997).

Because tens of thousands of systems are purchased in modular units in Kenya, Mozambique and United Republic of Tanzania, this model is worthy of study by PV companies and project planners. It meets the financing needs of poor people without incurring finance costs and without requiring collateral. Given an existing market infrastructure and well-informed consumers, this model has relatively low management costs, and it can also be integrated into battery charging networks.²⁷

2.1.2 Hire purchase

Hire purchase is an established method of purchasing consumer goods in Kenya, Mozambique, South Africa, the United Republic of Tanzania, Zimbabwe and elsewhere. Hire purchase agents typically stock a variety of household amenities and sell to customers who have jobs with agencies from which they can easily ensure payment. Terms offered by hire purchase companies are often harsh, with interest rates above 40 percent (Table 4). Still, the willingness of many customers to pay such rates is a strong indication of demand for amenities, even in poor rural areas.

In the Kenya and Mozambique examples, hire purchase companies mostly sold components, not kits. They found that consumers were interested in direct current TVs, PV modules and batteries. Installation and technical advice were rarely provided.

Starting hire purchase programmes requires a large investment (more than \$500,000). Hire purchase

BOX 4

Case study: Hire purchasing in Mozambique

In Mozambique, at least one hire purchase catalogue company has experience selling PV modules. The dealers offer a range of household goods to mine workers living in South Africa and deliver them to homes in areas such as Inhambane, Gaza, and peri-urban Maputo. Workers have the cost of the module deducted from their salaries, usually for a period of one to two years. As of 2002, several thousand 12 Wp modules had been sold in this market (*Energy for Sustainable Development* 2003).

BOX 5

Case study: Hire purchasing in Kenya

In Kenya, hire purchase has been well established as a practice since colonial times, and scores of operators based in small towns sell a wide variety of products – ranging from sewing machines and TVs to sofas, pumps and bicycles. Hire purchase shops target rural people who have salaried incomes from the government, companies, agricultural societies and parastatals. Although one attempt, in the early 1990s, failed, the first successful PV hire purchase occurred in 1997. A local PV firm then set up ventures with several hire purchase operators who had outlets strategically located where demand for solar home systems was strong. The firm offered PV systems to hire purchase providers on very good credit terms (180 days), and the hire purchase providers marketed the systems in shops. Within several years, thousands of systems were selling per year from hire purchase outlets, and nearly all PV distributors had relationships with hire purchase companies. Hire purchase business from PV is likely to be over \$1 million per year in Kenya. The cost to the consumer is high, however – close to \$900 for a 50 Wp system, plus an equal amount over the period of the loan.

Kenya's hire purchase success has largely been due to relatively high incomes in rural areas; a demand for 12VDC televisions and appliances; and an extremely well developed credit infrastructure in farming areas. The Kenyan experience provides an example that other countries can improve upon.

operations ordinarily include a variety of other products besides PV. They require a stable currency exchange situation, a minimum number of potential clients (companies and employees of public enterprises or state-owned companies, such as an electricity utility) and a minimum level of consumer demand.

Dealer-based consumer financing is very similar to hire purchase, except that companies doing PV dealer financing tend to focus exclusively on PV. Examples of places where dealer credit has worked well are Indonesia and Sri Lanka (both of which took advantage of national PV

programmes). At present, Africa has no large-scale examples of dealer credit.

2.1.3 Consumer loans and revolving credit

Dozens of initiatives have attempted to establish 'revolving credit'²⁸ payment schemes for African consumers. Consumer loan types can be broken down into three categories: commercial loans, cooperative loans and micro-finance institution/village bank loans. Most PV financing efforts have been driven by PV projects, handed over to rural development cooperatives or micro-

finance institutions, and then administered by them. Some financing systems have been set up exclusively for PV projects.

Commercial bank loan initiatives were launched in Kenya by several banks in the early 2000s. Although they were widely promoted, they did not result in many sales, and only one is still operational. Attempts by UNDP-GEF's Uganda Pilot Photovoltaic Project for Rural Electrification to work with commercial banks were also unsuccessful.

BOX 6

Case study: Revolving credit fund in Uganda

Uganda has a fairly long history of PV development, since energy prices are high, there is a proximity to the Kenyan market and the government has an interest in making energy sources available to rural people. In the early 1990s, several companies were already selling PV equipment, but demand was largely for NGO, government and communications companies.²⁹

As the Ugandan economy grew in the late 1990s, consumer interest in PV power, especially for solar home systems, rose as well. Two community-based projects in the mid-1990s catalyzed the market: about 100 houses in Kasese received PV solar home systems in a project supported by Habitat for Humanity and the Solar Electric Light Fund. Another 150 solar home systems were installed in Kibale district through a project managed by the Uganda Rural Development and Training programme (funded by a Dutch NGO). Both of these projects disseminated solar home systems through subsidized revolving credit funds that were established and managed through the projects. Neither of the credit funds was sustainable, and neither survived beyond the completion of the projects. Nonetheless, the experience gained by companies and technicians installing and maintaining large numbers of systems was useful. This was augmented by various projects that installed donor-funded institutional systems, including hundreds of vaccine refrigerators in clinics and hospitals, schools and government institutions.

BOX 7

Case study: Commercial bank in Kenya

Two commercial banks have launched PV solar home system loan programmes. These include the Kenya Commercial Bank and Solagen Solar Loans programme (2002) and the Barclays-Chloride Solar Loans programme. These programmes were not considered to be successful, and are not currently active.

Commercial bankers are reluctant to finance consumer goods to widely dispersed (and hard to chase) rural people. The costs of processing, verifying and servicing rural loans are prohibitive for urban commercial banks. At the same time, rural people prefer to deal with their agricultural savings and credit cooperatives or other credit groups, since the terms are easier and they are closer to home.

²⁷ For example, PV marketing and awareness activities can be conducted from places where customers come to charge their lead-acid batteries (usually grid-connected charging stations). If the charging station can derive an income from PV sales, and provide a technical service, then both sellers and consumers benefit.

²⁸ Revolving credit refers to a system of offering loans to recipients whereby the principal and interest repaid by loan recipients is offered – or recycled – to other recipients. The term, and the use of the system, is often associated with soft, 'donor-supported' loan practices, rather than commercial financing practices.

²⁹ A study commissioned by the World Bank Energy for the Rural Transformation programme in 2001 found that the World Bank had been the single largest consumer of PV equipment for health, district office improvement, and communications projects. However, the Bank had little awareness of the level of its own support for PV.

BOX 8

Case study: Consumer credit in Namibia

The consumer credit initiative of the Namibia Home Power Programme, started in 1996, offers five system types that are matched to the income levels of communities, from 'small' (50 Wp) to large (350 Wp) systems. Consumers were issued five-year loans, administered by the project, with subsidized 5 percent interest. The loan includes the cost of the equipment, installation, transport and insurance. The Namibian Ministry of Mines and Energy is the nominal 'owner' of this project, though it outsources management to a private company. Suppliers and technicians are engaged by the project manager to sell and install systems as necessary. In seven years, the project has disseminated 650 solar home systems.

As with other solar loan programmes, repayment for the solar home systems was high (85 percent), but the loan facility still was unable to replenish itself sustainably. This experience is similar to that of many other centrally financed pilots that did not include dedicated finance organizations. There were also some quality control and maintenance problems. Lack of familiarity with the systems and system 'abuse' on the part of consumers also resulted in technical problems.

Cooperative loans: PV loans have been offered through savings and credit cooperatives (SACCOs) or parastatal agricultural banks in Zimbabwe, Kenya and elsewhere. Such agencies are set up to meet the needs of rural farmers and have long experience providing them with credit. SACCO loans are characterized by low member interest rates and liberal collateral requirements (because of strong ties with members). Strong cooperative banking systems, however, are in place in only a few countries.

In Zimbabwe (Box 9) several thousand loans were provided through the Agricultural Finance Corporation through a UNDP-GEF project. The project deliberately subsidized the interest rates on the loans, and this, combined with the rapid deterioration of the Zimbabwe economy and the devaluation of the Zimbabwe dollar, left the credit fund empty by the end of the project.

BOX 9

Case study: Consumer financing in Zimbabwe

This UNDP-GEF project in Zimbabwe aimed to set up individual consumer financing, dealer financing for aggregate loans (this did not occur because of UNDP legal restrictions), and loans to institutions and community associations backed by a loan guarantee from the project fund. Most of the project finance activity was devoted to the setting up and maintenance of consumer loans through the national agricultural bank, called the Agricultural Finance Corporation (AFC).

Qualifying customers (who were identified by their participating companies) paid a 15 percent deposit to the AFC and had their systems installed by company of choice. Loan terms were a payback period of three years with a 15 percent per annum interest (compared with the 40 percent commercial rate, the project interest rate was negative in real terms). Of all the project systems purchased, 54 percent were purchased with AFC loans and 6 percent with cash.

Shortly after the project began, inflation climbed to more than 50 percent and the value of the Zimbabwe dollar plummeted. Fund values dropped fivefold between 1998 and 2000, and by the end of the project only a fraction of the original revolving fund base was left.

Pilot loans programmes with Kenyan tea SACCOs, most of which were catalysed by donors, have installed at least 300 PV solar home systems among tea grower communities. However, these numbers are small in comparison to the total number installed by the cash market. Though they have shown promise, the projects have yet to go to scale.

2.1.4 Micro-finance institutions and village banks

In the 1980s and 1990s micro-financing was vigorously promoted for rural areas, often with great success, all over Africa. Micro-finance institutions, such as the Bangladeshi Grameen Bank,³⁰ disburse loans to small but organized groups of rural people who provide risk guarantees for each other. Strong social cohesion ensures that loans are paid

back. The loan programmes also encourage rural people to save money, or sometimes even require them to keep savings accounts in addition to their loans. They focus loan portfolios on small businesses that generate returns to pay back loans. Loan periods are usually short (a year or less) and interest rates are often close to commercial rates. Such terms may be attractive to entrepreneurs starting income-generating schemes, but less so to people buying consumer goods.

In theory, small targeted and rurally oriented micro-finance institutions would seem to be ideal partners in the development of the PV markets. However, their loans are often aimed at businesses and income generation, and, unlike hire purchase, do not usually target consumer goods such as PV. In addition, loans are usually small (\$150 or less), though creditworthy recipients are often offered larger follow-up loan packages. Finally, as with other finance organizations, micro-finance institutions are often not familiar with PV and they see entrance into the PV financing as risky.

National micro-finance institutions in Ethiopia (Sidamo Rural Credit Agency), Kenya (Kenya Rural Enterprise Programme) and Uganda (Centenary Rural Development Bank, Uganda Women's Finance Trust),³¹ have piloted PV loans. However, experience with PV lending by micro-finance institutions is limited in the three countries, and no organization was lending for more than a few systems per year as of 2003 (Boxes 10 and 11).

Village banks or rural-based revolving credit funds are often set up (or tapped into) by projects to serve PV projects. Typically, a credit fund is set up among the community or NGO managing the project, and this group is tasked with collecting funds from members. In Kenya, Uganda, the United Republic of Tanzania and elsewhere, this approach often fails because of a lack of focus on managing the funds. Nonetheless, the approach has had some success and provided some valuable lessons (Box 11).

BOX 10

Case study: Consumer financing in Kenya

Between 1996 and 1998, a World Bank ESMAP³² project piloted PV consumer finance with the Kenya Rural Enterprise Programme (K-REP) and the Cooperative Bank of Kenya (Coop Bank), as well as the Muramati tea savings and credit cooperative. About 100 systems were installed in 18 months in three areas (the project was slow in taking off because it took time for the banks and consumers to gain confidence in the concept). K-REP and Coop Bank were each given grants of about \$50,000 for technical support in PV technology and to 'on-loan'³³ to consumers. One of the installation sites was later incorporated into the International Finance Corporation-GEF Photovoltaic Market Transformation Initiative, but neither of the two finance groups continued to provide PV consumer loans.

Two tea SACCOs, Kiegoi and Michimikuru, recently developed loan programmes with their members for buying PV systems. Kiegoi financed and installed over 50 systems (as well as a number of biogas systems) on a commercial basis with a local consulting firm and a PV company. Michimikuru, which received over \$30,000 from the GEF Small Grants Programme, has installed over 100 PV systems. Quality control was carried out by a local NGO, Solarnet. In both programmes, systems were fully designed and inspected, and maintenance contracts were issued. It is still too early to tell whether the SACCOs will continue their PV financing programmes.

³⁰ Grameen Bank in Bangladesh is one of the most famous social micro-finance organizations in the world. It has developed a successful methodology of lending small amounts of money (less than \$100) to groups of people who act as guarantors for each other.

³¹ Both these micro-finance institutions in Uganda were urban-based, and this probably reduced the chances of success.

³² UNDP/World Bank research programme that assists developing countries to explore energy strategies.

³³ On-lending means that the banks were to use the grants only for the specific purpose of offering solar PV loans to their customers as provided for by the project.

BOX 11

Case study: Village banks in Uganda

The UNDP-GEF-supported Uganda Pilot Photovoltaic Project for Rural Electrification (UPPPRE) project made several attempts to develop consumer credit delivery mechanisms. Early on, it set up guarantee funds in two banking organizations in Kampala: the Uganda Women's Finance Trust (a micro-finance institution) and the Centenary Rural Development Bank. The project provided a guarantee fund to leverage risks. In turn, the banks designed solar home system finance packages that included short repayment periods (less than a year) and relatively high interest rates (38 percent annually). However, very few loans were disbursed.

In 2001 the project then turned to a village bank model to take PV systems directly to rural areas. The model was implemented with rural micro-finance institutions in six areas and involved granting village banks a revolving fund for consumer loans. Loan terms were made more consumer-friendly; interest rates were reduced to 18 percent (from the market rate of 48 percent); and the repayment period was extended from one to two years. Furthermore, a flexible repayment schedule took into account the seasonality of consumer incomes.

The UPPPRE project required active involvement of village banks and vendor companies. UPPPRE selected participating village banks and trained the village bank staff. Village banks mobilized consumers and selected loan recipients. The village bank procured PV systems through a competitive tendering process, for which the project provided standard tender documents, contracts and help in evaluating bids. Companies supplied PV systems and gave a warranty of one year on service and equipment. The village bank recovered funds and deposited them in a secure account. Before final payments were issued, UPPPRE inspected all installed systems to ensure compliance with national standards. UPPPRE also monitored the revolving fund.

Through this effort, 510 PV systems, valued at \$350,000, were installed in six locations in 18 months. The clustering of the sales reduced costs by 15 percent from the normal retail prices, and village bank loan recovery rates range from 80 to 90 percent. According to UPPPRE, satisfaction in the quality of service provided by PV is high and the initiative has sparked demand for more systems. In addition, private sector companies have acquired funding and are replicating the model on their own.



Road side bottle store selling refrigerated drinks, Mozambique.

2.1.5 Subsidy and grants

It is generally agreed that subsidizing PV technology to stimulate demand and drive up production will, in the long run, lower prices and make the technology more accessible. However, poorly applied subsidies can ruin markets by causing unfair competition. For example, the UNDP-GEF-supported Zimbabwe project subsidy benefited only those participating companies. On the other hand, rural electrification has always been cross-subsidized – market needs and rural equity needs must be balanced when planning projects.

BOX 12

Case study: Subsidies in Zimbabwe

A project supported by UNDP through the GEF in Zimbabwe exceeded its target of installing 9,000 PV systems by creating a subsidized market for participating companies through the use of consumer loans and NGO purchases. Because equipment was purchased duty free, in bulk, consumer prices were more than 15 percent lower than those that commercial dealers could offer. This practice distorted the market to the disadvantage of non-participating PV companies importing through normal channels.

On the other hand, the project was extraordinarily successful at raising awareness and priming the market. Demand for PV increased rapidly over the course of the project. In its early stages, 60 companies sprang up, though midway through the project only 30 remained and six of these accounted for 80 percent of the total installations completed by this point. By 2000, fewer than 15 PV companies remained in the market. Although this decrease was partially due to a downturn in the Zimbabwean economy, it also reflects a return to 'steady state' for the PV market.

In the North (Japan, Germany and the US state of California), governments have subsidized the purchase of hundreds of megawatts by household consumers through the use of 'smart subsidies' (Box 13). Such programmes co-finance the cost of systems and have driven the dramatic rise worldwide in the production of PV systems as well as their dramatic drop in prices (over the period

1996 to 2003). In mid-2003, Germany finished installing 300 megawatts of rooftop, grid-integrated PV systems, virtually all of which were paid for by government subsidies. Given the success of programmes offered in the North

BOX 13

Case study: Smart subsidies

Smart subsidies are market interventions that strategically overcome pre-identified barriers. Subsidy programmes provide payments to companies (as in Sri Lanka and Uganda) or directly to consumers (in Germany and the United States). They are implemented for a given period of time only, and are fairly applied and carefully regulated so that they do not distort the market. A smart subsidy introduced at an early market stage – when PV system prices are high because of small volume and lack of competition – might reduce the cost of a PV solar home system by as much as half. With increased demand would come competition and lowered prices. As the market matured, the subsidies could be reduced to 40 percent, then 20 percent, then nothing (as the subsidy funds run out).

for customers buying systems of 20 modules or larger (more than 1,000 Wp), similar smart subsidies would also be useful (and equitable) for consumers in the South, who usually require much smaller systems.³⁴ In fact, the GEF is supporting subsidy approaches in Uganda (Box 16), Mozambique and elsewhere. The subsidies are, however, targeted at companies, not consumers. Subsidies offered to companies (Chapter 2, section 2.2) enable a fairly large number of systems to be efficiently managed, encourage entrance into the market by companies (and therefore increased competition and lower prices), and provide an incentive for the private sector to develop market demand. A major problem with this approach is that it is expensive and invites graft.

³⁴ A typical German system is 2,000 Wp, while a typical African system is 50 Wp, or less.

Since the beginning of the very large-scale German and Japanese PV subsidies, worldwide PV prices have fallen by over 20 percent and demand in those countries has grown exponentially. Subsidizing PV power in Sri Lanka has also lowered consumer prices and increased competition and PV demand. Consumer subsidies should be established so that they are accessible in an equitable manner. They also need to be phased out in a way that allows the market players to adjust.

BOX 14

Case study: Grants in Uganda

The World Bank-GEF supported Uganda Energy for Rural Transformation project has taken a cross-sector approach to identifying the most appropriate uses of PV systems. During the project formation, the project worked with government ministries in agriculture, health, water and education to identify their energy priorities. Based on this input, the project will be installing grant-funded institutional PV systems in off-grid locations. Several hundred school lighting systems and health clinic systems will be installed under the project.

Grants will have a role in the supply of PV systems for the foreseeable future. Although it is hard to imagine a project supplying household PV systems free to consumers, community-based systems have been provided to governments, NGOs and communities on a grant basis for decades. Eritrea, for example, has installed hundreds of school, pumping and health care PV systems that are provided to the government on a grant basis.

In the long term, however, viable financing and delivery strategies are needed to help communities cover running costs and – eventually – investment costs for energy systems they use. This will involve pooling targeted funds from government ministries, donors and communities themselves.

2.2 Financing companies

Financing to encourage business participation in the African PV market is still in its early stages and experience is limited (compared to South-East Asia, for example). Nevertheless, conventional wisdom and experience elsewhere dictate that companies should be financed before consumers. Why? First, the companies have a stake in the market and will invest in it. They are only likely to take a loan if they believe they are going to benefit from making sales. Second, companies are easier partners to work with than hundreds of dispersed consumers; they have addresses and can be easily tracked down. Third, companies can be assisted in many ways, through loan packages that offer various types of business or technical support. Finally, assisting companies to get lower prices can allow them to pass along savings to the consumer.

Several levels of players may require investment or financing to carry out their respective roles in the delivery chain (Figure 3). These range from international or multinational companies (for example, Shell and BP Solar), to importers and distributors, to retailers and technicians. All require specialized forms of credit support and, depending on the development of the market, a particular initiative might provide financing on several levels. As explained below, methods of providing business finance are still being developed.³⁵

Credit and financing options can assist key transactions. For example, financing between international suppliers and importers can help large players purchase container loads of equipment. Credit can also facilitate transactions between importers and distributors or dealers who work further downstream in the supply chain. Finally, consumer credit can assist customers to buy systems outright.

Because commercial debt and suppliers' credit play a key role in the normal commercial operations of solar distributors, financing support can help companies extend the boundaries of their credit and debt facilities.

³⁵ The World Bank's Energy for Rural Transformation, Solar Development Group (SDG) and E+Co have focused on developing company financing programmes.

FIGURE 3

Finance Tools to Build the Market

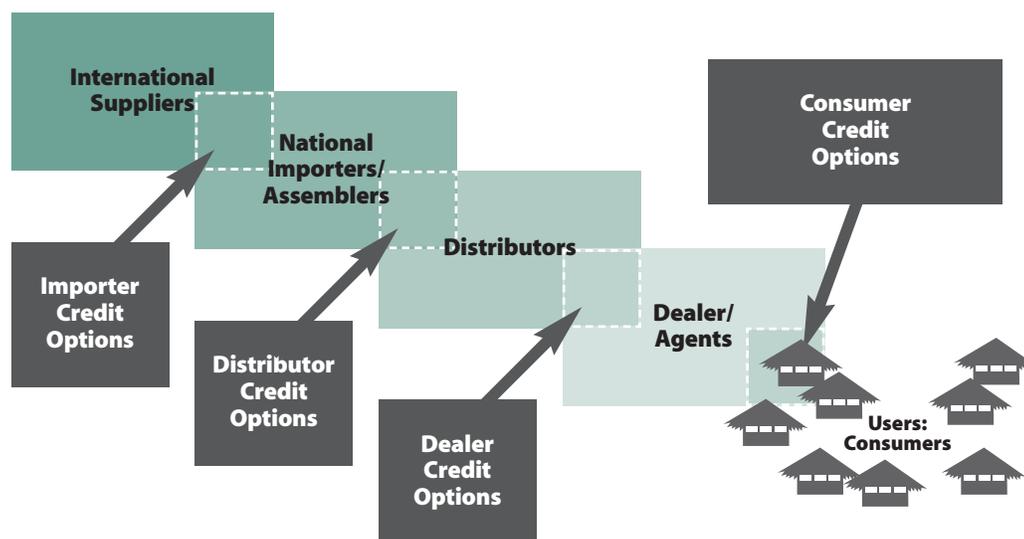


TABLE 5

Company Financing Tools

Financing method	Description	Experience
Loans and lines of credit to companies	Company provides a standard line of credit to agents. Ordinarily, payment terms are for a certain number of days (for example, 90).	Ample experience, mostly in Kenya, but also in other advanced economies.
Bank guarantee for loans or equipment purchase	A guarantee is deposited in a bank against loans to client companies; this allows the company to purchase equipment up to a limit approved by the financier.	Limited experience.
Large project tender-based finance	A project issues a tender to install a number of systems over a given period. The winning company is provided with an appropriate guarantee of service from a project bank. (As above, but tailored to projects.)	Limited experience.
Subsidy to company (sales-based grant)	Project provides buy-down to company (instead of the consumer) at an agreed-upon price per watt.	Just beginning in the World Bank-GEF Energy for Rural Transformation project in Uganda and in similar World Bank-GEF efforts in Ethiopia and Mozambique.
Subsidy to company (cost-sharing)	Cost-sharing grants for business planning, capacity building and market development. Cost sharing can be combined with long-term equity investment or company loans.	Limited experience through the World Bank-GEF Energy for Rural Transformation project in Uganda, the Solar Development Group in Kenya, Tanzania and elsewhere.
Micro-finance institution loans/equity for PV companies	Downstream finance is made available to small PV companies. This would ordinarily be offered through micro-finance institutions that have expertise working with less sophisticated small companies.	Limited experience.

Loans for business do not have to come only from specialized banks or development agencies. They can also come from business partnerships. For example, larger companies can provide lines of credit to smaller companies or subsidiaries. Creative relationships between business partnerships and official development assistance have the potential to stimulate PV markets quickly and reduce end-user costs.³⁶ However, financing for companies will only be useful if the policy framework for importing, retailing and trading in PV-related business is also favourable.

2.2.1 Company-to-company lines of credit

Offering retailers or product distributors attractive lines of credit is a normal method of doing business and, in this regard, PV is no different than any other enterprise. In Kenya, because of the large number of players in the market, suppliers compete with each other to offer more competitive terms: very attractive payment terms underpinned the success of the country's hire purchase experience.

Because projects work on a national level, they can create conditions that make it easy for companies to build credit networks, from the international to the consumer level. National projects can also facilitate formation of partnerships all along the chain, through support to solar energy industry groups and through certification of companies. For example, in Sri Lanka, a PV project supported by the World Bank-GEF offered subsidies, consumer credit and assistance to companies – all of which gave companies the confidence to invest in the development of the market.

2.2.2 Bank guarantees

Reducing consumer prices, for any product, means buying and selling at as large a volume as possible. Potential PV distributors in undeveloped markets may be unable to buy, say, a container of modules because they cannot amass enough funds at once. In some countries, this problem is compounded by regulations that make it difficult to exchange currency. Meanwhile, at the retail end, small

BOX 15

Case study: Guarantee fund, vendor and consumer financing in Uganda

The UNDP-GEF-supported Uganda Pilot Photovoltaic Project for Rural Electrification installed 2,300 solar home systems by PV vendor financing and PV consumer lending in three years.³⁷ To strengthen private-sector delivery mechanisms, the project arranged credit financing through a commercial bank to help suppliers buy in bulk. A guarantee fund of \$150,000 was set up for qualifying local companies. Funds were provided at a lower interest rate (12 percent) with reduced collateral requirements. Over the course of the project, six companies borrowed funds to procure and install several hundred PV systems.

players continually have problems selling stock, replenishing it and responding to fluctuations in demand. Bank guarantees, by enabling companies to order equipment quickly and efficiently, can help all types of companies respond more quickly to demand forces.

By coordinating banks with the entire private sector engaged in PV, guarantees can help companies to set realistic limits, build better relationships with financial institutions and trading partners, and grow in a sustainable manner. Guarantees can also be provided to winning companies in large-project tenders. As an example, a World Bank-GEF project in Mozambique will award tenders to several companies to supply institutional systems for health centres and schools. Through a rural energy fund, it plans to encourage the same companies to stimulate the solar home system market by providing bank guarantees.

2.2.3 Subsidy to company

The World Bank-GEF Energy for Rural Transformation (ERT) project in Uganda, which is based on experiences in East Asia, is now using 'smart subsidies' to encourage companies to develop the PV market. In Uganda, two types of subsidies are offered. The first is a simple dollar-per-watt rebate to companies for verifiable systems sold.

BOX 16

Case study: Subsidy to company in Uganda

Through the Ugandan Private Sector Foundation (PSF), the Energy for Rural Transformation project is subsidizing PV companies to help them grow sustainably and to help lower consumer prices by building volume and introducing competition. To participate in the project, companies must pre-qualify by meeting a set of criteria. As of July 2003, six companies had been approved to participate. Strategies to work with companies include:

- Large system tenders: These will be awarded to qualifying local PV companies.
- Business planning and capacity building component: PSF is providing cost-share grants to companies to help them develop business plans, conduct technical training or carry out other business-related activities. To qualify for these grants, companies prepare a plan and a budget for the activities, and have these approved by PSF. The Foundation then pays a 50 percent cost grant *after* the activity is completed and they are satisfied with the results.
- Sales-based grant scheme (subsidies): The project is paying \$2 to \$3 per watt grants to qualifying companies that install PV systems under the project. Grants are payable to approved dealers against audited sales of systems.
- The project is also developing financial intermediation efforts to address the cash flow problems that companies and consumers face. A new rural energy fund will help develop these tools.

For example, if the project is offering \$2.50 per watt, and a company sells 100 50 Wp systems, it would receive a \$12,500 subsidy upon confirmation (by an appropriate auditor) that the systems were installed. This scheme offers an equitable and competitive incentive for companies to develop the rural PV market. At the same time, it ensures that companies maintain minimum standards on the systems they install, because those that do not meet these standards are disqualified.

A second type of company subsidy, a 'cost-sharing' grant, assists companies to complete ventures that they otherwise might not be able to afford. For example, in the Uganda ERT project, companies are provided with cost-sharing grants to cover 50 percent of the costs of developing business plans, training staff, or developing and executing marketing plans. The project asks for an application from the company before it undertakes an activity. If the project approves the activity (and the budget), then it funds the activity after it has been completed and a satisfactory report is produced.³⁸

BOX 17

Partnering with the Solar Development Group

The Solar Development Group (which is made up of a grant-based funding section, Solar Development Foundation, and a venture capital section, Solar Development Capital) and E+Co have combined strategic equity investments or loans in growing PV companies with cost-sharing grants to help them build markets. Initial Solar Development Foundation loans are soft in nature (up to \$50,000) and are often combined with technical support. For larger companies, Solar Development Capital provides larger equity investment of \$500,000 or more. The Solar Development Group has partnered with companies in Ethiopia, Kenya, Uganda and the United Republic of Tanzania and dispersed well over \$1 million in loans and grants in the region. Results are encouraging, but development of partners is expensive and time-consuming.

³⁶ This area has been explored by the Photovoltaic Market Transformation Initiative, SDG and E+Co extensively. Shell Renewables is also seeking to establish a public-private partnership to help it develop better finance methods.

³⁷ As with the Zimbabwe project, it is likely that several times this number of systems were installed outside the project.

³⁸ Since Uganda's Energy for Rural Transformation project began recently (late 2002), experience with this subsidy is still limited. However, as mentioned elsewhere, the approach has succeeded in Sri Lanka.



Battery based system, Eritrea.

2.2.4 Downstream loans to small companies

One area that has received little attention is financing for very small players who serve as the last link in the delivery chain. Because such players are often micro-enterprises themselves, operating within low-income economies, they have trouble raising the cash to buy systems from upstream traders. Project financing, offered through specially sensitized micro-finance institutions or rural energy funds could help such players go from selling one system at a time to selling greater numbers and serving larger areas. However, this requires policy and legal frameworks and possibly some type of subsidy. A rural energy fund may be able to facilitate the process. Schemes for small companies are being piloted in Ethiopia, Mozambique, Uganda and the United Republic of Tanzania. In Zambia, small service companies that provide fee-for-service PV systems to consumers have been assisted through project grants.

2.3 Financing the financiers

An important task of development agents is helping financiers to become involved in rural energy in general and PV in particular. Getting financiers involved, be they commercial banks, micro-finance institutions, savings and credit cooperatives or hire purchase agents, requires incentives. Most African countries have comparatively

weak finance sectors, with a poor reach into rural areas. The short-term perspective of PV projects (most GEF projects last five years or less), makes it hard to bring financiers on board. First, they view rural areas to be risky. Second, they are wary of product-based lending in general. Third, bankers are not usually knowledgeable about rural energy.

For these reasons, PV initiatives may find it helpful to work with rural energy funds that are specifically set up for the purpose of providing rural electricity. Ethiopia, Mozambique, Uganda, the United Republic of Tanzania and other countries are in the process of setting up funds to stimulate rural energy investments. The World Bank (through the Energy for Rural Transformation programme) has been especially supportive of these new rural energy agencies and funds. The new paradigm, developed by the Uganda ERT project (Box 16), proposes to use rural energy funds in specific, targeted ways to ensure that the funds are:

- Private-sector oriented (for example, companies carry out the work, and donor financing simply catalyses the funding and planning)
- Independent of government
- Technology neutral (that is, they support the most cost-effective energy choice)
- Support only projects whose costs are covered over the long term (for example, upfront capital investments can be subsidized, but not the long-term operational costs of energy).

Rural energy finance bodies are especially important when it comes to supporting larger PV systems to serve community needs. For example, vaccine refrigerator and health clinic projects have received bilateral and multilateral funding on a fairly sporadic basis. In many cases, communities have been passive recipients, unable to participate in selecting their priorities and unable to choose technologies. However, rural energy funds can be designed to allow much more community involvement in energy choices. Essentially this means creating autonomous funding agencies whose decision-making boards

are composed of individuals who are independent of the government and who represent the rural areas, communities, private sector and municipalities involved. Although rural energy agencies have had some success in setting up road and water boards to build infrastructure, they are really only just starting to develop in Africa.

A long-term challenge facing PV and other rural energy projects is educating potential financiers. Part of the problem is that finance groups have little knowledge of rural energy needs and priorities, and this lack of knowledge translates into a lack of investment. One task of rural energy funds is educating finance agencies about the opportunities in rural areas.

Finally, diversification of PV loan approaches and of the activities of lending agencies is needed. Instead of setting up credit for PV systems alone, for example, PV loans can be provided along with home improvement loans, rural energy system loans or even car loans. One reason that hire purchase loan companies have been successful is that they offer PV systems along with a full catalogue of products. This benefits both the consumer and the supplier: the consumer gets a wider selection of loan choices and the supplier incurs less risk.

Rural energy funds typically use grants and guarantees to other commercial banks or intermediaries to stimulate their investment in rural energy projects. Some of the tools available to support rural financing are listed in Table 6.

TABLE 6

Financing Tools to Develop Finance Organizations

Financing method	Description	Experience
Rural energy agencies and funds	Rural energy agency provides cross-subsidy or outright subsidy for financing rural electrification.	Used in many Northern countries (for example, the National Rural Electric Cooperative Association in the US); several are now being established in Africa (Ethiopia, Mozambique, Uganda, Tanzania).
Risk guarantees from government or rural energy fund	Rural energy fund or multilateral/government fund is used to guarantee commercial bank credit line.	Not known.
Bank guarantees for micro-finance institutions	Rural energy fund or multilateral/government fund is used to guarantee commercial bank credit line.	Not known.
Grants to micro-finance institutions	Micro-finance institution is given grant to provide loans to consumers or small companies.	Common pilot practice to encourage micro-finance institutions to get into PV loans.
Government/project 'revolving credit'	Government holds revolving credit fund on behalf of project.	Government manages credit fund (for example, Zimbabwe).
Catalysing bank-to-bank relationships	Not strictly a method of financing. Donors can encourage commercial, development and rural-focused banks to cooperate with each other, without necessarily having to provide loans.	Not known.
Subsidized loan	Interest rate is reduced by using subsidy element to cover banking costs.	This type of loan often upsets lending practice of micro-finance institutions and banks, and is subject to misuse.

3 STATE OF MARKET DEVELOPMENT AND APPROPRIATE FINANCE ACTIVITIES

Different types of credit are useful at different stages of market growth, and the use of specific financing tools must be coordinated with the status of a country's PV market as it develops.

Like other commercial and service markets, PV markets grow in an organic manner.³⁹ Consumer demand grows once awareness is built up, given a genuine need for the product or service. Once demand is at a certain level, a supply chain to deliver and service the product develops. For some time, demand grows rapidly until the market begins to saturate. (In the case of PV, this would probably take decades.) Demand for PV systems needs to reach a minimum state of development before large-scale

consumer finance is useful. Otherwise, the finance intervention needs to include, and cover the cost of awareness-raising, market-building and installation/service.

Demand for 240VAC only occurred when people were able to buy 240VAC light bulbs and, much later, appliances. Power companies like General Electric in the United States supplied both power and the appliances. Similarly, demand for PV depends on the local demand for the appliances it powers. Because the PV power 'platform' is 12 volts, 12-volt appliances must be available in order to stimulate demand for PV technology.⁴⁰ In Eritrea, Ethiopia and the United Republic of Tanzania, a major obstacle to industry development is the low awareness and availability of 12VDC appliances and lamps.

Television and radio are powerful drivers of demand for PV solar home systems. PV planners and financiers need

TABLE 7

State of Market Development and Appropriate Finance Activities

State of market development	Features	Appropriate finance activities
Pre-commercial market	<ul style="list-style-type: none"> • No shops, specialized suppliers only • Donor financed • Institutional systems and telecommunications • Little use of 12VDC appliances • Low awareness 	<ul style="list-style-type: none"> • Little opportunity for finance because of lack of demand
Pioneer market	<ul style="list-style-type: none"> • Few shops, mainly concentrated in major cities. Retail and wholesale carried out by same groups • Emerging market for solar home systems • Low awareness 	<ul style="list-style-type: none"> • Pilot finance for pioneer companies • Pilot schemes through micro-finance institutions • 'Smart subsidies' through consumers or companies
Emerging market	<ul style="list-style-type: none"> • Many shops in major towns, and some retail outlets in smaller towns • Rapidly growing awareness of PV • Increasing use of 12VDC appliances 	<ul style="list-style-type: none"> • Larger loans for PV companies • Mainstreaming of PV consumer finance packages
Mature market	<ul style="list-style-type: none"> • Clearly defined wholesale and retail sectors of the market, with established relationships to international suppliers • Wide awareness of PV and use of 12VDC appliances • Advertising and media presence • Financing emerges 	<ul style="list-style-type: none"> • A wide variety of finance activities can be implemented • Will depend on development of the local finance industry

to know what portion of the market owns radios and TVs and is covered by TV and radio transmissions.

PV markets develop in stages (Table 7). In the *pre-commercial stage*, no PV companies exist. Virtually all countries have already moved beyond this stage, at least to the *pioneer stage*, in which a few companies operate. These companies tend to do everything (import, retail, install) while awareness is low and prices are high. In the *emerging market stage*, players emerge at different levels of the supply chain; demand grows quickly and prices are reduced because of competition. In the *mature market stage*, demand levels off, and niches evolve for importers and distributors, manufacturers, retailers and installers and other players.

The above describes a ‘normal’ market progression. But other patterns may be seen as well. In the case of fee-for-service delivery models, a mature market could develop in a very short period, as companies invest large amounts of capital over a short time period. The same is true where subsidies are introduced.

3.1 Pre-commercial market

In a pre-commercial market, there is, by definition, no commercial PV market and demand for the technology is scant. No companies are engaged in the business full-time. The major market includes missionaries, NGOs and aid programmes. Since no shops carry the technology, the prevailing method of purchase is through tender or import from outside the country. Markets move out of the pre-commercial stage once a minimum demand develops from NGOs, the local telecommunications sector or households. At a certain point, one or more local companies enter the market. This has occurred throughout Africa.

3.2 Pioneer stage

In the pioneer stage, start-up companies do importing, retailing and installations themselves. Because of the perceived risks of competition they are reluctant to collaborate with each other. A fundamental interest at this stage is increasing the number of operators in the PV market, and to diversify and increase the number of players. At this stage, projects can coordinate public awareness and technical training activities in the public sector to encourage companies to target rural customers.

Finance in the pioneer stage can be effectively used as follows :

- *Loans and lines of credit support companies.* In the early market stages, this enables companies to scale up their delivery capacities as demand increases and to conduct many of the activities to stimulate the market.
- *Pilot consumer financing.* Where there is interest, consumer financing through hire purchase schemes and loans from savings and credit cooperative or village banks can be introduced through pilot programmes.
- *Smart subsidies* can be offered to companies or consumers to quickly scale up volume (Box 16) when prices are high because of low competition and high margins. Offering subsidies directly to consumers is more difficult to implement logistically.
- *Guarantee funds* that provide companies with the financial resources to import products and offer attractive payment terms to retailers can help distributors consolidate their position in the market and their ability to successfully work with many retailers.
- *Cost-sharing grants* can help companies complete business plans, start marketing and public awareness initiatives, and conduct technical training courses.
- *Project-based tenders* can help start-up companies gain valuable experience by amassing a relatively large amount of work in a single contract, for example, to install a number of school, clinic, institutional or pumping systems at one time. At the same time, such contracts can help meet priorities of the health, education, water and communication sectors. Such tenders can be disaggregated by region so that they offer equitable opportunities to a number of companies. Involving regional agents instead of only city-based companies can also help distribute the benefits of this kind of arrangement.

³⁹ The significant exception to this is the ‘utility’ approach, where there is a very rapid growth from the initial stages. Essentially, the difference is one of market models. See Chapter 3 for more information.

⁴⁰ Or low-cost inverters to step 12VDC to 240VAC.

3.3 Emerging market finance activities

During the later, emerging market stage, activities should seek to help to build the market, strengthen the links of the supply chain, open up new markets by diversifying the products (for example, by varying PV system size), lower prices and maintain quality control. Since a basic level of demand already exists, the focus does not need to be so much on raising awareness. Likewise, increasing the number of players in the market is not a primary consideration. Instead, the strategy is to help existing players to become more efficient and better able to meet customer needs. Consumer finance is best developed in the emerging or mature market stages, when the technology is well known, when demand is strong, and when bankers and micro-finance institutions understand this demand and are willing to take risks.

During this stage, projects should seek to catalyse involvement of finance players in the PV market. In early stages of market development, most loan activities are pilots. During the emerging market stage, such efforts can be strategically scaled up with donor assistance:

- *Hire purchase and dealer finance schemes* can be enlarged. In early-stage markets, hire purchase and dealer financing would not normally be viable. In the Kenya market, hire purchase became viable only after there was a large cash demand for PV systems. Donors can catalyse this by helping partner finance organizations, specific demand centres and PV companies.
- Continued installation of *project-based tenders*. Project-based tenders build local PV markets. Given the huge unmet electricity requirements of rural schools, water supply stations, clinics and the communication and information sector, donors have a great opportunity both to meet their development objectives and to help build sustainable in-country PV industries. The PV sectors in Kenya, Mozambique, South Africa Uganda and the United Republic of Tanzania have all benefited from long-term support of PV companies by multilateral, bilateral and NGO donors through project-based tenders.
- *Bank guarantees/loans* for large-scale purchases by importers and distributors or for manufacturer set-up and expansion. Through innovative banking arrangements, projects can share the finance risks that companies face when they are trying to scale up volume and increase their reach. Funds can be deposited in banks over project periods, on the condition that they are made available to qualifying companies for specific purposes, such as importing of equipment or development of dealer-finance networks. Such programmes need to be carefully developed so that they are not misused or improperly applied.
- *Rural energy fund grants/loans/guarantees*. Ethiopia, Mozambique, Uganda, the United Republic of Tanzania, Zambia, and other countries are developing agencies and funds whose designated task is to help to build rural energy infrastructure through projects that meet the needs of rural business and households. Through rural energy funds, projects can be set up to support micro-finance and other institutions working with PV companies and customers. Alternatively, funds can be set aside to subsidize PV purchases through rural energy agencies, as has been done through the Energy for Rural Transformation project in Uganda.

3.4 Mature market finance activities

As a commercial market matures, opportunities for commercial financing increase. In Kenya, where the PV market could be considered mature, commercial hire purchase operators have entered the market, as have rurally targeted finance institutions – without any subsidy. How useful the finance interventions will be in a mature PV market depends to a high degree on the strength of the finance sector in the country, as discussed below.

In a mature PV market, rural energy funds can ensure that the needs of unserved markets continue to be met. The endgame of any project is a sustainable market, so smart subsidies would have to be reduced as the market matures. However, because rural electrification is always more expensive than urban electrification, it may always require some degree of support.

4 STABILITY OF FINANCIAL SECTORS AND THE POLICY ENVIRONMENT

Any attempt to develop the finance infrastructure of rural energy services (whether the end product is PV, liquefied petroleum gas, improved stoves or biomass) depends on the strength of the country's finance sector. Different countries have very different banking sectors, in part, for historical reasons. The banking sectors in Ethiopia, Kenya, Uganda and Zimbabwe, for instance, are each unique and very different from each other.

When planning finance efforts, the following should be considered:

- *History.* What is the history of the banking sector? What are the relationships among players? What types of finance have been attempted?
- *Stability of currency and overall economy.* If the currency is unstable, then financiers and companies will be reluctant to accept loans that must be repaid in a more stable currency, such as US dollars. For example, if a company takes a loan in US dollars to buy a container of PV modules, any devaluation of its own currency will mean that the company will have to quickly raise its prices to recoup the loan amount. If a revolving credit fund based on US dollars extends loans to hundreds of PV customers who are repaying in local currency, any devaluation of the local currency will mean that the fund managers may need to take a loss or renegotiate the loans.
- *Inflation and interest rates.* As with currency fluctuations, the rate of inflation and the rate of commercial interest will determine whether financial institutions can offer attractive loans and whether consumers will be interested in taking them.
- *Risk of drought or other upheaval and drop in commodity prices.* Agriculture sectors are vulnerable to drought. Even in areas with relatively high incomes, drought will reduce expenditures on amenities in rural areas considerably. Agriculture and mining sectors are prone

to boom-and-bust cycles depending on demand for their products. Coffee and copper are examples of commodities that have fallen in value in recent years; tea is an example of one that has gained value. Conflicts will also diminish consumer spending.

- *Donor investment.* The level of engagement of donors in the economy, and the possibility that they may invest in a project or sector, will have a bearing on company choices for entering rural energy markets.

Finance efforts should consider the institutional structure and capacity of the banking sector. Planners must determine how the banking sector is set up, which institutions occupy which niches, and how projects have used them in the past. Commercial banking is strong in some countries, weak in others. Some countries use development banks for large projects. The status of national and regional cooperatives, as well as micro-finance agencies in the non-government sector, should be established. Finally, if there is an active rural energy fund, projects and initiatives should identify how it can support the PV market (and other energy alternatives) in rural areas. All of these have a potential role to play in financing PV companies and consumers. Before proceeding with projects, however, knowledge of how the banking sector is regulated, and who is allowed to lend money, is essential. For example, in Ethiopia, there are strict limitations about NGOs performing finance or micro-finance operations.

A GEF project assesses the government's policy towards renewable energy. However, GEF and other multilaterals generally do not determine whether policy conditions in countries are favourable for financing of these renewable energy technologies. In the Zimbabwe project, for example, it was not discovered until much too late that UNDP could not provide loans to companies. As a result, the project was unable to offer company credit. In other countries, although governments have promised to relax value-added taxes and duties on PV, they have not carried out these promises. In some countries, gaining access to foreign exchange is a long process, and the inherent bureaucracy may impair the ability of companies to trade. Investing companies may also face restrictions on how they can operate. Therefore, it is important to

know in the planning stages the government's policy towards finance.

Another aspect to consider is the reach of the finance sector into rural areas. Are banks located only in cities, or also in towns and regional headquarters? In Kenya, most farmers and employed people belong to cooperatives and use them for their financial transactions. In Ethiopia, Uganda and other countries with less developed finance sectors, far fewer people use cooperative banking institutions than in Kenya.

It is also important to consider the level of interest that finance institutions have in new types of lending products. If the overall business climate is poor, bankers will have little interest in trying something new. However, if the economy is growing, and rural people are participating in the economy's growth, then some interest in financing rural energy is likely. Most GEF-supported projects have found that it took time to familiarize the banking sector with PV. In the case of the Uganda Pilot Photovoltaic Project for Rural Electrification and the Photovoltaic Market Transformation Initiative in Kenya, deals with the banking sector were not completed until the end of the project.

Finally, it is important to consider the preferences and borrowing and lending behaviour of the target rural communities and businesses. If there is no 'formal' credit, how do they access finance traditionally? What are their views towards taking loans? Is interest acceptable, and if not, how do banks operate?

BOX 18

Case study: Market transformation in Kenya

In 1998, the \$5 million Photovoltaic Market Transformation Initiative (PVMTI), supported by the International Finance Corporation and the GEF, was launched in Kenya. It proposed to use finance leverage for market transformation. Companies (or finance group/company 'consortiums') had to come to the table with a minimum of \$500,000 to be eligible. In an unstable financial climate, most companies found this to be quite difficult.

After four years, the initiative had committed \$4.7 million to three projects, but as of July 2003, only one of the projects had commenced. A variety of problems caused delays:

- Having to persuade financial institutions to get involved in this specialist sector
- Reforms in the financial services sector
- Having to coordinate and mediate between multiple project sponsors
- Legal complexities in finalizing security arrangements
- Poor performance of the Kenyan economy in recent years
- Political uncertainty in the run-up to the recent general elections
- Difficulties in changing consumer mindsets from a 'component' to a 'systems' approach to PV

Important lessons include the following: it is difficult to close on deals between multiple partners; investment structures should be kept as simple as possible; timing is important in PV projects (the Kenya investment climate was poor); and the loan sizes may have been too large for the intended market.

5 CONCLUSIONS AND LESSONS LEARNED

Ordinarily, planners think about financing end users, but other dimensions to financing PV projects need to be considered as well. Making sure that a PV industry can efficiently supply equipment is important, for example, and this also requires finance. Further, if projects intend to address poverty, they need to address community systems or provide electricity in ways that can help generate incomes.

First, the level of demand for electricity and appliances, and the sophistication of the demand, should be evaluated. Existing rural finance structures (whether formal or informal) adapt themselves to the desires and buying capacities of the communities, and the project should take advantage of what is already in place.

Second, planners should consider the state of market development in the country. Pioneer-stage markets, where awareness is low and technical capacities are weak, will require different interventions than mature markets. For example, in a market where few people are aware of PV technology, sustainable consumer financing packages will be difficult to arrange, and some sort of pilot arrangements will be necessary.

Third, the relative stability of the finance sector, the existing finance practices and the overall policy environment need to be carefully examined. Where policy towards PV is not favourable, offering systems at competitive prices may be difficult. Thus, if PV systems have been heavily taxed, addressing the tax structure may be more useful than setting up subsidy schemes.

Financing can help stimulate and coordinate the development of PV markets, but it is just one tool among many, and its effectiveness depends upon careful management. Lessons drawn from project and private sector experiences are:

- **Finance at the appropriate level.** Financing should be used strategically depending on the specific situation. Finance can be provided at the *consumer level* to help households, businesses and institutions overcome the

barrier of the high initial investment in PV. It can be provided to *PV companies* to help them expand their reach or ability to source equipment. Or, it can be used to assist *financial intermediaries* to play roles in the PV supply chain. For example, donor finance can be used to catalyse and facilitate the involvement of banks, cooperatives or micro-finance institutions in building PV – and rural energy – infrastructure.

- **Have realistic project objectives.** In all PV projects, tensions arise between different and sometimes competing objectives: alleviating poverty, opening up commercial PV markets and trying to identify the best financing mechanisms for consumers. Project designers and managers should be clear about their expected outcomes and realistic in their approaches.



Family with SHS from ESCO, Eastern Province, Zambia.

- **Tailor finance packages to the needs of the market .** Finance packages should be appropriately sized to meet the needs of the players in the market. Some projects have had over-ambitious targets with entrance thresholds that were too high. Others have not had enough finance and have been unable to have an incremental impact.
- **Vary the types of finance used depending on the local situation.** Projects should use as many types of financing mechanisms as deemed necessary. The cash market should not be underestimated, since it is an important base for long-term sustainable markets in all countries. Interventions need to be based on the stage of the PV market, the needs of the consumers and companies, and on the overall economic condition of the country.
- **Use finance all along the supply chain.** Finance interventions can be used to assist all links in the supply chain. Consumers, technicians, retailers, wholesalers, assemblers, manufacturers and even multinational companies all have roles – and different financial resources and requirements.
- **Be flexible but keep it simple.** Finance interventions should seek to avoid bureaucracy and complicated processes. They should be flexible enough to serve a wide range of stakeholders, PV companies, consumers and potential finance groups. Adapting existing application practices may be easier than creating complicated new ones. Make the process easy for competent companies to qualify – and make the milestones clear.



SHS at a household, northern KwaZulu-Natal (Nuon RAPS), South Africa.

- **Allow enough time for finance mechanisms to develop.** In rural areas, success with PV projects and financing often takes more time than expected. Motivating and educating the appropriate finance institutions is a long-term process. Finance organizations may not be interested in the PV product or the rural market, both of which they may view as risky. Market inertia is another factor. Just because funds are made available does not mean they will be taken up right away.
- **Leave finance scheme design and management to the experts.** Many revolving loan funds set up by non-finance-specialist projects or NGOs have not endured. The problem with PV projects is that planners are often so concerned about affordability that they do not address sustainability. Financing is best done by financing agencies, and it should be up to the finance agency to set interest rates, repayment periods, deposits and other parameters according to the needs of the project and the consumers. If professional financiers cannot develop appropriate schemes, then perhaps the whole idea needs to be revisited.

If finance capacity or institutions do not exist in a region or country, then the project should question whether to use finance at all. A PV project – unless specially set up to do finance work – is not a finance project. However, if the finance infrastructure is weak (especially in rural areas), then there may be reasons to provide assistance for finance development within the context of the overall project. Nonetheless, PV finance still needs to be integrated into the overall technology, finance and development requirements of the community.
- **Seek to cooperate with national rural energy funds.** Rural energy funds can play a role by making financing available for appropriate finance groups. If a country has a rural energy agency and fund, then that group should be the first stop for PV projects and companies. Rural energy funds should be encouraged to incorporate the use of PV and other off-grid energy technologies into their programmes.
- **Use finance as a carrot to ensure quality and post-installation services.** All PV systems installed with financial support, especially donor support, should be installed to minimum acceptable standards. Such standards should be clearly defined to consumers and suppliers by an appropriate national body or by the project itself, and legal agreements should be in place to make sure that such arrangements are followed. Because they are able to lump all costs together, finance agencies are in a unique position to leverage payments in a way that ensures that companies provide warranties, maintenance agreements and consumer education.
- **Take risks to gain experience.** Initiatives for pilot loans (such as those carried out in Kenya, Uganda, United Republic of Tanzania, Zimbabwe and elsewhere) often result in ‘devolving’, as opposed to revolving, loan funds. Though risky, they often help stimulate consumer demand, develop company skills in marketing and installation, and create interest and awareness among finance communities. When a revolving credit fund fails, or when PV systems implemented by a project fail, it does not necessarily mean that the project was a failure, especially if lessons are learned. The lessons learned from less-than-successful efforts provide valuable resources for others setting up new projects in other places. The point is that the experience gained from unsuccessful projects is also useful. The original planners of failed revolving credit activities might not have had the experience – or hindsight – that we now have to predict what would happen.

1 INTRODUCTION

1.1 Background

Beginning in the early 1990s, a number of medium- to large-scale initiatives delivered household-scale solar home systems to rural Africa. Perhaps the best known is a project supported by UNDP through the GEF in Zimbabwe to deliver 9,000 solar home systems during the late 1990s. In South Africa, the household market was dominated by private sales through dealers until 1999, when the South African Government initiated the large-scale ‘concession’ or ‘off-grid service provider’ (primarily smaller, private utilities) approach, which is now actively under way. In Kenya, a strong market, based primarily on a new, more efficient amorphous PV technology, has evolved. Botswana, Ghana, Namibia, Swaziland and Zambia have all developed PV markets, in many cases with special funds set up to support consumer credit. By 2003, 17 GEF-funded programmes to deliver household and other PV systems on a large scale had been approved or were under preparation; 11 of them are in Africa.

This section explores the delivery mechanisms used in these various PV projects. In particular, it looks at the main differences between large-scale utility,⁴¹ or fee-for-service type approaches, programmes that have a strong multi-stakeholder management unit and typically involve consumer credit, and programmes that seek to mobilize a broader industry base of participants – or commercially led models. Though the primary focus is on models that result in large-scale delivery to households, institutional service delivery is also discussed. Also addressed are the broader questions of energy services for rural areas and the need to consider approaches that support more integrated delivery.

Several excellent reviews of PV delivery methods already exist (see, for example, Martinot et al. 2001, Wamukonya et al. 2001, Cabraal et al. 1996). A recent and very comprehensive overview of experience and lessons learned has been conducted by the International Energy Agency Photovoltaic Power Systems Programme Task 9 team. This series of studies (known as IEA PVPS 2002 and IEA PVPS 2003b) is recommended for readers

seeking further analysis of different delivery models and case studies.

To provide a common framework for discussion, the basic delivery models are diagrammed below. Subsequent sections identify criteria for analysing the appropriateness of different models in specific contexts. The discussion is based on the following assumptions:

- Readers are seeking to find the best way to deliver PV systems. The critical question of whether PV systems are the most appropriate solution in a particular case was discussed in Chapter 1. As noted, PV systems are not the only solution, and are not always the best solution, for remote rural electrification in Africa.
- Some support will be required to increase the rate and sustainability of PV dissemination in rural Africa. The range of options is far reaching, including the setting of standards, marketing/advertising support, consumer financing, direct subsidization, financial support to businesses, enterprise development services, assistance in policy and strategy formulation, and building of technical or financial capacity.

If PV systems (or other rural energy options) are to make a significant impact on rural livelihoods in Africa, then successful business models must be shared and replicated on a vast scale. Tens of millions of households still need energy services in Africa. The scale of initiatives and their ability to be replicated are thus important criteria in deciding which efforts to support. As with many rural development activities, the challenge lies in finding methods that work at the community and household levels, that respond to local, often highly variable needs, yet have the volume and efficiency normally associated with highly managed, sometimes inflexible mass roll-out programmes. As delivery models are still evolving, it is hoped that the perspectives presented here will encourage methodologies that serve rural communities effectively, efficiently and sustainably.

⁴¹ Note that the word ‘utility’ in this context does not imply that the national grid utility need be involved. These programmes are often run by smaller, private sector utilities.



PV light in road side shop, Eastern Province, Zambia.

2 MAIN DELIVERY METHODOLOGIES

In categorizing the many delivery mechanisms for PV dissemination, this chapter focuses on the types of delivery and institutional infrastructure required, rather than specific financing methods. The latter are dealt with in more detail in Chapter 2. Four delivery – or business – models encompass the main elements of the many approaches used in PV projects:

- Commercially led approaches, in which suppliers and dealers develop the market (typically relying on cash sales)

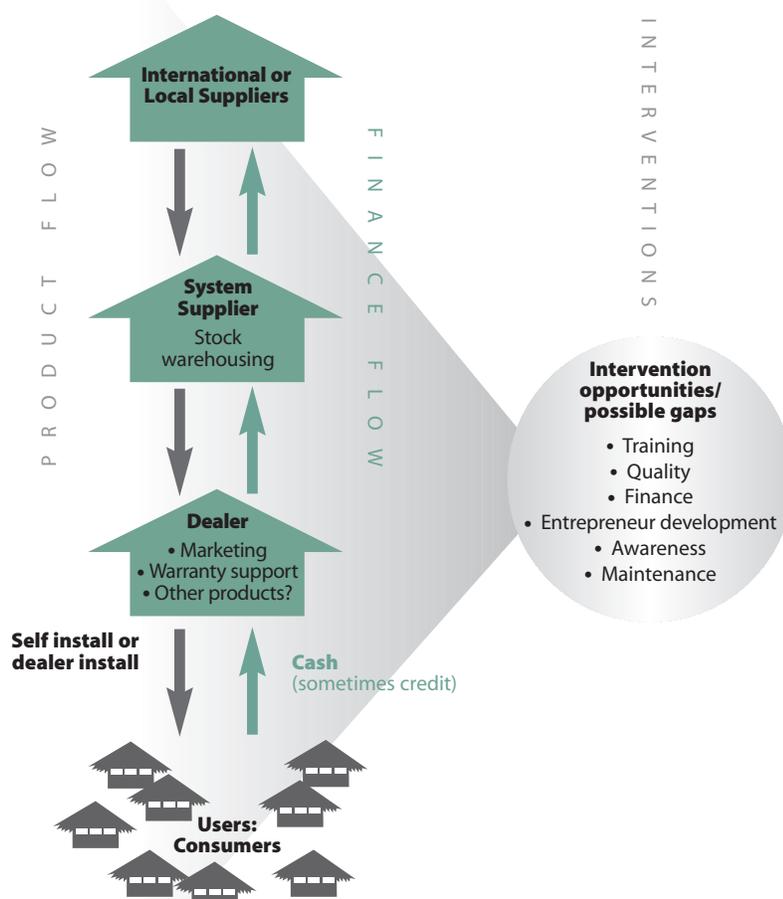
- Programmes managed by a variety of stakeholders (typically relying on consumer credit)
- Utility models (often, but not exclusively, with fee-for-service payment)
- Managed, grant-based models (typically used for institutions).

2.1 Commercially led models

Commercially led approaches are driven by suppliers and dealers who compete in the development of a market that responds to customer purchasing capability (Figure 4). In its purest form, there is relatively little control or

FIGURE 4

Commercially led delivery model: Suppliers and dealers are the principal agents driving the programme. A range of funders or institutions may provide support, but do not take a lead role.



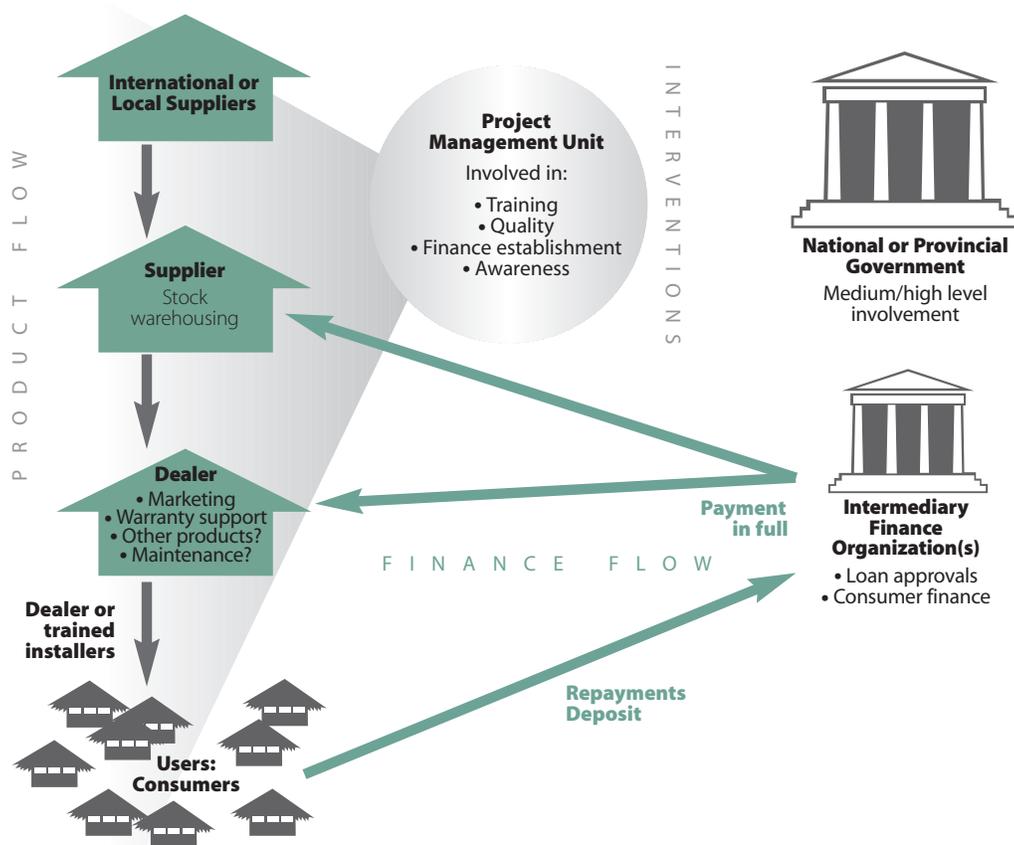
management of the process by government, aid agencies or international funders. Purchases are usually for cash, and customers may often purchase systems piece by piece. Dealers or vendors may operate a consumer finance scheme, sometimes in partnership with a consumer goods retail chain (Chapter 2). In countries such as Kenya, various interventions to support the market, such as training and the development of quality assurance standards, have helped develop the industry, but they do not lead or control the process. The entrepreneurs developing the infrastructure may also be supported by various development services and by gaining access to specialized funds. In Africa, AREED,⁴² E+Co and the Solar Development Group have been particularly active.

In Figure 4, the arrows indicate financial flows – from customer, through dealer, to supplier/wholesaler and then to the original equipment supplier(s) – and the movement of products. The intervention opportunities on the right indicate support services that may or may not be supplied by a range of NGOs, international PV support programmes, training centres, industry associations or government. Dealers and wholesalers will almost certainly make use of conventional banking services, but they may also receive financing and enterprise development services from appropriate organizations.

⁴² A United Nations Environment Programme (UNEP) initiative, offering rural energy entrepreneurs a combination of enterprise development services and start-up financing.

FIGURE 5

The multi-stakeholder programmatic model. This typically includes a project management unit or multi-stakeholder management committee. Consumer credit is usually offered through an intermediary finance organization, which is sometimes a village level cooperative or informal bank.



2.2 Multi-stakeholder programmatic models

Multi-stakeholder programmatic models typically have a targeted consumer credit option and involve a project management unit or a multi-stakeholder management authority. Figure 5 illustrates the actors typically involved. Usually more than one PV supplier or dealer participates. These programmes use formal technical standards and arrange for consumer finance according to defined rules, often in partnership with a specialist finance organization. Projects can be open to either individuals or communities from a wide geographic area, or they may try to batch installations in clusters using a village-by-village approach. Examples of this type of programme include the Zimbabwe UNDP-GEF project; the Uganda Village Bank, Uganda Women's Finance Trust and the Centenary Rural Development Bank components of the UNDP-GEF UPPPRE programme in Uganda, and the Home Power project in Namibia (see also the case studies in Chapter 2).

Although product flow is similar to that of the commercial model, the flow of funds is usually through an intermediary finance organization. This organization receives payments from consumers over a defined repayment period (typically three to six years), but makes lump sum payments to suppliers and/or installers. The project management unit typically carries the primary responsibility for programme establishment and management, setting up the finance systems and certifying suppliers or controlling installation quality and specifications.

2.3 Utility models

Utility models often involve a subsidy and may be linked to exclusive access to a defined geographic area. Figure 6 illustrates a typical utility concept. The approach is usually equated with fee-for-service payment, involving integrated long-term maintenance service. Revenue collection may either be carried out manually or by using a prepayment technology. The latter method aims to reduce the cost of collection and to provide clear signals to customers that payment is due (for example, lights are switched off when payments are overdue). However, other payment options are possible and may also lead to customer ownership of the equipment.

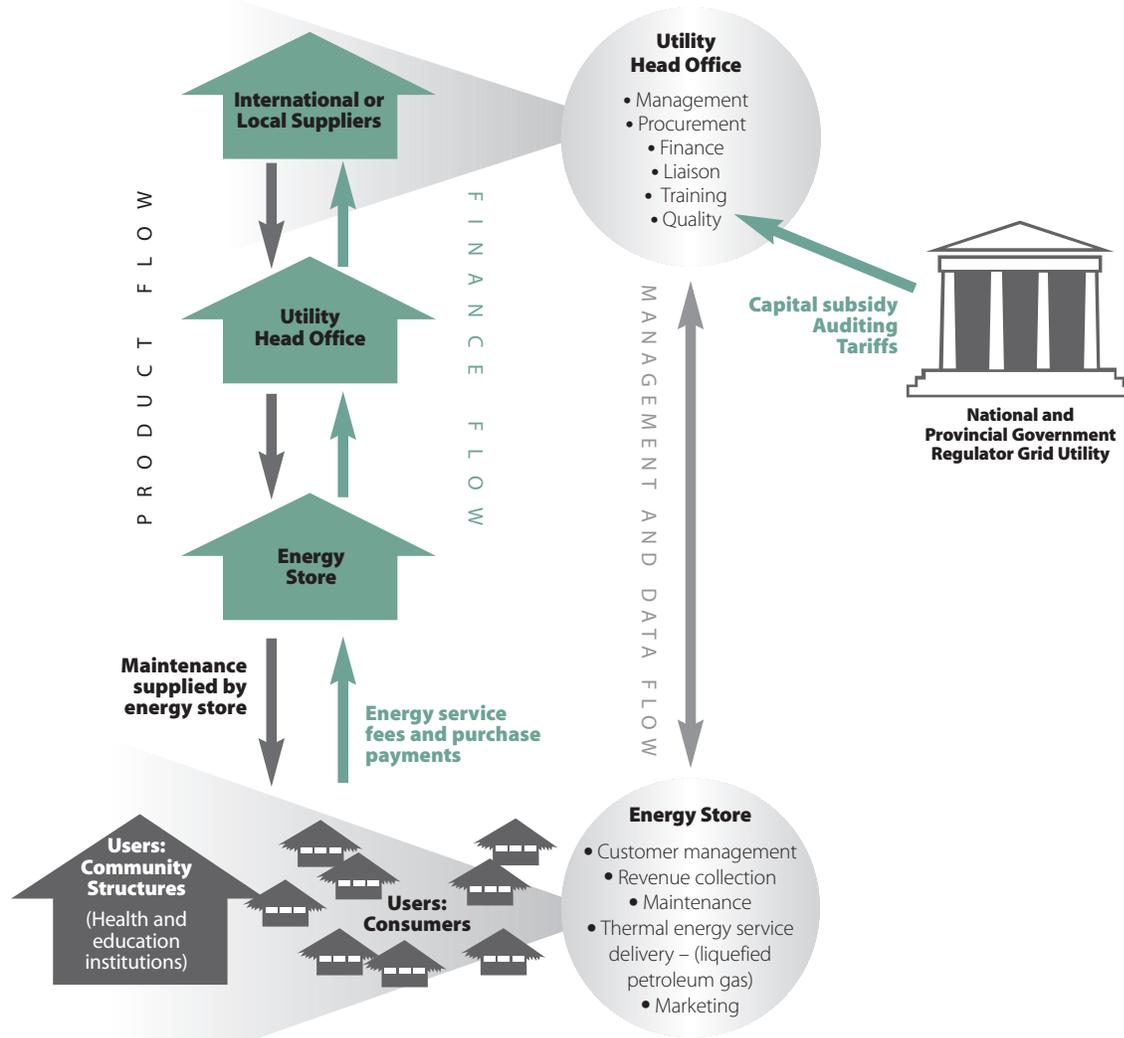
BOX 19

The Utility Model in South Africa

Figure 6 illustrates an approach adopted by the Nuon RAPS utility in northern KwaZulu-Natal, South Africa. The three arms of the utility (head office, regional office and 'energy stores') all work together to manage the delivery process. The process is directed by the utility (service provider) head office. The energy stores are the primary access point for customers, and are located in towns that customers visit for monthly purchases. They serve as the marketing focus, recipient of service applications, revenue collection node, base for maintenance management, and as retail outlets for other products such as liquefied petroleum gas, kerosene, gas appliances, insulated 'hotboxes' (thermal storage cookers), and energy-efficient 240VAC lights. The utility uses a software- and hardware-based Energy Service Management System to handle customer records, record all transactions and help to manage stock. Now in its second year of operations, Nuon RAPS has more than 6,000 customers, six energy stores and 60 staff. The application fee for a basic four-light, 50 Wp system is \$13.50,⁴³ and monthly service fees are \$2.40. Each system carries a capital subsidy to the value of \$466. The utility also supplies larger systems, some with inverters. The National Electricity Regulator plays a key auditing role, administering capital subsidies on behalf of the government.

FIGURE 6

Utility mode: Dissemination to households uses a pre-payment approach. Other forms of payment/ownership are also possible.



Such utilities are usually set up as public-private partnerships, using a competitive bidding process to identify private sector actors who are willing to invest in and operate within a framework defined by government. Ongoing regulation by government is usually necessary, since some sort of subsidy is usually involved. In this section, the key issue that distinguishes the utility approach from other approaches is that the utility – or service provider – is effectively responsible for the full

chain of activities. This includes financing, marketing, delivery, customer education, revenue collection, and maintenance of battery, charge controller and PV module. Although some of these tasks may be subcontracted to specialists, a single organization has to ensure that the programme operates successfully.

⁴³ Exchange rate used: US\$1 = 7.5 South African Rand

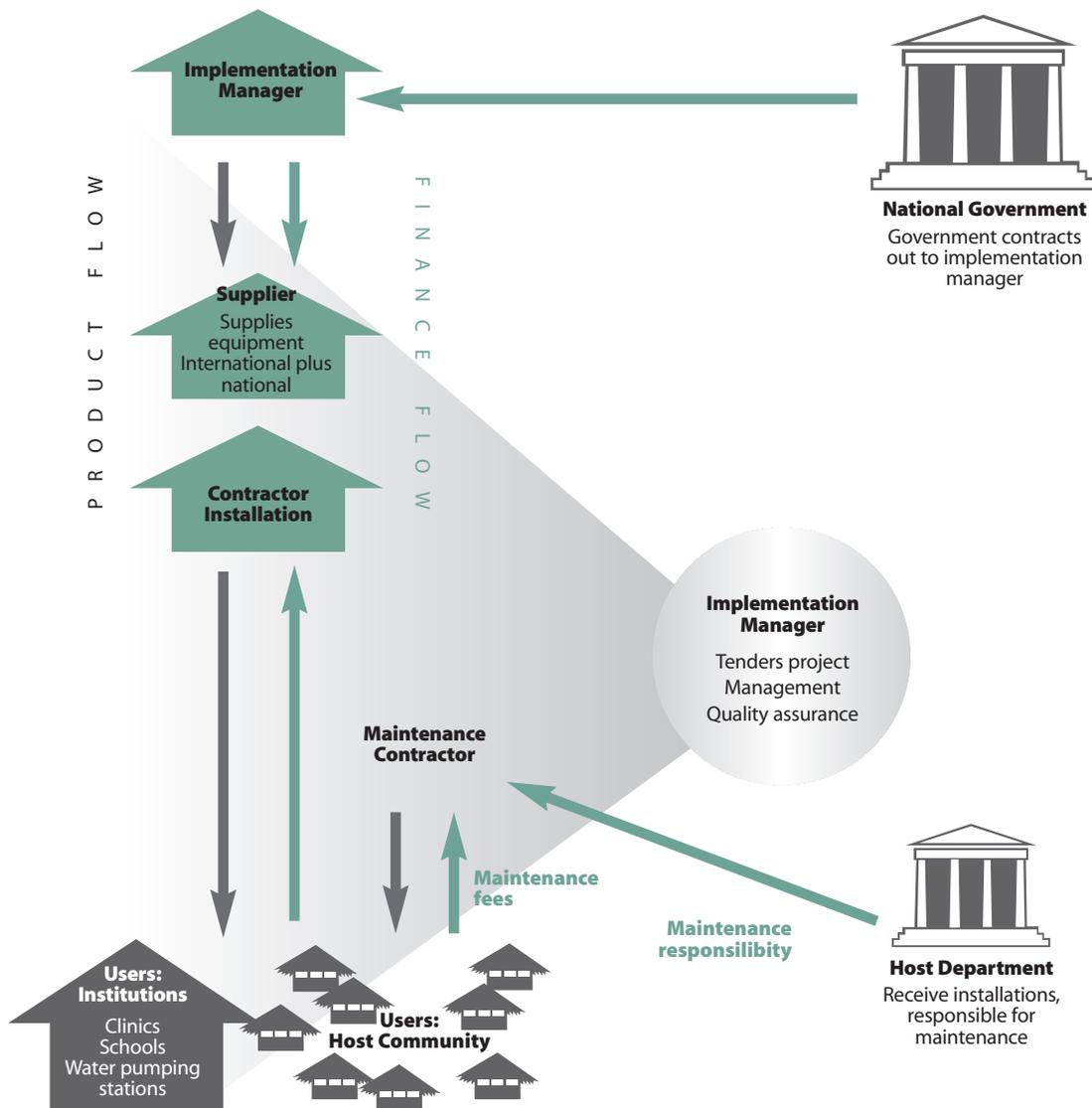
2.4 Grant-based models

Grant-based programmes tend to have an institutional focus. Typically, the entry point into the market is the need to provide energy services to rural institutions such as schools or clinics (Figure 7). Grant-based models are usually highly structured and managed: a project engineer is appointed, detailed specifications are drawn up and

suppliers are requested to tender for supply and installation. Host departments (usually education or health) may drive the programme, although in many cases a development agency or even a national grid utility has taken on this role. Funding is usually provided through national budgets or international grants. From the perspective of the recipient institutions, the installation is grant funded, although in many cases host institutions, local communi-

FIGURE 7

Grant-based model. Such models are often used to provide energy to institutions or water pumping stations. Typically they are medium-scale projects with formal tenders and a project manager.



ties or regional departments are expected to cover maintenance costs. Examples of this sort of programme include the Eskom-managed schools programme in South Africa (in which more than 1,000 schools were equipped with PV systems), and a project in Madagascar that will see more than 80 health centres and 40 schools receive PV electrification during 2004.

3 ANALYSIS OF DIFFERENT MODELS

Each of the above business models for PV dissemination has strengths and weaknesses. Their suitability to different country contexts depends on a range of factors, including technical and managerial competence available in the PV industry, status of the PV market, knowledge of PV by rural communities and demand levels among customers, affordability issues, financial and regulatory institutional capacity, and availability of subsidies or other financial resources. When considering the suitability of different models, it is also important to understand stakeholder objectives. These could include all or some of the following: household electrification, integrated energy service delivery, electrification of rural institutions, climate change mitigation, PV market development, profit and social responsibility.

In practice, delivery models are usually hybrids of the basic models described above. For example, the World Bank-sponsored Energy for Rural Transformation programme in Uganda seeks to use an institutional focus as the driver. Tenders and formal contracts for institutional supply provide a vehicle to get PV implementation started in rural areas. Similarly, a well-established fee-for-service utility that has households as its primary customer base would typically also seek to service institutions in the region of operation, and over time develop the skills to service 'productive use' applications as well. Many delivery models include some sort of grant or subsidy element, and project management units may have widely differing levels of responsibility and mandates for action.

The following sections discuss various business models. The first three models are reviewed in more depth since they address the largest market (in terms of the number

of systems) and have received the major share of GEF support to date.

3.1 Customer perspective

A key element of any delivery or business model is the ability to identify and respond to the needs of customers, whether they be households, users of institutional services, or prospective entrepreneurs who plan to use energy for activities that can generate income. The most successful models are likely to be those that find more customers, concentrate customers closer together, meet their needs better, and do so in a low 'cost-to-customer' and 'cost-to-business' manner.

3.1.1 Reaching customers

In a utility-type operation, viability is strongly enhanced if active customers are clustered around energy stores or service centres. Customers can be recruited only in regions that can support a maintenance technician. To achieve high customer densities, the roll-out of services needs to be carefully planned. Active marketing in specific areas can have a rapid and significant impact. In the South African case described above, the intent is to achieve market penetration rates of well above 40 percent of households in target communities. A typical fee-for-service utility, however, is unable to respond to requests from customers farther than 70 km or so from the stores. These customers must often wait until the utility moves to their region; even worse, they may fall outside the planned target region.

In contrast, dealers and vendors involved in a commercially led programme tend to have outlets only in cities and larger towns. Although these outlets are far less accessible to the customers they serve, determined customers from a wide area can at least gain access to PV systems. If PV equipment is treated as a commodity, sold in furniture stores or alongside other electronic goods such as televisions, then market reach may be both wide and deep, as general goods dealers tend to have distribution networks that reach into larger and medium-sized towns in rural areas. However, these generalist retailers are unlikely to be able to offer specialist customer advice or maintenance services.

Programmes that follow the multi-stakeholder programmatic model typically have two agreements with the customer: the finance contract, which is usually signed with an intermediary finance agency, bank or village bank, and the product purchase contract set up with a supplier. This can mean two sets of negotiations for the customer with both a time and a distance/location disadvantage. If only one of the parties (typically the PV dealer) is charged with finding the customer and taking the credit application, transaction costs can be effectively minimized. However, there is a risk that the dealer will not take proper care regarding credit risk assessment. Management units associated with such programmes usually have the resources and skills to market and raise awareness about PV, effectively acting on behalf of the PV companies and credit institutions that fall under the programme umbrella.

Institutional programmes funded by grants normally identify the recipient institutions (customers) through a regional or national prioritization process. These programmes need to take special care to ensure that adequate local-level consultation takes place, and to ensure that real needs are appropriately targeted.

Customer relations tend to differ in the various models. In the fee-for-service approach, customers are a long-term asset that must be built up over time. Cash sales require very infrequent interaction with customers, but must make sufficient positive impact during that interaction to garner referrals for future business. In a credit sales approach, a short-term relationship is required between customer and installer/supplier, but a longer-term relationship develops between the customer and the credit institution. Over time, if PV system performance is poor, it is the credit institution that will bear the brunt of customer ire (and possible failure to meet repayments).

3.1.2 Product choice

Different models tend to vary significantly in terms of the range of products they deliver. A commercially led programme tends to offer low-power systems, sometimes in a modular approach, since they work within the financial constraints of customers (Table 4 in Chapter 2). Several different suppliers may compete in the market and, at least initially, consumers will have to trust

warranty statements in order to assess whether they are purchasing the most appropriate products. As a result, sales can be limited. As market awareness increases, consumers will become more astute purchasers, industry associations may exercise some control, and certain minimum specifications may become compulsory.

In a multi-stakeholder programmatic approach, consumer financing is arranged. Detailed specific minimum standards are usually set, and consumers are given fewer options. Consumers have more confidence in the products offered since they are provided with technical and institutional support.

A utility service provider typically procures in bulk, and, while customers may be able to choose the size of the system, they have little or no flexibility regarding the specific components procured or the type of lights installed. Here the utility is selling the energy 'service', not the specific PV equipment. Marketing is easier and depends to a large extent on consumer perceptions of the value of the utility: for example, if the utility will fix problems quickly and whether it will be viable over the long term.

Institutional delivery programmes typically follow an international tender for product selection. End users thus have little input regarding the specific technology used, but they may influence which service options take priority (for example, medical lights, vaccine refrigeration, lighting, radios or staff lighting).

3.1.3 Affordability and willingness to pay

Affordability is key when looking at various delivery models from a customer perspective. The cost efficiency of a PV programme as a whole is reviewed in Chapter 1. Willingness to pay and affordability are influenced by a variety of factors, including:

- *Trust that the package being offered is the right one:* Utilities need to develop a service image, and vendors operating in a commercially led model need to build up the status of specific product brands.
- *Flexibility and frequency of payment schedules (for non-cash models):* Payments should be the right size to

justify a trip to the payment point, but not so high as to be a barrier. In communities with variable cash flows, flexibility regarding payment scheduling is critical. For example, many Nuon RAPS customers in South Africa pay for two or three months of service at a time, preferring to pay in advance rather than to make frequent trips to energy stores. In Ethiopia, many potential customers receive more than 80 percent of their income during a two-month period. If consumer credit or fee-for-service options were offered to these customers, provision should clearly be made to accept annual, rather than monthly, payments.

- *Proximity to payment points:* Remote payment points can be a severe constraint for models based on credit or fees for service. Transport costs to get to a payment point can easily exceed the monthly amounts payable.
- *Length of time that payments will be required:* “This is a 24-month finance arrangement, and then the system is mine” (credit), versus “I have to keep paying regularly in the foreseeable future” (fee-for-service).

Although fee-for-service type models tend to have the most affordable payment options (for a medium-sized, 50 Wp solar home system), the fact that these payments will continue indefinitely does tend to put some customers off. On the other hand, cash purchase of medium-sized systems is often too expensive. Thus cash consumers tend to buy lower-power units, and/or purchase in a modular fashion – first the battery (for TV), then a panel to charge it, and only later lights.

3.1.4 Customer education

Customers need to be adequately informed about the limitations of PV systems as well as proper management of the battery to maximize life and service benefits. Where sales are over the counter and the user self-installs, there is a risk that customer education will not be adequate. Opportunities for ongoing training are limited, since the vendor is likely to see the customer again only if a warranty fault is reported or if the customer wishes to upgrade the system.

In a multi-stakeholder programmatic approach, the stakeholder group or project management unit may arrange customer education programmes. Installers would also be expected to train customers. Typically, a maintenance contract is established for at least the period of any consumer credit repayments. This provides additional opportunities for ongoing customer education.

A utility or fee-for-service company has a direct incentive to ensure that customers manage the systems well, as this will prolong battery life and reduce direct costs to the utility. Thus there is a business incentive to have good customer education programmes in place. This type of education can take place at the time of marketing, installation, installation inspection visits or maintenance visits, or during regular interactions when service fees are paid. Some fee-for-service companies also have arranged community workshops or have included renewable energy items into the curriculum at schools.

3.2 Set-up processes: finding the players and initiating action

Photovoltaic system delivery in rural areas requires the active participation of a variety of players, (Figures 4–7). This raises two important questions:

- Will it be possible to attract partners of good quality into the programme within a reasonable period of time?
- Are there adequate incentives to ensure that partners will remain in place as long as is necessary?

For a commercially led approach to expand and reach high market penetration, a supply industry must develop. This usually requires a combination of international and local companies and the establishment of a commercial delivery infrastructure. Although the various players are dependent on one another, relationships can be quite fluid, and almost informal. The key partners in the chain are involved primarily because it is profitable. Growth and expansion can be fuelled only if the profits are sufficient to attract further investment. As noted in Chapter 2, support for such a model may come in a variety of forms, depending on the status of the market in the country context. In

pre-commercial and pioneer markets, it is necessary to demonstrate the advantages of PV electricity, conduct training and support marketing exercises. Once entrepreneurs have been identified, nurtured and 'pulled' into the action, they should be encouraged to drive the process, without undue interference from government and international agencies. A variety of support measures will be required to respond to needs that are identified over time, such as enterprise development services and financing activities, and establishing links to international suppliers.

Programmes that follow a multi-stakeholder programmatic model (Figure 5), such as the Kenya Photovoltaic Market Transformation Initiative (PVMTI) project or the Namibian Home Power Project, tend to have a more structured approach, particularly if consumer credit is involved. Rules of the game are set down, and businesses must go through a sometimes drawn-out process to gain the necessary approval to participate. In a number of such programmes, significant effort has been spent (sometimes with little success) on finding the right financial intermediaries to deal with consumers (REFSA,⁴⁴ Uganda UPP-PRE and PVMTI). For example, one objective of the project funders may be to pass on low interest rates directly to rural consumers. This can conflict with normal rural credit practices, and there is a risk of distorting or compromising the credit institutions' other lending activities. Managed programmes also usually require that formalized arrangements for installation, maintenance and procurement standards be set up. This can take time and will require ongoing project resources to oversee.

In some ways, a rural utility approach is the simplest to start up, but it is also the most complex. Once an area of operation has been identified and the necessary financing secured, the utility or service provider has to invest resources to build up the entire chain of marketing, supply, delivery and maintenance. Responsibility rests with a single organization that typically controls most aspects of the programme. Governments and funders have little to do but monitor. However, if the utility approach relies on or has access to a public subsidy, and if it involves exclusive access to a defined geographic area, then issues such as competitive bidding, selection of the service provider, identifying public sector signatories, formalizing contracts, and regulation come into play. These processes and agreements

involve several stakeholders and can be difficult to set in place. Over time, forms of contracts and modes of regulation will become more standardized, but the South African experience indicates that their complexity should not be underestimated. Four years into the process, government and implementers are still negotiating long-term agreements (see Banks 2003).

3.3 Procurement of technology and technical innovation

Choosing to deliver basic electricity services to rural communities using PV means adopting a technology that is costly and for which efficient supply chains often do not yet exist. In many GEF programmes, a key objective is to reduce supply chain barriers to PV delivery. Major issues are the cost of equipment supplied to rural households and the quality and fit-for-purpose aspects of the specific systems supplied. Equally important is establishing a sustainable supply infrastructure that has the necessary flexibility and reach to support ongoing market development. GEF programmes have adopted the following interventions:

- Developing national, regional and international standards for PV equipment. Several international and national standards exist, but technical developments are still taking place and procurement specifications need to evolve in a parallel manner.
- Bulk procurement on behalf of installers and suppliers (as in the Zimbabwe UNDP-GEF project)
- Allocation of working capital or other financing to dealers and suppliers as in the E+Co and UNEP AREED activities (UNEP 2003)
- Assistance in building links between local companies and international suppliers.

The four delivery models (Figures 4–7) have significantly different effects on the process of selecting and procuring products.

Commercially led models tend to bring various products and suppliers into the market, since different supply chains and partnerships are set up by entrepreneurs. However, at

least in the early stages of market development, it is difficult to bring prices down because quantities for individual deals are small. In many African countries, PV systems retail for more than twice the cost of those that can be obtained through large-volume purchases. Once a vibrant market is established (as in Kenya), prices will drop as the volumes flowing through importers or manufacturers increase.

Multi-stakeholder programmes tend to be more conservative and prescriptive with regard to product specification, and often use bulk procurement (as in the Zimbabwe UNDP-GEF project). Where used, the bulk ordering by the project management unit can reduce the price of individual systems, but the indirect links between procurement, marketing, installation and credit disbursement will make inventory planning more difficult (there is a risk that stock may not be used as quickly as envisaged). In some programmes (for example, Namibia's Home Power Project), suppliers set up their own procurement, reducing the potential for volume-based discounts but supporting the development of the supplier-dealer relationship.

Larger-scale utility models have the necessary purchasing power to secure significant cost reductions from an early stage in the market development process. Stock moves rapidly through the supply chain, and inventories can therefore be kept low, minimizing the tying up of capital. Such programmes do, however, tend to restrict growth in the supply industry to those few suppliers that are fortunate to win the tenders.

Delivery focused around institutional needs (Figure 7) tends to follow a more traditional tender-based approach.

BOX 20

In the Kenyan market, which is dominated by commercial sales of basic PV systems (often less than 50 Wp), supplier competition and consumer acuity have resulted in warranties of at least one year on all batteries. However, many rural shops have not been able to honour them. In the case of solar modules, there have been significant sales of specific products that have a high failure rate. The failure of the market and consumers to identify and stop purchasing the inferior product is a cause for concern (Duke et al. 2001).

Several excellent technical specifications for schools and clinics have been developed for national or regional programmes – often with orders of tens to hundreds of systems being placed at a time.

Procurement policies and standards also have a significant impact on technology innovation and diversity. Innovation is risky, and those responsible for procurement have to be strongly motivated to test out new ideas. In the case of commercially led approaches, motivation is quite strong because the market is competitive and reduced prices or better products can immediately lead to greater profitability. However, the constraints of working in a small business environment mean that returns on innovation must be rapid. Furthermore, if an innovation improves quality and product life, but has a higher cost, the vendors may be constrained from actively pushing this into the market by their need to respond to customers' sensitivity to price. Regrettably, the Kenyan experience has shown that the market can innovate in the wrong direction, with cheaper, inferior products gaining market share (Box 20). This is a critical risk for the commercially led approach, as the relative lack of control can mean that methods to exclude sub-standard products from the market are inadequate.

Formally managed multi-stakeholder programmatic approaches are less flexible regarding product innovation, and may have time-consuming approval processes. The project management unit will, however, be able to steer product selection in a particular direction (through credit access qualification criteria), and can thus require that systems have approved charge controllers or higher-quality lights.

In the utility approach, purchasing managers will tend to be more conservative – especially if the roll-out rate is quite rapid – since mistakes could be costly. However, reduced prices or longer component lifetimes can significantly increase the profitability of the utility, so the motivation for

⁴⁴ REFSA (Renewable Energy for South Africa) was a company established by the Government of South Africa in 1996. It sought to engage financial institutions to leverage grant funds for consumer finance. It was eventually closed after more than a year, without having financed a single deal – but in the process it helped facilitate the start of the 'concession model'.

innovation is high. Furthermore, the scale of the operation may be adequate to allow some innovation investment, either by suppliers or by the utility companies directly. In South Africa, a concession programme has resulted in significant new product development on charge controllers and revenue management systems, battery boxes and module mounts, as well as lights and switches. The concessions do operate within the constraints of a national specification, but have sufficient motivation and lobby capability to explore reasonable deviations from the specifications.

3.4 Rolling out: expanding once started

Once the key partners are in place, and the main financial instruments have been defined, success will be measured, to a large extent, in terms of roll-out capability. Key issues here are the rate at which the supply industry, the marketers/vendors and the installers can build up the necessary capacity. Rapid expansion is relatively easy to achieve (if adequate working finance is available), but ensuring that the foundations are solid and that the key players will stay involved over the long term is not.

In a commercially led approach, roll-out is partly constrained by the need for growth to be incrementally profitable, since the dealers and vendors involved typically need to have a quick turnaround on investments made in new staff, new retail premises or even vehicles. If the vendors are not exclusively PV dealers, but also use their infrastructure for other products (such as furniture, automobile parts or electrical goods), then the additional PV business can be rolled out as one of many products, sharing the risks and speeding up dissemination. As noted in Chapter 2, most successful PV companies in Ethiopia, Kenya and the United Republic of Tanzania are multi-product companies. In some cases, international role players have become directly involved (for example, Shell Renewables in Sri Lanka), which can allow for long-term retail infrastructure development. As commercial businesses expand, business plan development and access to business finance will be critical in supporting growth. The range of vendors operating independently does mean that roll-out or expansion will tend to be more organic, with less national-level planning. However, if the system really is profitable at every step, expansion could be quite rapid.

In a more structured multi-stakeholder programme, where consumer credit may be offered, expansion can be directly stimulated by the programme. This can be achieved by using pilot village projects, marketing, centralized training services and active brokering of implementation partnerships. Roll-out can cover a relatively wide geographic area, since several players may be involved who are effectively responsible for their own management.

The utility approach, in contrast to others, will tend to follow a highly structured roll-out programme. Management is responsible for most of the implementation chain – including staff recruitment, training, establishment of regional offices, establishment of customer liaison points, marketing and procurement. The rate of roll-out (assuming demand is adequate) is primarily determined by management's access to resources and its ability to control the process and set up the necessary infrastructure in rural areas. After core staff have gained the necessary experience, and once detailed procedures and methodologies are in place, expansion can be rapid.

3.5 Assurance of long-term maintenance

Long-term maintenance of solar home systems remains one of the most difficult problems faced by the promoters of PV. Although PV panels often come with warranties of 10 to 20 years, batteries have a life of one to four years, and lights and wiring do require occasional maintenance. Charge controllers (if used) can fail, or blow a fuse, and need attention from time to time. Although literature on evaluation of PV systems installed longer than three years is scarce, there are sufficient examples to raise concern. A review of the UNDP-GEF Zimbabwe project, for example, indicated that 48 percent of the GEF project systems were faulty. Of these faulty systems, 33 percent of them had battery failure, 23 percent had light failures and 12 percent had charge-controller failure (Chigwada 2003). It is useful to ask the following questions when looking at different business models from a maintenance perspective:

- Who is responsible for maintenance?
- Do they have the resources and skills to do it?
- What is their incentive to keep maintaining these products?

In the commercial or supplier-led models, customers are responsible and have a direct incentive to ensure proper maintenance, provided that they paid full price for the equipment. Because of their limited access to financing, customers tend to purchase relatively low-cost systems with components that can be replaced. As the technology becomes better known in a region, one would expect customers to learn to recognize products with better warranties and reliable performance. This is not necessarily the case (Duke et al. 2001). Customers are therefore at risk of losing their investment because they have made poor product choices or because they are unable to repair components if they fail. On the other hand, if the density of customers in the region increases sufficiently, small repair shops will likely develop.

In a multi-stakeholder programme, with larger systems relying on consumer financing, the risks are higher because batteries and charge controllers may cost more to replace than customers can readily afford (unless credit terms are extended for component replacement as well). Typically, in this sort of scenario, technicians are trained by the project in the hopes that they will remain in the project area to service customers. Will these technicians resist the allure of the city, and will the amount of maintenance work in the region be sufficient to keep them employed? This depends in part on customer density, affordability of the maintenance services, and the long-term funding allocated to providing the infrastructure for technician support. Programme experience to date indicates that one cannot simply assume that the maintenance infrastructure will establish itself, or that the consumers will be able to afford replacements.

Assured maintenance is arguably the strongest aspect of the utility approach. The customer is effectively obligated

BOX 21

A mobile technician should be able to visit at least three households a day. If he visits each customer once a year, this means that each technician could service about 660 customers annually. Labour alone is likely to cost about \$3.60 per customer,⁴⁵ resulting in an income of about \$2,400 a year. Depending on the terrain and the density of the population, travel costs could significantly erode into these profits.

to set aside resources (through the service fees), and the service company assumes direct responsibility to ensure that maintenance is carried out and that the battery is replaced as required (internal lights may, however, remain the responsibility of the customer). Here, the biggest risk to maintenance is either that the utility goes bankrupt, or that payments have to be increased at some stage beyond what customers can afford. The utility faces the risk that customers will not look after the systems properly, since they assume that they will be repaired at no cost to the customer. Four key measures are required to prevent this: good customer education and relationships, use of charge controllers that protect systems against overuse, clear lines of responsibility for both customers (for example, lights and internal wiring) and the utility (battery, charge controller and PV module), and efficient management of the maintenance process.

Institutional programmes face a different set of challenges for long-term maintenance. Although users can be trained to undertake first-line maintenance, rural institution staff will move from time to time, and often lack the technical and financial resources to repair or replace major components. Instead, recipient regional departments (of health or education) often are expected to provide a long-term maintenance budget and possibly even maintenance personnel. The South African experience indicates that this kind of government support is difficult to put in place, and competing priorities for scarce operational budgets can easily divert funds from PV system maintenance.

3.6 Market diversity

Different PV delivery models vary in their ability to supply and support PV applications beyond the specific target of their core business. For example, a grant-based programme for the electrification of health centres and schools that uses a tender approach, tight deadlines and very specific contract terms (Figure 7) may have little or no ability to directly support household electrification, or even other institutional electrification activities beyond awareness-raising and marketing. However, if suppliers/installers of institutional programmes are

⁴⁵ Based on experiences from South Africa.

consciously encouraged to look for broader markets while in the rural areas, then it may be possible to use an institutional delivery programme to stimulate household demand.

The ability of commercially led delivery to support diverse PV markets will depend primarily on the nature of the companies driving the process. Where household solar home systems are retailed through furniture stores or other conventional rural outlets, there is little likelihood of servicing institutional or productive use clients, since the products commonly stocked may not be suitable for institutional use. Specialist PV system retailers, on the other hand, have a strong incentive to broaden their market to include institutions, telecommunications and security services, and water pumping stations. In particular, suppliers may respond to tenders for grant-based projects.

To date there has been relatively little institutional supply directly associated with the fee-for-service utility model. However, several of the utilities in South Africa are starting to look actively at institutional markets, and government has indicated that the off-grid utility companies are strong potential partners for installation, and more importantly maintenance, of rural institution PV systems.

Most consumer-credit type programmes have been limited to households because the focus of credit mechanisms, standards development and market development all relate primarily to this market. Although a multi-stakeholder management unit would be well placed to facilitate delivery to other types of customers, there is typically little direct incentive to broaden the programme beyond the original design goals. More recent projects, such as the World Bank-GEF Energy for Rural Transformation in Uganda and Mozambique, have explicitly targeted households and institutions (see relevant case studies in Chapter 2).

3.7 Ability to supply other energy service needs

Photovoltaic systems meet a limited range of energy needs. In households, they provide power for radio, television and lights. Rural communities, however, have broader energy needs, including cooking, heating, transport, pumping and heating water, and servicing of health and education institutions. From a socio-economic

or development perspective, a focus on funding PV projects for household electricity can raise doubts. Is it the best use of funds in South Africa, for example, to spend \$500 on a subsidy for a household PV system in communities whose women and children spend several hours a day searching for fuelwood. When funds are allocated primarily for PV electrification, it is therefore useful to consider whether the models used will have a broader impact on the delivery of other energy services. Given the current reliance in many countries on fuelwood and charcoal, and sometimes dung or paraffin (fuels with a significant adverse effect on health and the environment), integration of PV delivery into the broader energy picture becomes especially relevant.

The South African Nuon RAPS utility model illustrates the potential to use PV delivery, revenue control and management infrastructure to retail paraffin, liquefied petroleum gas and associated appliances. Indeed, gross revenue from these fuels can easily be far higher than the revenue generated from PV, and the different products can be synergistic. A growing number of projects have tried these combinations, for example, the KwaBhaza (Kloot 1998) and Parallax activities in South Africa (Cooper 2003). In the former, liquefied petroleum gas appliances and fuel delivery were bundled with solar home system delivery, reducing customer choice but also reducing marketing and transaction costs. Maintaining diversity in the supply chain is not easy, however, since it requires both broader training of retail staff and adequate incentives to run a more complex business. In Kenya and Zimbabwe, some retailers who have good rural networks for other appliances have stocked PV products (even using the same hire-purchase agreements). These cases do not involve other energy services, but they demonstrate how retailers can reduce costs through supply chain synergies.

For certain PV programmes, however, the institutional, funding and infrastructure design is not amenable to the provision of thermal fuels. For example, where a rural credit institution handles revenue collection, there is no regular and direct interface between a supplier and the customers. In these cases, it may be better to promote PV well, rather than to undertake integrated energy service delivery haphazardly.

In some countries (for example, Ghana and Kenya), a rural liquefied petroleum gas network is expanding by using petrol service stations as the host and link for improved delivery. Where such thermal energy delivery infrastructure exists, business owners and programme designers will need to consider whether integration of PV with thermal energy delivery is appropriate, or whether it is better to focus on less integrated models.

3.8 Is delivery innovation encouraged?

It is apparent from the literature that the PV market and delivery models are still evolving. Furthermore, businesses and programmes need to be responsive to local situations and changes that may occur in the institutional and policy environment. How flexible are the different business approaches? Can they innovate and respond to change?

In the commercially led model, where several suppliers and dealers operate in a relatively unfettered manner, successful innovation will be rewarded through increased sales and profit margins, and the business infrastructure needs to adapt to changing circumstances. With several independent players, one expects new ideas to be tested and success stories to emerge. On the other hand, the commercial environment is unforgiving of errors, and vendors and dealers thus tend to be conservative. Moreover, some desirable innovations, such as establishing a locally trained technician to support various brands of PV equipment, may not be embraced by dealers because of competition.

The utility or fee-for-service approach involves long-term commitments and relies on institutional relationships that make it hard to change aspects such as tariffs, payment contracts and subsidy allocations, or clauses in any concession contracts. The relationship with regulatory authorities, however, is a public-private partnership, and the utility should therefore be able to raise issues of concern in a constructive manner. One risk is that a 'utility mindset' may develop, which tends to be conservative and resistant to change. In other respects, however, the approach is quite flexible. Management, if motivated, can implement changes to business practices and customer management processes fairly quickly, as they control most

aspects of the finance, delivery and service chain. In the South African utility experience, operators have changed several key elements, including installation management (Nuon RAPS) and revenue collection methodologies (Solar Vision and Eskom Shell).

Multi-stakeholder programmes should, in principle, be strong on innovation. They have input from several actors, including credit institutions, suppliers and the project management unit. Key stakeholders in the management group will often have broader development priorities and can therefore allocate resources to issues such as generic technician training and user education. However, the reliance of multi-stakeholder programmatic approaches on cooperation and participation from these various stakeholders – all of whom have different objectives – can create institutional inertia.

A major source for innovation is the ability of a particular business model to attract and retain creative personnel. Many internationally funded programmes recruit for a period of one to five years project managers who may be very innovative in the short term (provided that the project design leaves them adequate flexibility), but who leave the project in an essentially static state when their contract expires. Environments and policies change continually, and sustainable businesses have to be innovative as a long-term strategy, not just a start-up concept. This requires that delivery models be able to retain involvement of innovative personnel. In this respect, commercially led and utility-type models are attractive, since in both cases there is a strong profit incentive to keep the business going over the long term.

3.9 Financial efficiency and the ability to raise funds

Large-scale PV system delivery can only take place if significant funds are raised and resources are used wisely. Thus the financial efficiency of different business models will help determine which models are better suited to a particular country context. Financial options, and the relatively merits of different models from a financial perspective, are discussed in more detail in Chapter 2. Procurement costs and efficiencies have already been addressed in section 3.3 of this chapter. Apart from the

cost of hardware, other critical costs to consider are financing, revenue collection, technical and support staff required, delivery of products to target areas, project design and set-up, and ongoing management of project teams. Detailed financial comparisons of different business models are not readily available, and those that are tend to be context specific. For example, there are significant differences in cost and personnel structures within three of the operating off-grid utilities in South Africa, even though they all use a fee-for-service approach – and even the same revenue management system. It is therefore difficult to say which models make most efficient use of scarce resources. However, the questions raised below provide a list of points to cover when considering any model.

Finance: How is financing raised and at what cost? Does a long financing chain involved high transaction costs? Do investors need market rates of return, or do they have other motivations to commit funds – such as social responsibility or environmental commitments?

Infrastructure: What infrastructure needs to be established? A utility may require several energy stores, but if they are kept busy and have a high turnover of stock, this is acceptable. A commercial supplier may have fewer outlets, but then must stock them with slow-moving goods.

Revenue collection: What does it cost to collect money from customers, and to ensure that all of it is accounted for? Are audit controls simple and effective? Is physical infrastructure used to its fullest capacity?

Technical staff: Are technicians employed efficiently, or do they spend most of their time travelling? Are they suitably trained for the tasks at hand?

Administration and support staff: Are many support staff required for purchasing and stock control, revenue control and database administration?

Delivery and transport: Who transports solar home systems to remote rural households? Are many systems carried at once (lower cost), or does the marketing and installation process require ‘one-off’ delivery (higher cost)?

Project design and set-up: Did the project take years of expensive consultancies to develop? What is the relationship of design and set-up costs to the number of systems delivered?

Management costs: Senior-level management tends to be very expensive in developing countries. Are the skill levels appropriate? Will management be able to achieve delivery rates that justify their salaries?

Reporting costs: Do governments and international funders need to be kept up to date on progress? What is the cost of providing the necessary data and auditing?

Commercially led models have low local-level infrastructure costs (customers come to the city to purchase PV systems). A fee-for-service utility will require rural technicians, significant rural travel and infrastructure for long-term revenue collection. On the other hand, large-scale programmes will achieve significant procurement savings and, if installations and maintenance are managed efficiently, may be able to keep economic costs⁴⁶ (if not financial costs) low. Marketing, applications processing and installations can be done in a structured manner, with high product turnover and high productivity.

Revenue collection (applicable to fee-for-service, credit-based schemes and even for shorter-term dealer-financed options) needs to be cost effective, both for the collector and for the consumer paying the bills. If payment points are far from homesteads, then customer travel costs can be significant. Furthermore, the administration involved needs to be simple and cost effective. Prepayment metres can help reduce administration and debt collection costs, but require additional capital investment. Paper-based systems are more vulnerable to mistakes and fraud, and require more staff to monitor and produce the necessary records. Once volumes increase, it will almost certainly be more efficient to computerize records for all but the simplest of cash-based schemes. Village banks or other cooperative loans schemes can provide an alternative method to consolidate loan repayments, placing the administrative burden on the community and consumers and lowering costs for the project.

Overall, the resource requirements to achieve significant off-grid electrification in Africa are relatively low when compared with defence budgets, or even household energy expenditures in developed countries. For example, at \$500 per household, an allocation of \$1 billion could fully subsidize electrification of two million households in Africa. This raises an important question: Which business model is best able to attract investment? To date, all four models presented in section 2 of this chapter have been moderately successful in raising funds. Programmes in Africa (primarily credit and fee-for-service type models) have seen more than \$230 million invested or committed to PV (a combination of GEF financing and co-financing from other donors and governments). An additional \$525 million has been committed by GEF and co-financing from other donors and governments to projects in Africa that have some element of PV among other renewable energy technologies applied (GEF 2003). The South African fee-for-service programme has a current target of \$112 million investment.⁴⁷ In Kenya, 120,000 systems have been installed primarily following the commercially led model (see Kenya case studies in Chapter 2). This represents an investment on the order of \$60 million (raised primarily from customers' pockets). However, if delivery is to take place on a scale that makes a difference to a significant proportion of the Africa population, then 20 million households need to be connected, at a cost of \$10 billion. This will require several large-scale, highly organized programmes that can efficiently channel funding for subsidies and climate change projects. Consumer-driven commercially led models will need to evolve to such a stage that they can generate sufficient profits to attract large-scale commercial investment.

3.10 Risk management

Several risks are associated with the delivery of PV systems to rural areas. The manner in which these risks are spread out among various actors and mitigated by the different business models provides useful insight into their suitability in a particular context. Some of these risks are discussed below.

3.10.1 Theft

In many countries, PV modules and batteries have a high value and have been the target of theft. The fee-for-

service approach is particularly vulnerable, in that customers do not own the system and cannot realistically be held liable for replacement costs. With this approach, customers carry the least risk. As with any service, the attitude of customers is dependent on the ability of the utility to build a positive relationship with clients and to instil a sense of ownership. Credit and cash schemes have progressively less vulnerability to theft (on the part of the supplier), with increasing risk for the customer. If customers feel a strong sense of ownership and value the PV service, this will undoubtedly help to avoid theft. However, there are some drawbacks to placing the full theft risk on the shoulders of customers:

- If a system is stolen and the customer owns it, the customer has to carry the full cost of the loss and is unlikely to be able to replace the system. From an equitability perspective, it does not seem fair to make individual customers carry the full risk of theft.
- Individual customers are not really in a position to reduce theft risk; the community as a whole is best positioned to do so. This requires that the community be motivated through a combination of customer efforts and interventions by the service provider, the police and even the government.
- If the supply company or service provider or even the credit institution carries a significant part of the risk, then they will be strongly motivated to try to arrange group insurance schemes; find technical solutions to make equipment less attractive to thieves or more difficult to steal; work actively with community policing forums to put an end to crime; and to negotiate with communities who want the service to ensure that theft risks are reduced.

⁴⁶ Although programmes using local technicians and revenue infrastructure may incur higher 'wage bills', these will be paid primarily to people living in rural areas. Thus, from an economic perspective, there is a circular funds flow within target communities – a positive result.

⁴⁷ Assume 220,000 systems to be installed by existing government-funded concessions over the next eight years, and a further 30,000 by the proposed concession to be funded by Kreditanstalt für Wiederaufbau (KfW). At an average subsidy of \$450, this amounts to \$112 million. Additional investments from the service providers and from the customers take the value far higher.

3.10.2 Grid electrification of formerly off-grid areas

Electrification using PV systems is costly, demands considerable maintenance and delivers small amounts of electricity. Grid electrification, if affordable and at least reasonably reliable, is thus far preferred for households, institutions and businesses. In South Africa, where there is an active grid electrification programme and a strong national grid, the risk of grid encroachment into areas without electricity and areas powered by PV is regarded by some as the most serious impediment to off-grid electrification. In many cases, customers do not want to invest in PV systems, thinking that the grid might soon arrive. In other areas, customers that have solar home systems have stopped paying for them when they see the grid nearby. From the perspective of the customer, fee-for-service approaches are attractive in this sort of situation, since the customer has not made a major personal investment in the system and can simply stop paying for the service when the grid arrives. The service provider will then have to retrieve the system and find an alternative location for it. In South Africa, some compensation is paid to the off-grid service provider by the national electrification fund in such a case. When a system is owned by the customer, it is possible to sell part or all of the system – if a buyer can be found.

In countries with very weak grids or low levels of rural grid electrification, and in areas remote from the grid, arrival of the grid is unlikely and the risk of grid electrification has little impact on the choice of delivery models.

BOX 22

Dynamic shifts in rural markets can affect even a robust industry:

Sales of solar home systems in South Africa were hard hit when a massive grid electrification programme got into full swing in the early 1990s (Morris 1996). In more recent years, the cash market has also been affected by the fee-for-service utility programme. This offers highly subsidized PV systems to certain market regions, making private sales of systems comparatively unattractive (although some suppliers have in turn become suppliers to the utility companies).

3.10.3 Inflation and exchange rate risks

Most solar home systems are imported, and even if some items are manufactured locally they often follow international currency prices. As a result, markets are sensitive to changes in national currency values and inflation. Rapid shifts in the exchange rate will hurt any business model, but those dependent on long-term revenue collection will be most affected. Credit-based schemes typically have a fixed interest rate, and the investment and repayments are made in local currency. Thus the ability of recovered funds to finance a new purchase is significantly compromised if devaluation or significant inflation occurs (see IEA PVPS 2003b). Commercial models with cash or very short term credit-based vending are obviously least vulnerable in this regard. In the case of a fee-for-service approach, tariffs can be revised on a yearly basis, typically subject to review by a regulatory authority. Provided that customer affordability remains constant in real terms, there is some scope to raise tariffs and to keep them high enough to finance ongoing operations and support new installations.

3.11 Another look at objectives

As the title indicates, this chapter of the report focuses on delivery of PV systems to rural areas. PV systems use renewable energy and have been identified by the GEF and other organizations as an important vehicle for supporting both climate change mitigation and development in Africa. The primary objectives of typical GEF projects are the following (Martinot et al. 2000):

- Remove the barriers to the use of commercial or near-commercial renewable energy technologies
- Reduce any additional implementation costs for renewable energy technologies that result from a lack of practical experience, from initial low-volume markets, or from the dispersed nature of applications, such that transactions that are profitable for all parties and activities increase the deployment of renewable energy technologies.

However, if one sets the objective along the lines of ‘seeking to improve the quality of life or rural communities through improving access to energy services

BOX 23

Concept: Integrated Energy Service Centre

Picture a rural area, with 150 villages, each between 50 and 500 households in size (a total of 45,000 households), scattered across a region hundreds of kilometres across. At several of these villages is located an 'energy store' that has sales staff and provides a base for a few maintenance technicians. This energy store stocks liquefied petroleum gas, gas appliances, kerosene, improved biomass stoves, hay boxes,⁴⁸ perhaps even solar cookers. The store also sells PV equipment or, alternatively, does the marketing and payment collection for a fee-for-service utility or even a credit-based PV delivery model. In addition, the store acts as a payment/customer service point for grid customers in the area. It has a computer system that tracks customer payments, and uses information gathered about customers' purchasing behaviour to help assess creditworthiness. Loans are issued to some customers on behalf of a partner rural credit organization. The technicians based in the area install and maintain household solar systems, either on a cash basis or on contract to a fee-for-service utility (or as part of a maintenance contract for a credit-based scheme). They also carry out basic maintenance on several institutional systems and productive use energy systems in the area (also on hybrid systems with wind and/or diesel generation). Their basic knowledge of electricity is adequate to

allow them to assist the grid customers in the electrified settlements with simple fault resolution. Every two weeks, a supply truck visits each store as well as specific points in some of the neighbouring villages, dropping off pre-filled gas bottles and kerosene at selected sub-agents and collecting service fees or credit payments from agents in smaller villages. These agents in turn supply local consumers, saving them a trip to the energy store.

The stores report to a management team that arranges longer-term supply deals with liquefied petroleum gas and kerosene companies, PV equipment manufacturers and suppliers. The management team also negotiates with regional and national government on behalf of the energy stores. This secures maintenance contracts for the institutional PV systems, access to financial support for energy service delivery, and a vending contract for grid electricity. Shareholders who have international connections facilitate access to renewable energy certificate trade for the PV systems installed in the region. Management also monitors fuel cell and other alternative technology developments, since new technology may be more cost effective than PV for some of the productive use and institutional customers served by the energy stores.

(including basic electricity) in a sustainable manner', then business models may emerge that have a slightly (or radically) different institutional infrastructure, but which still help to achieve the GEF objectives. An example is the integrated energy service centre concept (Box 23).

The key to integrated energy service company concept is that sufficient infrastructure (human and physical) is put in place in rural areas – supported by a management team – to improve access to fuels, appliances and energy sources. This infrastructure provides the necessary channels for information flow both down to and up from communities. It is maintained through a variety of revenue streams, with financial flows both up and down the chain. The specific nature of the technology delivery model can vary – for some products cash, others credit, and perhaps even fee-for-service. In some cases, products may carry a government subsidy, and other products or services delivered by the infrastructure could be on strictly commercial terms.

Although it is a hypothetical example, elements of the above model are being tested in various projects in South Africa by organizations such as Solar Vision, Nuon RAPS and KwaZulu Energy Services. The national government has also recently started establishing integrated energy centres in partnership with petroleum companies, where cooperative ownership of liquefied petroleum gas and paraffin vending points in rural areas is being tested. There seems to be a strong interest in integrated delivery models from other African countries.⁴⁹ Though they do not focus on PV systems exclusively, they could provide a large-scale, sustainable delivery channel. Furthermore, PV is one of the few catalysts that could help establish such rural energy

⁴⁸ A hay box is a well-insulated container into which a pot of food that has been boiled for a few minutes is placed and left for several hours. The heat stored in the pot, food and liquid is sufficient to completely cook many different types of food.

⁴⁹ Discussed during the 2003 UNDP-GEF May workshop.

service business. PV has an international profile and access to climate change funds and other funding resources; it also meets a clearly defined need in off-grid rural communities. Another catalyst that is receiving growing attention is liquefied petroleum gas, since it is a clean safe fuel that is in many ways preferable to kerosene and could help to reduce reliance on fuelwood and charcoal.

3.12 Potential for broader development impact

If PV systems are only for households, and only the wealthiest households can afford them, spending of scarce resources on promotion can reasonably be questioned. This constraint unfortunately makes it difficult for governments to commit significant electrification funds unless the business model is such that it can deliver services to a reasonably high percentage of the population in the target area. Accountability and audit records are also important for government and funders, and for these reasons fee-for-service or perhaps credit-based schemes tend to be favoured in projects that have significant government involvement. This is unfortunate, since simple ‘dollar-per-watt’ subsidies used to bring down the cost of PV systems could be far simpler to implement. Such subsidies have had a significant impact in other markets, including those in the US state of California, Germany and Sri Lanka (see section 2.1.5 in Chapter 3).

The development impact of solar home systems themselves, or even institutional systems, are not discussed here, since it is assumed that direct benefits will be relatively similar regardless of the business model used. However, the delivery and revenue collection infrastructure established as a result of a particular business model may have significantly different development impacts. Specifics will depend on the details of the implementation: How many jobs are created? How close are outlets to rural communities? What other services can those outlets offer? For example, a rural credit institution financing PV systems may be able to deepen its rural networks and offer similar credit for productive use applications. If the delivery model involves establishment of outlets or stores near rural communities, the links established among rural communities, store staff and, through those, management and national-level decision makers, can lead to other development activities. The

rural energy stores established as part of fee-for-service approaches could act as an information conduit – outwards in terms of issues such as energy safety and general awareness in communities and also upwards, in that the voice of those communities will be carried through the internal communications mechanisms of the utility to other parties in government, funding or development circles. In the longer term this could lead to a higher profile for rural energy issues in the broader policy environment.

Job creation opportunities and the nature of those jobs can vary significantly for different PV business models. A PV retailer, who sells self-installing systems directly to the public, will need sales staff in stores and a distribution infrastructure, but little else in terms of personnel. In models that require controlled installation (many of the credit models and utility models), installation teams are required. These are usually recruited from target communities, with the idea that some will remain in the area as maintenance technicians.

3.13 Sustainability in the longer term

The delivery of PV systems needs to be sustainable in the long term for two reasons: to service the systems already installed (see this chapter, section 3.5), and to deliver new PV equipment (or energy services) in significant volumes to new clients and to meet the expanding needs of old clients.

Sustainability of new product delivery infrastructure is difficult to assess. A proportion of vendors and dealers

BOX 24

The impact of household PV systems on development:

- Education: potential to study at night
- Income generation and increased local employment: light to work at night, power for sewing machines and other low-power tools
- General awareness, participation in national society: access to TV and radio
- Health: less smoke and paraffin fumes that can cause respiratory and eye diseases
- Security: better lighting at night, less risk of fires from candles

operating in a commercially led market are likely to find ways to keep themselves in business and to continue to grow once the market is established. The long-term strength of the vendor/dealer approach is that it is diverse and not dependent on a single factor or institution. Where a delivery approach relies for its existence on a government subsidy (some of the utility approaches), or a specific credit fund or institution (several of the multi-stakeholder programmatic approaches), then there is a gain in simplicity. But there is also a significant risk that policy changes, currency crises or bankruptcy could bring the programme to a halt.

As noted in section 3.8, longer-term survival will depend on the ability of the businesses or institutions involved to respond in an innovative way to changes and threats that may emerge. Motivation to adapt depends to a large extent on the nature and commitment of investors and management teams, and on the projected changes in revenue streams. Consider the perspective of a credit manager in a rural finance institution. Is PV financing seen as a growing business opportunity, or something that they have been persuaded to try by determined project managers and funders? Does it lead to a growth and a deepening of their business? Does it introduce new customers that they can sell other credit services to and develop a sustainable business? Will the credit manager be sufficiently up to date with technology shifts to realize that standards and technologies need to change? To date, there is inadequate experience with the utility approach to judge, but the financial models developed by this author indicate that it is in the latter part of a utility's life that cash flow becomes strongly positive (once the high investment costs have been settled). In particular, if the utility has been able to develop other businesses alongside the PV service, the utility should develop into a robust business entity that can operate over the long term.

4 CONCLUSION

The delivery of PV systems and other energy services remain unresolved challenges for policy makers, programme designers, investors and rural communities. Although there have been some successes in a variety of countries, a massive roll-out of PV systems into rural areas of Africa has not yet happened. Even in

Kenya, where a strong commercial market has developed, the number of new systems sold each year is still only about 20,000 per year (or less than 1 percent of the number of rural households in the country). Only if connection rates of 5–10 percent of the country's households can be reached each year will a truly significant impact be made over the next decade. Other technologies such as the kerosene stoves, battery-based systems, cell phones and even motor vehicles have been far more successful in finding their market niche in Africa. If PV technology is to make a significant impact, then the industry, retailers, programme designers, funders and governments need to continue striving to identify the best ways of financing it, getting it out to households and communities, and keeping it working once it is there. Ultimately, success should be measured not only in terms of how many systems are installed, but also in terms of how many systems are still working after five or ten years. If a subsidy or development support has been financing the programme, it is also necessary to measure the results in terms of the development impact, in areas such as jobs, education, health and quality of life.

All of the business models discussed above share common difficulties in raising finance, dealing with theft, and keeping maintenance and management costs low. Some have distinct advantages, for example, consumer affordability in the case of fee-for-service models. In every model there is a significant weakness: establishment costs and minimum scale required for fee-for-service approaches; high costs to the customer in the case of cash sales; multiple stakeholder involvement and concerns regarding long-term maintenance in the case of consumer credit models. Each has variations and hybrids, since participants have found ways to overcome the different obstacles. The intention of this report is not to recommend a single approach. Rather, by raising issues and possible pitfalls, it intends to help those involved in setting up, supporting or financing PV delivery schemes (or other energy service delivery operations) to analyse their options and make informed decisions. The tables presented below highlight the essential points raised and summarize the main conclusions.

Summary Tables

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	Commercially led models – typically cash-based sales	Multi-stakeholder programmatic models – typically involving consumer credit	Utility models – typically fee-for-service	Grant-based models – typically used by institutions
Reaching customers	<ul style="list-style-type: none"> National suppliers Dealers have strong local marketing incentive, but may be far from customers Multi-product retailers have much better market coverage 	<ul style="list-style-type: none"> Project management unit has main responsibility Suppliers motivated but may not be concerned about customer's ability to pay Finance organizations typically have other priorities 	<ul style="list-style-type: none"> Utility has primary responsibility Clustering of customers is critical Utility needs to establish long-term customer relationship Focus on project regions 	<ul style="list-style-type: none"> Recipient institutions identified at national level Risk of mismatch between local needs and national department objectives Risk of inadequate consultation
Product choice	<ul style="list-style-type: none"> Smaller, modular systems more common (often without charge controller) Warranties and certification possible, but difficult to enforce 	<ul style="list-style-type: none"> Often 50 Wp systems Supplier qualification and setting of standards easier, but customers may still have choice of different suppliers 	<ul style="list-style-type: none"> Customer may be able to choose system size, but would have no choice regarding brands and components selected 	<ul style="list-style-type: none"> Usually international tender, according to formal specifications End users have little choice (except through early project workshops)
Affordability	<ul style="list-style-type: none"> Business generally based on cash, thus affordability constrained 	<ul style="list-style-type: none"> Consumer credit used to improve affordability 	<ul style="list-style-type: none"> Lowest upfront and monthly costs Fee-for-service payments do not end (and may increase with inflation) 	<ul style="list-style-type: none"> Typically requires little upfront contribution from institution Long-term maintenance costs are significant and often not adequately provided for
Customer education	<ul style="list-style-type: none"> Dependent on specific dealer (if customers are disappointed, business slows) PV sold over the counter through multi-product retail outlets; little scope for consumer advice 	<ul style="list-style-type: none"> The system installer is usually responsible Some projects arrange village-level training, but long-term financing for this is difficult 	<ul style="list-style-type: none"> Utility has direct incentive in order to prolong battery life Energy store staff educate customers during marketing and revenue collection Installers, during post-installation workshops Maintenance technicians, in the course of their work 	<ul style="list-style-type: none"> Installer may be required to do this as part of tender Specialist training could be provided

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	Commercially led models – typically cash-based sales	Multi-stakeholder programmatic models – typically involving consumer credit	Utility models – typically fee-for-service	Grant-based models – typically used by institutions
Set-up process: finding the right players and initiating action	<ul style="list-style-type: none"> Range of interventions to stimulate: <ul style="list-style-type: none"> • Training • Access to technology • Demonstration of business opportunity • Entrepreneur development services • Enterprise finance 	<ul style="list-style-type: none"> • Identify or establish institution(s) with rural reach and financial expertise willing to pass on low interest rates to consumers • Identify suppliers, installers, maintenance and marketing partners • Negotiation of formal links difficult and time consuming 	<ul style="list-style-type: none"> • Regulatory and legal framework needed (public sector negotiation) • With big enough projects and sufficient market information, will attract operators interested in integrated services • Once selected and contracted, the utility as integrated service provider has primary responsibility 	<ul style="list-style-type: none"> • Fairly conventional project start-up requirements • Need to ensure that host departments and institutions are adequately represented in project team
Procurement	<ul style="list-style-type: none"> • Dependent on dealer-supplier relationships • Usually smaller quantities and mixed products • Quality and mark-ups not controlled except by market forces • Prices tend to be higher until market matures 	<ul style="list-style-type: none"> • Quality assurance guidelines and specifications set nationally • Programme may have central procurement, or at least facilitate batch procurement • Requires careful inventory management • Prices are fair to low 	<ul style="list-style-type: none"> • National specifications should be used as guide. Utility might be allowed minor deviations, but has to ensure that it can maintain the system • Bulk repetitive procurement is possible, with resulting downward pressure on prices 	<ul style="list-style-type: none"> • Programmes tend to define detailed specifications • Procurement can yield lower prices but be difficult for the local industry to manage
Technical Innovation	<ul style="list-style-type: none"> • Strong incentive to innovate, provided that returns on investment are fairly rapid and do not result in higher costs to customers 	<ul style="list-style-type: none"> • Innovation potential depends on project manager • May be constrained by institutional inertia 	<ul style="list-style-type: none"> • High potential for innovation because of strong incentive to reduce life-cycle costs and large, predictable volumes • Some conservatism to reduce risks will emerge 	<ul style="list-style-type: none"> • Project tenders typically issued in cycles, with opportunity to learn and innovate from batch to batch
Rolling out – expanding once started	<ul style="list-style-type: none"> • Depends on operations being seen as incrementally profitable (sufficient returns to attract investment) • Lack of entrepreneurs may require ongoing training, sharing of experience and finance support • If retail uses pre-existing outlets, expansion is easier 	<ul style="list-style-type: none"> • Provided that credit facility is adequately resourced, additional implementers/installers can gear up rapidly • Management unit can directly stimulate market through regional pilots 	<ul style="list-style-type: none"> • Ability to scale up depends on financial resources and utility's ability to recruit and train staff • Initial roll-out relatively slow, but speeds up significantly once experience gained 	<ul style="list-style-type: none"> • Rate of delivery primarily dictated by availability of grant funds

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	Commercially led models – typically cash-based sales	Multi-stakeholder programmatic models – typically involving consumer credit	Utility models – typically fee-for-service	Grant-based models – typically used by institutions
Long-term maintenance	<ul style="list-style-type: none"> User takes primary responsibility Dealer (if close enough) will support, but on cost-recovery basis Medium risk of system failure – as if bought with cash or dealer credit, user can presumably afford to replace battery 	<ul style="list-style-type: none"> Maintenance contract usually set up for finance period User is ultimately responsible Project should market in batches to improve customer density Higher risk of system failure, since battery may be too expensive for user to replace with cash and credit may be difficult to obtain 	<ul style="list-style-type: none"> Utility has primary responsibility for long-term maintenance (including battery replacement) Maintenance is part of defined service conditions Important for utility to focus on customer density Medium to low risk, provided that utility stays in business 	<ul style="list-style-type: none"> If host institution has strong commitment to project, maintenance budgeting and management can be secured Experience indicates that adequate resources are frequently not set aside – especially if implementation authority moves ahead without full endorsement by host institution
Ability to support diverse PV targets (schools, clinics, water pumping stations, etc.)	<ul style="list-style-type: none"> If suppliers support dealers, can diversify into other PV markets, often through tenders Multi-product retailers unlikely to be able to diversify beyond household market 	<ul style="list-style-type: none"> Depends on initial programme objectives and project management motivation The consumer finance organization has little direct incentive, except if financed productive-use applications are developed 	<ul style="list-style-type: none"> Other PV targets in service regions are attractive additional market Utility has ability to negotiate at multiple levels to develop large programmes Local-level infrastructure can readily support liaison and maintenance May need special division to supply design or installation support 	<ul style="list-style-type: none"> Programmes usually have focused objectives, but they can help raise awareness Participants (suppliers) can be encouraged to develop more commercial markets
Ability to supply thermal energy services	<ul style="list-style-type: none"> Outlets very unlikely to be close enough to most customers 	<ul style="list-style-type: none"> In some cases finance or PV outlets will be too far from customers In certain projects an explicit link has been made, using local technicians or entrepreneurs to facilitate repayment collection, maintenance and sales of liquefied petroleum gas 	<ul style="list-style-type: none"> Revenue collection and maintenance infrastructure can be utilized for other fuels Viability of the utility can be enhanced through thermal fuel profits and sharing of infrastructure 	<ul style="list-style-type: none"> Not aware of experience to date

	Commercially led models – typically cash-based sales	Multi-stakeholder programmatic models – typically involving consumer credit	Utility models – typically fee-for-service	Grant-based models – typically used by institutions
Is delivery innovation encouraged?	<ul style="list-style-type: none"> • Yes. But within constraints of running small business operations (shortage of working capital means that innovation must be profitable in short term) 	<ul style="list-style-type: none"> • Yes, especially at design phase • Risk that innovation during implementation phase is hampered by multi-stakeholder institutional inertia • Projects tend to have 'short' duration; are lessons carried through properly? 	<ul style="list-style-type: none"> • Overall institutional/finance structure difficult to change, but utility can raise issues with regulatory authority • The utility has strong incentive to improve efficiency of installation/maintenance/revenue collection operations • Utility can change certain aspects of operational mode easily 	<ul style="list-style-type: none"> • Opportunity for innovation is primarily confined to the project design phase; once tenders are issued the process becomes rather rigid
Financial efficiency	<ul style="list-style-type: none"> • Less costly because village-level infrastructure not needed • Retail outlet sustainability requires high mark-ups on goods (unless product turnover becomes very high) • Revenue collection is low cost (cash) 	<ul style="list-style-type: none"> • Village bank or energy agent options have medium/low cost. Intermediary finance organization will have higher financial costs • Need to ensure that range of stakeholders and participants does not result in excessive costs for liaison and management 	<ul style="list-style-type: none"> • Utility approach requires significant scale to justify the different level of expertise required • Once lessons can be shared, smaller-scale projects could be viable • Pre-payment meters, if used, have medium initial costs, but lower revenue collection costs and provide detailed transaction records in the longer term • Paper-based systems have lower initial costs but are more open to fraud 	<ul style="list-style-type: none"> • Grant-based programmes are efficient at dispersing funds, but tend to have poor record with regard to collecting medium-term maintenance funds
Vulnerability to theft. What is the risk of loss through theft?	<ul style="list-style-type: none"> • User carries primary responsibility • Low to medium risk since user has strong sense of ownership • Risk to dealer higher if provided finance 	<ul style="list-style-type: none"> • User has primary responsibility • If subsidy involved, risk increases • During repayment period, finance institution carries significant risk • Low to medium risk, as user has strong sense of ownership 	<ul style="list-style-type: none"> • Utility carries main risk • User carries some risk • Very dependent on utility relationship with community • Medium to high risk, as sense of ownership is not developed 	<ul style="list-style-type: none"> • Institutional systems installed with grant funds have very high risk profiles for theft • Critical to take security measures, and to encourage a strong sense of community ownership

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	Commercially led models – typically cash-based sales	Multi-stakeholder programmatic models – typically involving consumer credit	Utility models – typically fee-for-service	Grant-based models – typically used by institutions
Sensitivity to uncertainty regarding grid/off-grid planning	<ul style="list-style-type: none"> User carries full risk If users are uncertain they are not likely to purchase If system costs are subsidized, subsidy will be 'lost' 	<ul style="list-style-type: none"> User legally carries risk, but can default on payments, so finance organization will share risk After payments finished, user carries full risk If system costs subsidized, subsidy will be 'lost' 	<ul style="list-style-type: none"> Utility carries risk Can structure risk-sharing with electrification fund or electrification planning authority (compensation if grid arrives in preauthorized off-grid areas) Can redeploy equipment, as does not belong to customer 	<ul style="list-style-type: none"> If installed according to formal standards, large parts of an off-grid distribution system often can be integrated into subsequent grid electrification layouts Generation and storage systems need to be moved
Sensitivity to inflation and currency devaluation	<ul style="list-style-type: none"> Cash-based business can survive inflation reasonably well 	<ul style="list-style-type: none"> Programmes are vulnerable to inflation, particularly if interest rates subsidized or fixed for the longer term 	<ul style="list-style-type: none"> Tariffs can be reviewed (with regulatory approval), but if customer affordability is compromised by increases, system become vulnerable 	<ul style="list-style-type: none"> Grant programmes are reasonably insensitive to inflation initially Inflation needs to be carefully considered for longer-term maintenance
Potential for broader development impact (apart from the direct development impact of the service offered)	<ul style="list-style-type: none"> Multi-party industry established over time Entrepreneur development services /small- and medium-sized enterprise agents may work in other areas Little direct engagement in other rural development issues Jobs created in sales and maintenance (assuming majority of systems are owner-installed) 	<ul style="list-style-type: none"> Credit facilities could be used for other services Entrepreneur development services /agents of small- and medium-sized enterprises may work in other areas Project management unit may specifically target other needs by trying to share skills, but usually only has mandate for defined period 	<ul style="list-style-type: none"> Multi-level structure facilitates interaction with stakeholders from communities and local council, and at national and even international levels Infrastructure can be used for other services Utility is likely to establish several jobs in rural communities 	<ul style="list-style-type: none"> Managed institutional programmes are unlikely to have significant development impact beyond those achieved as a result of the actual service delivery
Sustainable in the long term?	<ul style="list-style-type: none"> Many players, several with innovation capacity and strong incentive to stay in business No single dependency Should be able to survive various threats 	<ul style="list-style-type: none"> Dependent on multi-role-player relationship remaining intact Project term constraints – key individuals may only have medium-term contracts If true 'revolving finance', funding should last, but funds tend to 'devolve' 	<ul style="list-style-type: none"> Contracts should be long-term Vulnerable to government policy shift Companies could 'fizzle out' before achieving necessary critical mass of installed customers. Unless incentive to stay in business is adequate, utility should sell business to alternative operator 	<ul style="list-style-type: none"> Long-term sustainability depends on whether host institutions truly value service and have adequate resources for maintenance

References

- Banks, D. I. 2003. 'Rural energy service delivery: a public private partnership approach'. *Proceedings, Domestic Use of Energy Conference, Cape Town*.
- Cabraal, A. Cosgrove-Davies, M., and Schaeffer, L. 1996. 'Best practices for photovoltaic household electrification programs: Lessons from experiences in selected countries'. *World Bank Technical Paper No. WTP 324*. Asia Technical Department Series, Philippines, Sri Lanka, Indonesia, Dominican Republic. ISBN 0-8213-3728-9.
- Chigwada, J. T. 2003. Paper presented at the Workshop on Financing Mechanism and Business Model for PV Project, 27–29 May 2003, Pretoria, South Africa.
- Cooper, D. Personal communication, 2003.
- Duke R.D., S. Graham, M. Hankins, A. Jacobson, D.M. Kammen., B. Osawa, S. Pulver and E. Walther. 2001. 'Field performance evaluation of amorphous silicon (a-Si) photovoltaic systems in Kenya: Methods and measurements in support of a sustainable commercial solar energy industry.' *ESMAP Technical Paper No. 005*, UNDP.
- Energy for Sustainable Development. October 2003. 'Study on PV Market Chains in East Africa'. Study completed for the World Bank Africa Energy Unit.
- Energy Sector Management Assistance Programme (ESMAP). January 1999. 'Uganda: Rural Electrification Strategy Study. Final Report'. Washington, DC, The World Bank.
- Energy Sector Management Assistance Programme (ESMAP). 2000. 'Zimbabwe rural electrification study'. Report 228/00. Washington, DC, The World Bank.
- Energy Sector Management Assistance Programme (ESMAP). 2001. 'Kenya implementation manual: Financing mechanisms for solar electric equipment'. Report 231/01. Washington, DC, The World Bank.
- Global Environment Facility. August 2003. Six internal records of the GEF Operational Programme. GEF Secretariat.
- Hankins, M. 2000. 'A case study on private provision of photovoltaic systems in Kenya', Chapter 11, *ESMAP Energy Report 2000*, Washington, DC: The World Bank. ISBN 0-8213-4705-5.
- IEA PVPS. 2002. *Financing Mechanisms for Solar Home Systems in Developing Countries*. Report IEA PVPS T9-01.
- IEA PVPS. 2003a. *PV for Rural Electrification in Developing Countries: A Guide to Capacity-building Requirements*. Report IEA PVPS T9-03.
- IEA PVPS. 2003b. *Summary of Models for the Implementation of Solar Home Systems in Developing Countries*, Part 1 and Part 2. Report IEA PVPS T9-02.
- Karekezi, S. and K. Waeni. 2002. *Renewable energy strategies for rural Africa: Is a PV-led renewable energy strategy the right approach for providing modern energy to the poor of sub-Saharan Africa?* *Energy Policy* 30: 1071–1086.
- Kloot, B. 1998. 'Deep rural defined: Energization viewed from the grass roots'. Paper presented at Domestic Use of Electrical Energy Conference, Cape Technikon, Cape Town, 6–8 April 1998.
- Liebenberg and Stander Pty. May 2003. 'Delivery models for off-grid electrification'. Draft for discussion only. Ref. BL282/AD/4/2. Document produced for the Ministry of Minerals, Energy and Water Resources, Department of Energy Affairs, Republic of Botswana.
- Majero, S. and S. Chetse. 1997. Report of the Terminal Evaluation of the UNDP-GEF Photovoltaic Project for Household and Community Use in Zimbabwe. Department of Energy, Ministry of Transport and Energy, Zimbabwe.
- Martinot, E., A. Cabraal and S. Mathur. 2001. 'World Bank-GEF solar home systems projects: Experiences and lessons learned 1993–2000'. *Renewable & Sustainable Energy Reviews* 5(1): 39–57. http://gefweb.org/ResultsandImpact/Experience_and_Lessons/WBGEF_SHS_RSER.pdf

Martinot, E., R. Ramankutty and F. Rittner. 2000. *The GEF Solar Portfolio: Emerging Experience and Lessons*. Washington DC: Global Environment Facility.

Maycock, P. 2003. 'PV Technology, Performance, Cost: 1995–2010'. PV Energy Systems.

Morris, G. 1996. 'Structure of the South Africa photovoltaic industry and markets'. Annex 14 of Cowan, W. D., Geerds, P. C. and Banks, D. I. *Solar Home Systems: Techno-economic Study*. Final report, Department of Minerals and Energy, Pretoria. Alternatively, see same material in: EDRC, DECON, CIEMAT, EPIA. *Scheme for Large-scale Implementation of Solar Home Systems in South Africa*. DG XII. Brussels: European Commission.

Solar Development Foundation. 2002. *Consumer Finance Operations Planning Handbook*. Solar Development Group, Zeist, The Netherlands.

UNDP-GEF. 2003. *African Solar PV Workshop: Financing Mechanisms and Business Models*, Pretoria, South Africa, 27 – 29 May 2003.

UNEP. 2003. *Open for Business: REED (Rural Energy Enterprise-Development), Entrepreneurs, Clean Energy and Sustainable Development*. New York: United Nations Environment Programme and United Nations Foundation.

Wamukonya, N. (Ed.). 2001. *Experience with PV Systems in Africa: Summaries of Selected Case Studies*. Copenhagen: UNEP Collaborating Centre on Climate Change.



PV light in school, Eastern Province, Zambia.

BOTSWANA**Project Title: Renewable Energy-Based Rural Electrification Program****Stage: Project preparation (PDF B)****Project Duration: 5 years****Project Summary**

The focus of the project is on establishing a sustainable infrastructure to support the diffusion and maintenance of PV and low-GHG-emitting systems for electricity generation in Botswana, both for residential lighting and entertainment and for economically productive activities.

The project has three objectives: (i) to reduce Botswana's energy-related CO₂ emission by replacing fossil fuels and woodfuel with PV and LPG to provide basic energy services to rural homes and community users, (ii) to improve livelihoods by improving access to and affordability of modern energy services and (iii) to assist the Government of

Botswana with the initiation of a renewable energy programme for the rural areas under the auspices of the rural electrification division of Botswana Power Corporation.

Project activities are designed to remove barriers to the wide-scale use of PV and LPG. The project will consider what institutional, financial and market instruments are necessary for effective private sector participation in rural sustainable development through the delivery of basic energy services.

Key Indicators	Project Level	National/Market Level (estimated)
1. Number of systems installed/sold for households and typical system installed	Mobile systems: 5,152 solar home systems: 1,373 PV mini-grid: 1	To be determined
2. Number of systems installed/sold for institutions/ social services and typical system installed	Not part of this project	N/A
3. Total installed kWp and delivered Wh/year	Total 140 kWp installed 204,400 kWh delivered per year (when all systems installed)	To be determined
4. Price per system	Mobile systems: US\$160 Solar Home Systems: US\$800 PV mini-grid: US\$100,000	To be determined
5. Total value of equipment supplied under this project ⁵¹	US\$2,022,720	To be determined
6. Percentage of public and/or GEF funding per system	GEF money is not used for funding systems; financial assistance for hardware is provided by the government	N/A

⁵⁰ The information in this annex is based on the status of the PV projects (as of mid-2003) that were represented at the UNDP-GEF May 2003 Solar PV workshop, except the Sudan project. The World Bank-GEF Ethiopia, Mozambique and Uganda project were participating in the workshop, but no project information was submitted at time of publication.

⁵¹ Note the change of definition.

BOTSWANA (continued)

Key Indicators	Project Level	National/Market Level (estimated)
7. Improvement of awareness of PV among producers and users; type of instrument (e.g. capacity building); number of people reached; replication effects triggered, etc.	Increased awareness and changed perceptions with decision makers and rural end users. Business development services for private sector. Training for private and public sector.	To be determined
8. Development of power sector policies that support project goals (e.g. subsidies, rates and tariffs, taxes)	Project helps develop conducive policy and institutional arrangements necessary for the integration and provision of off-grid electricity services within the existing rural grid electrification programme	To be determined
9. Emissions avoided (estimated)	52,000 tonnes of CO ₂ over 20 years	To be determined

Delivery Mode

The delivery model consists of three separate but linked subsystems, each with its own technology, financing mechanism and mode of delivery, and to a certain extent different stakeholder groups. Roll-out is private sector driven and will be an integral part of the ongoing government effort to deliver electricity services to rural areas; it will run as long as deemed necessary. The three delivery models are: mobile systems with LPG, solar home systems and PV mini-grid.

The Off-Grid Electricity Unit of the Botswana Power Corporation will be responsible for the overall implementation which includes coordinating the off-grid electricity programme, monitoring and evaluation, promoting standardization and certification, assessing training needs, supervising training, and raising awareness.

Financing Structure

Each of these delivery subsystems has its own financing mechanism: cash sales and savings scheme for mobile systems and LPG, cash/lay-away, hire purchase and credit for SHSs; and fee-for-service for mini-grids. Similarly, each delivery subsystem will have its own tendering process and its own set of delivery agents.

Financing will take place at different levels by different stakeholders:

- Government of Botswana will finance the technologies offered to consumers. During the first year of the programme subsidy of 80 percent will be given on hardware, to be reduced over subsequent years.
- Commercial Banks will provide bank guarantees at the level of the private sector delivery agents.
- Commercial micro-finance will provide the savings schemes, hire purchase/lay-away and credit options at customer level.
- The Rural Collective Scheme of the Botswana Power Corporation will facilitate the consumer connection fees in the mini-grid sub-delivery model.

Key Successes and Key Failures: Lessons Learned

To be determined (project is in preparation stage)

Executing Agency:

Ministry of Minerals, Energy and Water Affairs, Energy Affairs Division (EAD), Government of Botswana, implemented through Botswana Power Corporation

Implementing Agency: UNDP

Cost of Full Project (incl. project preparation):

Total US\$8,693,600: US\$3,305,000 (UNDP-GEF), Co-financing US\$5,388,600 (Government of Botswana)

G H A N A

Project Title: Renewable Energy-Based Electricity for Rural, Social and Economic Development in Ghana

Stage: Full project phase is completed

Project Duration: 1999–2003

Project Summary

The project was established by the Ministry of Energy to provide electricity services to off-grid communities for house-hold, community and economically productive uses. The project started with three operation and maintenance facilities in the Mamprusi East District of north-eastern Ghana. In 2000 the project boundaries were expanded to include all rural communities in northern Ghana that could afford the conditions for the systems.

End users would contract for the energy services that they need (commercial refrigeration, vaccine refrigeration, community water pumping, household lighting, etc). The electricity services would then be provided by Renewable Energy Services Project (RESPRO) from free-standing PV units. Service fees were supposed to reflect revenue requirements for sustainability and growth of the

enterprise. However, this did not happen because the government intervened to reduce the very high unit cost of energy from PV systems. Ultimately the government intends to incorporate solar PV into the mainstream rural electrification activities, with RESPRO taking the lead.

The beneficiaries are mainly the rural dwellers of northern Ghana. PV companies benefited by supplying some of the materials and by doing installations for the project

The project implementation is led by a project coordinator, with a finance officer, administrative assistant and 6 technicians. The project is being implemented on a fee-for-service basis with RESPRO being the utility owning the solar systems. However, customers who can afford them are encouraged to purchase the systems.

Key Indicators	Project Level	National/Market Level (estimated)
1. Number of systems installed/sold for households and typical system installed	2,006 SHSs; typical installation is 100 Wp	3,583
2. Number of systems installed/sold for institutions/ social services and typical system installed	73	256
3. Total installed kWp and delivered Wh/year	189,000 Wp	423,300 Wp
4. Price per system	US\$1,100 per 100 Wp system	
5. Total value of private investments		
6. Percentage of public and/or GEF funding per system	20% public 80% GEF	
7. Improvement of awareness of PV among producers and users; type of instrument (e.g. capacity building); number of people reached; replication effects triggered etc.	The project has trained 80 technicians in design installation and maintenance of PV systems.	

GHANA (continued)

Key Indicators	Project Level	National/Market Level (estimated)
8. Development of power sector policies that support project goals (e.g. subsidies, rates and tariffs, taxes)		Customs duty on solar PV materials has been waived by government.
9. Emissions avoided (estimated)	400–500 tons of CO ₂ for about 2,000 PV systems.	Small, but significant if viewed in terms long-term emission reduction as market is transformed.

Delivery Mode

The materials were purchased through international competitive bidding through the UNDP country office in Ghana. There were 11 companies both local and international.

The project was done on a fee-for-service basis. The installations were done by project staff and by private contractors. Would-be customers either applied for one of the standard systems (50 Wp/100 Wp) or opted to have a system to suit a particular need. They then were asked to make a payment for the installation work and charged a monthly fee for the electricity depending on the capacity of the system.

Payment for electricity service is done on six-monthly basis to cut down the cost of bill collection. This is also suits the rural dwellers with seasonal incomes.

Financing Structure

The project was implemented on a fee-for-service basis, so customers were not required to make upfront payment for the systems. Applicants were therefore usually able to pay for the installation.

Key Successes and Key Failures: Lessons Learned

- Establishment of rural energy services company (ESCO) inherently has high overhead.
- In RESPRO, high operating cost due to size and remoteness.
- Clear government electrification policy is essential for creating the PV market.
- Mix of strategies is best for implementing PV programmes.
- Suitable policy framework with appropriate financing mechanisms is necessary to encourage wider participation.

Executing Agency: Ministry of Finance, Government of Ghana, implemented through Ministry of Energy/RESPRO

Implementing Agency: UNDP

Cost of Full Project (incl. project preparation):

Total US\$3,072,000: UNDP-GEF \$2,472,000, co-financing US\$500,000 Government of Ghana, US\$100,000 US Department of Energy/National Laboratory for Renewable Energy

KENYA

Project Title: Photovoltaic Market Transformation Initiative (PVMTI)

Stage: Under implementation

Project Duration: Launched in December 1998

Project Summary

PVMTI is a strategic intervention to accelerate the sustainable commercialization of PV technology in the developing world. PVMTI will make selected investments in private sector PV market development projects received in response to a competitive solicitation, providing them with appropriately structured concessional financing in the range of US\$0.5–5 million. Additional co-financing of US\$60–90 million by project sponsors and other sources is expected to result in total project investment of US\$85–115 million. The project will be administered by the IFC through an external management agent. Projects will be selected based on their strategic impact in overcoming the barriers and transforming the PV market in a manner consistent with GEF policy. The private sector is considered the best agent to catalyse investment and business activity, and PVMTI's approach provides a competitive element that is expected to maximize financial leverage and deliver sustainable and replicable near-commercial projects by providing examples of good business and technical practices.

As of April 2003, 14 projects with a total project cost of ~US\$60 million and proposed PVMTI investment of US\$25.4 million have either been approved by IFC management or have been recommended for approval by PVMTI's investment review committee. Approved projects focus on developing a sales/service and financing infrastructure for SHSs

and other solar PV products, as well as providing financing for innovative business models that use PV to deliver value-added products and services.

In Kenya, PVMTI's stance has been that the key to future growth will be the availability of high-quality product combined with consumer finance to make SHSs affordable to rural households. PVMTI has therefore set out to establish partnerships between leading PV suppliers and financial institutions and to attract strong sponsors.

The project aims to secure broad involvement from SACCOs, which are considered ideal partners to grow the credit market for PV due to their focus on the target rural markets. SACCOs and banks implement consumer finance schemes for their members or customers. Progress with financial institutions has been difficult, but has quickened in the latter stages.

So far, two companies, Solagen Limited and ASP Limited have qualified with PVMTI's criteria for equipment supply. To ensure equitable and broad business growth, and not to favour larger PV companies, PVMTI has developed the PV SME scheme with Equity Building Society. PV SMEs qualifying for this scheme will also qualify to supply equipment under the consumer finance schemes.

Key Indicators	Project Level	National/Market Level (estimated)
1. Number of systems installed/sold for households and typical system installed	Installations at early stage. Indicative systems distribution: 2 lights, 18%; 4 lights, 51%; 6 lights, 22%; 6+ lights, 9%	Over 200,000
2. Number of systems installed/sold for institutions/ social services and typical system installed	None	
3. Total installed kWp and delivered Wh/year	Too early to have meaningful aggregate data	

KENYA (continued)

Key Indicators	Project Level	National/Market Level (estimated)
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4. Price per system	US\$18/Wp installed system US\$21.55/Wp incl. after-sales service and maintenance (2 years) and insurance	
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5. Total value of private investments	Too early to tell	
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6. Percentage of public and/or GEF funding per system	GEF – 50% as loan or guarantee	
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7. Improvement of awareness of PV among producers and users; type of instrument (e.g. capacity building); number of people reached; replication effects triggered etc.	Too early to tell	
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8. Development of power sector policies that support project goals (e.g. subsidies, rates and tariffs, taxes)	Not directly, but through collaboration with industry players and government	
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9. Emissions avoided (estimated)	Too early to tell	
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Delivery Mode

PVMTI-approved PV equipment- and service-dealers are required to enter into a memorandum of understanding (MOU) with the financial institutions (FIs). The agreement includes after-sales service and maintenance, system components warranties and system performance guarantees at least covering the loan period. For PV SMEs, business consultants and counselors will be hired to work with the SMEs borrowing funds, in order to improve their technical and business skills.

All loans to beneficiaries are in kind, with the service provider receiving system and installation fees from the FI. Service providers are required to build a reasonable level of local community capacity in the FI's region of operation. With some of the FIs, the service provider must agree to issue the FI with a buy-back guarantee for any repossessed systems as a result of default.

Financing Structure

Muramati Tea Growers Savings and Credit Cooperative (MTG): US\$600,000 was committed as loans and grant to enable MTG to introduce a solar loan scheme for their 20,000 members, with SHSs to be installed and maintained by ASP Ltd. Closure of the deal and disbursement of the funds were hampered by a number of factors, including a drawn-out procedure for perfecting the security for the loan. After initial delays, MTG and ASP are now receiving orders for SHSs.

Barclays Bank of Kenya: received a US\$2 million loan and grant to provide multiple SACCOs with financing for their member to purchase SHSs. Potential SACCO borrowers are to be screened by Kenya Union of Savings and Credit Cooperatives and SHSs are to be installed by Solagen Ltd., ASP Ltd. and other selected suppliers. The project is in the final stages of documentation as of August 2003.

Equity Building Society (EBS): In early 2003, US\$2.1 million was committed as loans, guarantees and grants to EBS to facilitate the parallel introduction of two PV-related credit schemes. EBS will provide consumer loans to finance the

purchase of SHSs, and will also introduce a credit scheme to lend to SMEs operating in the Kenyan PV market, which have historically struggled to raise finance.

PVMTI has also committed US\$2 million to two projects with Kenya Commercial Bank (KCB), although these projects were suspended for reasons unrelated to PVMTI. Despite this, KCB has since launched its own solar lending programme, with limited success to date.

PVMTI involvement in the Kenyan PV market has had other spin-off benefits: (1) It led to Solar Development Group's investment in Solagen; (2) it introduced Kenya Credit Traders (KCT) to the PV sector; KCT is now active in hire purchase finance for PV components. (3) It increased the general level of interest of PV manufacturers in the Kenyan PV market, including the entry of Sundaya.

Key Successes and Key Failures: Lessons Learned

Economic hardships and political uncertainty since project launch has made dealing in the Kenyan PV sector difficult. Sourcing, structuring, closing and implementing projects for the Kenyan PV market has been very challenging.

- Consortia of PV technical providers and financial institutions offer strong potential but co-ordination and aligning of divergent interests can be challenging.
- Investment structures and documentation need to be kept simple.
- Committed local expertise in commercial/financial issues is a vital prerequisite for success in putting together and implementing projects.

- The Kenyan PV market has historically focused on sales of components, with system installation performed by independent and often untrained technicians. After sales, service has been limited and system warranties largely unavailable.
- Consumer finance has been largely unavailable due to (1) high perceived default risk of the target rural markets, (2) a lack of understanding of the technology by financial institutions and/or earlier negative experiences, and (3) a lack of system warranties to guarantee system performance for the duration of the consumer loan.
- Consumer finance holds the key to growing SHS sales in Kenya by spreading the cost of an SHS over a number of affordable repayments. Unfortunately, most mainstream financial institutions have had limited experience with PV and will need evidence of creditworthiness among borrowers in this sector. It is hoped that PVMTI in Kenya can contribute to this process.

Executing Agency: IFC, implementation through an external management agent

Implementing Agency: World Bank

Cost of Full Project (incl. project preparation): US\$30,375,000 (Global GEF) Co-financing: 50 percent by the financial institutions and beneficiaries.

LESOTHO

Project Title: Identifying and Overcoming Barriers to Widespread Adoption of Renewable Energy-Based Rural Electrification in Lesotho

Stage: Project preparation (PDF B)

Project Duration: August 2002–February 2004

Project Summary

The purpose of this PDF B activity is to prepare a comprehensive project design and implementation plan to use renewable energy systems to provide high-value electricity and energy services to rural and peri-urban communities without electricity. The project will establish a durable infrastructure for the delivery of these energy services on a sustainable basis, with financial participation by the end-user communities and organizations, by the government, and potentially by external sources of finance. The focus of the project will be on delivery of energy services for economically productive activities, priority community services (e.g. clean water delivery, electrified schools and health posts, telecommunications), for households, and for local government and NGO facilities.

The final project design will reflect and incorporate the lessons learned from both GEF-funded and non-GEF PV and other renewable energy projects for off-grid communities. While it is expected that PV technologies will play a central role, other technology options including small wind electric systems, PV/wind hybrid units, and

PV/wind/fossil fuel hybrid plants will be evaluated for both DC and AC power delivery. Both freestanding and mini-grid applications will be evaluated for use. The project will be customer-driven rather than technology-driven, while using low- and no-greenhouse gas emission energy technologies. The project will also engage non-energy sector agencies of government, NGOs, and international donor programmes in areas including health, education, water supply, agriculture, micro-enterprise, and poverty alleviation to ensure that energy supply will be effectively linked with investments in social and economic development.

The beneficiaries are rural communities outside the service territory of the electricity utility. PV dealers have been actively involved in the project since the design of the PDF B process. They participate at technical and policy level, and they are represented in the Project Steering Committee, which is looking at the policy issues and the overall management of the PDF process. However, the institutional arrangement still has to be developed.

Key Indicators	Project Level	National/Market Level (estimated)
1. Number of systems installed/sold for households and typical system installed		1,100
2. Number of systems installed/sold for institutions/ social services and typical system installed		1,125
3. Total installed kWp and delivered Wh/year	(Wh/year not known)	2,825
4. Price per system	For 3 lights and colour TV	US\$1,000
5. Total value of private investments		
6. Percentage of public and/or GEF funding per system	To be determined	

Key Indicators (continued)

Project Level

National/Market Level (estimated)

7. Improvement of awareness of PV among producers and users; type of instrument (e.g. capacity building); number of people reached; replication effects triggered etc.

During the implementation of a full project

8. Development of power sector policies that support project goals (e.g. subsidies, rates and tariffs, taxes)

Rural electrification policy

National energy policy

9. Emissions avoided (estimated)

To be determined

To be determined

Delivery Mode

Delivery mode still has to be developed. However, the roles of the various players will be based on the barriers (in bold below) that need to be removed.

Fragmented institutional responsibility: NGOs, local authorities, energy regulator and Department of Energy

High initial investment costs: Donor agencies, Ministry of Finance, credit unions and financial institutions

Lack of after-sales service: Solar dealers, retail shops, consumers/communities

Lack of qualified staff: Technical and vocational institutions, solar dealers, Ministry of Education

Poor workmanship in the installation of PV systems: Energy regulator, Department of Energy, solar dealers, professional associations

Lack of public awareness: Department of Energy, media institutions, local authorities, solar dealers

Theft of PV systems: Communities, police and chiefs

Financing Structure

Public funds for rural electrification are channeled through a National Rural Electrification Fund. The fund does not have contact with the borrowers but appoints an intermediary agency such as the bank or credit union, which manage loans and appraise proposals submitted by the PV Dealers and Energy Service Companies (ESCOs). The end users will make the applications to the dealers and ESCOs.

Key Successes and Key Failures: Lessons Learned

Projects must be demand driven. Capacity building of communities is therefore essential for effective participation in projects. Project planners must inform the rural communities about the drawbacks and shortcomings of a technology before the communities can take part in technology choices. PVs should not be promoted in isolation but be part of the energy supply system.

Executing Agency: Ministry of Natural Resources, Department of Energy, Government of Lesotho (cooperating ministry: Ministry of Tourism, Environment and Culture)

Implementing Agency: UNDP

Cost of Full Project (incl. project preparation):

Total US\$6,975,500: UNDP-GEF US\$2,500,000, co-financing \$4,255,500 (Government of Lesotho, World Bank, UNDP)

M A L A W I

Project Title: Barrier Removal to Malawi Renewable Energy Programme (BARREM)

Stage: Full project under implementation

Project Duration: 2001–2006

Project Summary

The project will help mitigate greenhouse gas emissions by encouraging use of PV energy in households, institutions, commercial entities and agro-industries. The project will assist local stakeholders in building local capacities to promote, install and service PV applications; help develop and implement favourable regulatory frameworks; and facilitate the establishment of viable financial mechanisms (micro-lending). The latter will address upfront investment cost barriers and related risk perceptions. The project will help to demonstrate viability of investments in photovoltaic energy and encourage widespread replication. Expected project outputs: Increase of off-GRID PV installations from about 5,000 systems in 1998 to at least 30,000 systems by 2015.

The immediate beneficiaries and partners in this project are local PV companies. The project attempts to create an enabling environment for the private sectors and government by training and building capacity of PV dealers, technicians and engineers, as well as the department of energy and district advisors. Ultimately the beneficiaries are rural customers, individual households, institutions (schools, clinics) and small rural enterprises (tobacco farmers, restaurant owners). An innovative feature of this initiative is the productive use application of PV; solar fridges and PV-powered tobacco drying fans will be promoted in partnership with private companies.

The project is managed by a PMU, which reports to the Department of Energy. The PMU is receiving inputs and advice from a steering committee.

Key Indicators	Project Level	National/Market Level (estimated)
1. Number of systems installed/sold for households and typical system installed	Target: 4,000 SHSs (increase of 400% over baseline year 2003)	same
2. Number of systems installed/sold for institutions/ social services and typical system installed	Target: 200 health clinics, 400 schools, 300 solar fridges, 190 tobacco fans (increase of 400% over baseline year 2003)	same
3. Total installed kWp and delivered Wh/year	Not yet quantified	
4. Price per system	Target: reduce cost of PV systems 17.5% (US\$/kW) compared with baseline year 2002	same
5. Total value of private investments	US\$350,000 (SOBO)	
6. Percentage of public and/or GEF funding per system	Not yet established.	
7. Improvement of awareness of PV among producers and users; type of instrument (e.g. capacity building); number of people reached; replication effects triggered etc.	Target: Increase by 300% no. of businesses dealing in PV compared with baseline year 2002. At least 25 technicians, 10 engineers, and 10 trainers trained per year from 2003 onward.	

Key Indicators (continued)**Project Level****National/Market Level**
(estimated)

- | | | |
|---|--|--|
| 8. Development of power sector policies that support project goals (e.g. subsidies, rates and tariffs, taxes) | Energy policy, favourable to renewable energy technologies, to be finalized by 2004. Energy sub-sector strategies legislated by 2004 | |
| 9. Emissions avoided (estimated) | To be established. | |

Delivery Mode

Commercial Delivery Mode (End-User Credit): The Government of Malawi has made available a US\$100,000 credit guarantee fund (CGF) to the Malawi Environmental Endowment Trust (MEET), and MEET has opened buffer accounts with three commercial banks. The suppliers identify potential households and submit the loan application forms to MEET, which then authorizes the lending institutions to give the loan. The lending institutions provide credit to buyers through PV suppliers who in turn source the equipment, install and maintain SHSs under contracts. The buyer pays a deposit of at least 30 percent of the cost of the equipment to the supplier. The buyer signs loan and lease agreements with the lending institution. The lending institution then pays the supplier the amount of loan and signs a buy-back agreement with the supplier.

Industry Delivery Mode: The project procures and installs PV systems with beverage coolers to demonstrate the efficacy of the technology. SOBO is expected to commercially take the promotion of the technology after piloting.

Institutional Delivery Mode: The District Assemblies (DAs) identify government/quasi-government institutions to benefit from the project. The project contributes 90 percent of investment funding for rural health clinics; the remaining 10 percent comes from clinic owners. For schools, the contribution is 50:50. These contributions are paid directly to the supplier who in turn installs the equipment.

Donor/NGO Delivery Mode: The project works with donors and NGOs on ongoing infrastructure development. The project sensitizes these collaborating partners on the how PV technology can be integrated into community development activities. Financing comes from ongoing development activities. The project inspects installations and arranges maintenance contracts with PV suppliers.

Financing Structure

Part of the project strategy is to develop and test appropriate financing mechanisms for different end user groups. So far the project has experimented with a credit guarantee fund as described above. The design of other appropriate financing structures has not yet been completed.

Key Successes and Key Failures: Lessons Learned

The project has been quite successful in increasing public awareness of solar PV technologies and their uses. Training and sensitization of NGOs, communities and public/private electrical contractors, along with radio jingles, have greatly increased public awareness of PV power and its uses. More inquiries are being made and in average of two systems are installed each month.

A major lesson learned is the need to strengthen dialogue with other institutions involved in renewable energy technologies. The Department for International Development (DfID) has also been installing PV technologies in health clinics and schools. DfID has agreed to use the project's expertise in drawing up and/or evaluating tenders and monitoring.

Executing Agency: Department of Energy, Ministry of Natural Resources and Environmental Affairs, Government of Malawi. Cooperating agencies: United Nations Office for Project Service (UNOPS) and Danish International Development Agency (DANIDA)

Implementing Agency: UNDP

Cost of Full Project (incl. project preparation):

UNDP-GEF US\$3,418,000; co-financing US\$1,199,000 UNDP, US\$2,250,000 DANIDA, US\$2,000,000 SOBO, US\$1,855,000 Government of Malawi

NAMIBIA

Project Title: Barrier Removal to Namibian Renewable Energy Programme, Phase I

Stage: Full project (soon to be) under implementation

Project Duration: 2003–2007

Project Summary

The project will help to increase household, institutional and commercial demand for solar technologies by addressing market barriers. The project will specifically assist local stakeholders in building local capacities to promote, finance, install and maintain solar applications; help develop and implement favourable regulatory frameworks; and help establish viable financial mechanisms (micro-lending and mortgage additions). By demonstrating the viability of investments in solar energy, the project aims to encourage widespread replication. The first phase will concentrate upon technical assistance and the second phase will accelerate the implementation of demonstration units. Expected project outputs include an increase of solar installations (SHSs, PV pumps, solar water heaters, PV refrigeration and PV institutional lighting) from about 7,450 systems in 2000 to 41,950 systems by 2016.

The main beneficiaries of the project will be:

- rural and urban households that do not have electricity but can afford to make use of PV electricity for lighting (and radio);
- shops and bottle store in areas away from the electricity grid that sell refrigerated beverages;
- suppliers of PV systems, and later when replication occurs, other renewable energy technologies;
- commercial and communal farms that are required to pump water;
- clinics, educational facilities, police stations, NGO facilities;
- urban and rural households in private and/or government supplied housing who can afford a hot water service.

The activities described in the project are to be implemented by a PMU that will be put in place by the Ministry of Mines and Energy. The PMU will be advised by a Project Advisory Committee (PAC), composed of public and private sector institutions. The PAC will guide the implementation of the project to ensure that the results are disseminated to, and evaluated by, relevant stakeholders.

Namibian PV companies are currently restricted primarily by two barriers: high capital costs of the equipment and insufficiently qualified human resources. The project will aim to bolster current government-sponsored financing schemes (e.g. Home Power) and seek to encourage investment by private banking institutions (e.g. inclusion of solar water heater into house loans).

The project envisages the introduction of training courses for artisans, but also several energy-related modules in tertiary educational institutions like the Polytechnic of Namibia and the university. Private solar companies and large utilities will have access to this expertise, allowing them to improve their services, furnish more clients and establish a nationwide network of solar expertise. Introduction of an energy curriculum in schools is being considered and the early sensitization of Namibia's young about energy will greatly entrench overall energy awareness. The project also aims to address policy and framework issues that currently cause the unlevelled playing field between off-grid and grid electrification, as well as the possibility of large-scale independent power production from solar energy. This will offer private companies and investors access to subsidies, incentives and potential markets currently reserved for conventional approaches to supplying energy.

Delivery Mode

Key arrangements and actors for this project fall within public, private and NGO sectors. Specific roles of these include:

- NGOs: Installing and demonstrating Solar Energy Services (SEs) in their facilities.
- NamPower: Ensuring sustainability of solar energy market post-project.
- DANIDA: Parallel funding and providing capacity building to R3E, the Renewable Energy and Energy Efficiency Bureau of Namibia, whose mandate is to promote solar energy issues.
- GEF: Financing the incremental cost of the project.
- Government of Namibia: Complementing the project with baseline costs both in cash and in-kind.
- Public and private housing developers: Piloting PV by including solar water heating in the houses they develop.
- Southern African Development Community-Technical and Advisory Unit (SADC-TAU): Identification of some barriers to be addressed in the project.
- Finance institutions: Designing and marketing financial instruments for the purchase of SEs.
- Breweries: Applying the technologies if demonstrated to be viable for cuka shops.

Financing Structure

Possible financiers to the project include commercial banks, building societies, agricultural banks, parastatal development banks and funds, utilities and small lenders.

Possible functions:

- Make affordable loans to Solar Energy Technologies (SETs) users and SE providers: designing modalities for a low-interest, low-deposit limited collateral financial vehicle/mortgage supplement dedicated to SETs.
- Appraise loans for SETs users, suppliers, entrepreneurs and manufacturers.
- Identify opportunities and design business plans to take advantage of these, in collaboration with suppliers and manufacturers of SETs.
- Locate and engage with international concession finance companies dedicated to clean development and to develop proposals to cover exchange rate risks.

Key Successes and Key Failures: Lessons Learned

N/A

Executing Agency:

Ministry of Mines and Energy, Government of Namibia

Implementing Agency: UNDP

Cost of Full Project (incl. project preparation):

Phase I: UNDP-GEF US\$2,600,000; co-financing US\$990,000 Government of Namibia, US\$2,120,000 DANIDA

REPUBLIC OF SOUTH AFRICA

Project Title: Integrated National Electrification Program (INEP)

Stage:

Project Duration: 10–15 years

Project Summary

Although initiated in the early 1990s, the INEP started in earnest in 1994 with the aim to provide universal household access to basic electricity services and to electrify schools and health clinics. It was initially a conventional grid-extension programme implemented and funded by the Electricity Distribution Industry (Eskom – the national utility – and licensed municipal distributors) and regulated by the National Electricity Regulator.

With the publication of the White Paper on Energy Policy for the Republic of South Africa, 1998, government decided to

take the primary responsibility for funding the INEP, as well as introducing PV systems for schools and clinics and PV-based SHSs for household electrification in the more remote areas where conventional grid-extension is too expensive.

Private sector consortia, who are also encouraged to supply thermal energy fuels (e.g. LPG) were selected to implement the non-grid component of the INEP in allocated 'concession areas'; five consortia are now operational, and a sixth concession will be awarded early in 2004.

Key Indicators	Project Level	National/Market Level (estimated)
1. Number of systems installed/sold for households and typical system installed	16,000 SHSs of 50 WP (nominal) already installed (early 2004)	3 million households not yet electrified. Target over next 5–8 years for this off-grid programme: 300,000 (50,000 per provider)
2. Number of systems installed/sold for institutions/ social services and typical system installed	2,300 PV systems of 800 WP (nominal) already installed	8,000 schools not yet electrified. Target over next 5–8 years: 1,000
3. Total installed kWp and delivered Wh/year	2,440 kWp installed 2,671 MWh/day delivered	
4. Price per system	SHSs: R 4,500 Schools: R 85,000	
5. Total value of private investments	Not publicly available but of the order of R 60,000,000	
6. Percentage of public and/or GEF funding per system	SHSs: ~80% gov. subsidy Schools: Fully gov. funded.	
7. Improvement of awareness of PV among producers and users; type of instrument (e.g. capacity building); number of people reached; replication effects triggered etc.	Sustainable Energy Society of Southern Africa is active. Formal capacity building with industry not done, although scale of projects conducted has helped establish active industry.	

Key Indicators (continued)

Project Level

National/Market Level (estimated)

8. Development of power sector policies that support project goals (e.g. subsidies, rates and tariffs, taxes)	Nationally coordinated and funded electrification programme. Capital subsidy and some operational subsidy. National Electricity Regulator significantly involved	
9. Emissions avoided (estimated)	Currently 275 x 12,000 SHSs = 3 300 tonnes CO ₂ /annum (rough estimate)	300,000 x 275 = 82 500 tonnes CO ₂ /year

Delivery Mode

Selected private sector consortia through a PPP arrangement implement the non-grid component of the INEP in allocated 'concession areas'; PV equipment is sourced on the local and international market on a capital-subsidized fee-for-service model. The National Electricity Regulator regulates the programme as an integral part of the INEP.

Financing Structure

The programme is subsidized as part of the government funded INEP. Customers are required to pay a connection fee capped at R 100 (and optional to the non-grid service provider) as well as a monthly fee-for service, currently set at ZAR 58 per month (including VAT). The fee-for-service is partially subsidized through the government-funded Free Basic Electricity programme

Selected private sector consortia are responsible for top-up funding, marketing and installation of systems, managing customer databases, revenue collection and maintenance of systems for a period of 15 to 20 years.

Key Successes and Key Failures: Lessons Learned

- Low income in rural areas limits penetration. This is relieved by government subsidy.
- Disciplined revenue collection is essential.
- Theft of systems does occur.
- Management of the 'on the ground services' is complex and requires efficient systems and skilled people.

Executing Agency:

Department of Minerals and Energy

Implementing Agency: Private sector consortia engaged through a PPP arrangement in 'concession areas'

Cost of Full Project (incl. project preparation):

The INEP stretches over a 10- to 15-year period at current backlog, available budget and population growth rate. The estimated number of schools and clinics for non-grid supplies is 700.

Rough estimates of capital costs of project (US\$1 @ US\$7.5 = ZAR 1)

	Cost (US\$)	Qty	Total (US\$)
Subsidy per SHS	467	300,000	140,000,000
Connection fees paid by customers	13	300,000	4,000,000
Contribution by PPP	80	300,000	24,000,000
			168,000,000
Capital for Schools	11,333	700	7,933,333

Annual revenue (to cover maintenance and ROI for PPP) (US\$1 @ US\$7.5 = ZAR 1)

	Cost (US\$)	Qty	Total (US\$)
FBE subsidy for SHS (if maintained at current levels)	64	300,000	19,200,000
Consumers contributions (annual)	26	300,000	7,920,000
			27,120,000

Private sector partners are expected to contribute significant funds (~20 percent).

The German government (KfW) is to contribute approximately 15 million euros.

SUDAN

Project Title: Barrier removal to secure PV market penetration in semi-urban Sudan

Stage: Medium-sized project under implementation

Project Duration: 1999–2003

Project Summary

This project aims to provide electric energy in semi-urban Sudan through reliable, domestic PV systems as a substitute for fossil-based generating units. The project activities will focus on the removal of barriers to the market penetration of PV technology in 13 identified semi-urban towns in Sudan. The project will strengthen technical and financial capabilities and help put in place policies necessary for expanding these markets on a demand-driven, full-cost-recovery basis.

The project has implemented an intensive capacity building and awareness raising programme. It has built strong partnership with a wide range of stakeholders including banks, Ministry of Energy and Mining (MEM), Sudanese Petroleum Company, private sector, vocational training, research institutes as Sudanese Standard and Meteorology Organization and the National Assembly. Socioeconomic surveys assessed community and household energy demand. The project helped develop a national policy strategy and measures to enhance commercialization of PV technology, and legislation is now under way.

The Sudanese Social Development Bank established a loan guarantee scheme and MEM raised US\$600,000 from the government by initiating and implementing PV projects in seven states.

The main beneficiaries are rural and semi-urban communities, which will benefit from improved education, health, water supply and communication services. Most of these activities are joint projects with the ministries of Physical Planning in different states, coordinated by the National Energy Affairs Directorate of the Ministry of Electricity. The Sudanese Environment Conservation Society, Freidrich Eibert, ElAhfad University for Girls and several private sector companies are cooperating in the awareness raising efforts, aimed at the policy makers and communities. The Energy Research Institute (ERI) is actively involved in training and policy development. Demonstration equipment was supplied by local PV companies through open tendering. Now the established credit system is enhancing the growing PV market.

Key Indicators	Project Level	National/Market Level (estimated)
1. Number of systems installed/sold for households and typical system installed	50	250
2. Number of systems installed/sold for institutions/ social services and typical system installed	150	250
3. Total installed kWp and delivered Wh/year	~ 0.02 MWp ~ 40 MWh	~ 0.3 MWp ~ 600 MWh
4. Price per system	Cost of energy ~ US\$0.25–0.3 /kWh Equipment cost ~ US\$7500–US\$8,000/kW	Same
5. Total value of private investments	US\$150,000	US\$2,500,000
6. Percentage of public and/or GEF funding per system	50–80%	0–100%

Key Indicators (continued)

Project Level

National/Market Level (estimated)

7. Improvement of awareness of PV among producers and users; type of instrument (e.g. capacity building); number of people reached; replication effects triggered etc.	More companies interested in assembly and production of components. PV modules assembly plant at ERI. Private production of batteries, lamps and lanterns	
8. Development of power sector policies that support project goals (e.g. subsidies, rates and tariffs, taxes)	A Solar Energy Act being finalized in National Assembly, including tax exemptions, encouragement of private sector and institutional set-up. Results: Rural electrification unit established. Introduction of PV in 1,000 villages budgeted for 2004.	Investment Act modified to promote small-scale PV and other renewable applications. PV applications incorporated in development budgets of many states in 2003 and 2004.
9. Emissions avoided (estimated)	~ 75 tons CO ₂ /year	

Delivery Mode

The PV systems and most of the components are imported by nine national companies, who supply both to institutions, communities and individuals. Small enterprises (13) act as dealers in the states, especially in rural areas. They advise on system sizing, supply systems and spare parts and provide installation and maintenance services. Their trained technicians (about 250) provide after-sales services. In addition, technicians from ministries and institutions using PV systems are trained in PV systems sizing, selection of components, installation and maintenance.

Financing Structure

A credit mechanism is established with the Sudanese Saving and Social Development Bank whereby loans are provided for individuals and groups to purchase PV systems. This mechanism is supported by guarantee fund (US\$200,000) from the project while the bank is putting additional US\$100,000. Some of the states are now considering putting additional resources to this mechanism. Federal and states government are providing PV systems for institutions and service centres, for which the beneficiaries pay about 25–50 percent of the cost. Some other banks (Agricultural Bank, the Blue Nile Bank) have already started financing some individuals PV purchases (though still limited).

Key Successes and Key Failures: Lessons Learned

- High awareness among the policy makers at federal (including National Assembly) and state level: Solar Act with favourable policies ready and PV being incorporated in development plans of different sectors.
- Intensive awareness among beneficiaries on potential applications of PV, cost and maintenance requirements; and high demand created.
- Extensive training at different levels; well-trained providers of after-sales services available in all states. PV technology is now introduced in 4 vocational training centres.
- Financial capabilities of each sector dictate type of PV application. Modifications to financing terms and tax exemption would have different effects on each sector.
- Financing terms, especially maximum 2-year loan duration, not suitable for financing PV system.
- Policy adoption process too lengthy.

Executing Agency: Ministry of Energy and Mining (subcontracted institution: ERI)

Implementing Agency: UNDP

Cost of Full Project (incl. project preparation):
US\$1,710,000: US\$750,000 UNDP-GEF Co-financing
US\$250,000 UNDP, US\$400,000 Sustainable Rural Energy Development project, US\$310,000 Government of Sudan

TANZANIA

Project Title: Transformation of the Rural Photovoltaics Market

Stage: Full project (soon to be) under implementation

Project Duration: 2003–2008

Project Summary

The project aims to introduce PV as a substitute for fossil fuel in rural areas and to improve livelihoods by improving access to and affordability of modern energy services.

Proposed activities are designed to remove barriers to the wide-scale utilization of PV to meet the basic electricity needs of households, small businesses and of community users like health clinics and schools, initially in the Mwanza region, but eventually in the whole country.

Activities and outputs are designed to achieve 5 immediate objectives:

- To refine the policy framework and the institutional arrangements necessary for the widespread adoption of PV for providing off-grid electricity services.
- To increase awareness, especially among decision makers, consumers, and other end users, of the potential for PV to meet the basic energy needs of rural communities in off-grid areas.
- To strengthen and support joint efforts between the private sector and the PV sectors to develop models for providing PV services to rural areas and to improve quality of service.

- To explore, develop and test viable financing options for disseminating PV systems.
- To disseminate experience and lessons learned to promote replication in other regions of the country.

Project activities are focused on removing import duties and establishing codes of practice and standards; launching awareness campaigns; demonstrating PV systems at schools and health facilities; assisting PV companies in business planning and training of technicians; testing end-user and supply-chain financing mechanisms such as salary withholding schemes and providing grants to innovative business ideas for productive uses.

Main beneficiaries are the households and community members in rural Mwanza region who would be the end users. Another group of beneficiaries is the private sector – from producers of PV to importers, wholesalers, dealers, retailers and technicians. In addition, some selected communities will benefit from installed demonstration equipment. Civil society will benefit from expansion of the PV market.

Key Indicators	Project Level	National/Market Level (estimated)
1. Number of systems installed/sold for households and typical system installed	Because the project will not be installing SHSs, but only stimulating the market to increase sales, there are no project targets for sales.	No. of PV systems sold per year in Mwanza to reach 1,682 in year 5 of the project as compared to the baseline scenario of 631 systems for the same year. Typical unit size 14–50 Wp.
2. Number of systems installed/sold for institutions/ social services and typical system installed	A few demonstration systems will be installed in schools, community centres and health centres/clinics	
3. Total installed kWp and delivered Wh/year	Increase in installed capacity in Mwanza from the current 40 kWp to 120 kWp by year 4.	Increase in no. of Watts installed per annum from 10 Wp to 20 Wp

Key Indicators (continued)	Project Level	National/Market Level (estimated)
4. Price per system		
5. Total value of private investments		
6. Percentage of public and/or GEF funding per system		
7. Improvement of awareness of PV among producers and users; type of instrument (e.g. capacity building); number of people reached; replication effects triggered etc.	100% increase in customer inquiries about PV systems in local dealer shops by year 4.	
8. Development of power sector policies that support project goals (e.g. subsidies, rates and tariffs, taxes)	Reduce import duties and taxes on all PV equipment components reduced to a level comparable to Kenya's	
9. Emissions avoided (estimated)	19,585 tons of CO ₂ in the Mwanza region (based on minimum 43,286 rural households in the Mwanza region using PV energy).	An additional 113,139 tons CO ₂ in the other regions of Tanzania over the 20-year lifetime of the PV equipment, based on adding 47,396 PV-powered households in other regions.

Delivery Mode

An independent PMU will be set up and based in Mwanza. The project manager will be responsible for day-to-day operations and coordination with the main stakeholders and donors/investors. An international pool of experts will support the PMU with international best practice.

The PMU will involve and support the private PV sector in design, sale and setup of demonstration systems; joint awareness and marketing campaigns; testing of productive uses of PV; piloting financing methods. The PMU will also interact with financing institutions, NGOs, training centres, communities, local and central government, donors and international partners. The PMU will use consultants, research institutions, PV companies and NGOs to subcontract activities.

Financing Structure

The project will explore, develop, test and adopt viable financing options, for both end users and dealers.

Executing Agency:

Renewable Energy Section, Ministry of Energy and Minerals, Government of Tanzania

Implementing Agency: UNDP

Cost of Full Project (incl. project preparation):

US\$2,570,000 UNDP-GEF; co-financing US\$240,000 UNDP, US\$3,176,000 Swedish International Development Cooperation Agency (SIDA), US\$630,000 Dutch Government/Umembe Jua, US\$147,000 Government of Tanzania, US\$540,000 others (associated institutional financing SIDA US\$2,352,00)

UGANDA

Project Title: Uganda Photovoltaic Pilot Project for Rural Electrification (UPPPRE)

Stage: Full project (completed 31 March 2003)

Project Duration: 1998–2003

Project Summary

UPPPRE's goal is to establish the foundation for the sustainable use of PV technology for rural electrification in areas that will not be accessed by the national electric grid in the foreseeable future. Its objective is to overcome the financial, social and institutional barriers that presently exist to the widespread dissemination of the technology within Uganda. The targets of the project are individuals, communities and government entities that have the ability/willingness to pay the real-market cost of PV-based services.

The project has created programmatic linkages particularly those between PV equipment vendors, the formal financial sector and village-level micro-lenders. It has established a functioning financing mechanism for vendors and end users of PV systems, built technical capacity in the public and private sector, and helped establish the Uganda Renewable Energy

Association, a representative body for the a renewable energy industry sector. The project has developed standards for the installation of PV systems and components. During 1998–2002 an estimated 2,000 PV systems were installed. The project was implemented through the Ministry of Energy and Mineral Development by a Programme Implementation Unit.

The innovative village bank financing mechanism, while in its infancy, will be replicated nationwide.

The installation of the systems was done by private PV suppliers/dealers who benefited from the project's awareness campaigns, vendor financing, establishment of equipment leasing arrangement through village banks, and training programmes. Suppliers are selected through competitive bidding. The development of standards was spearheaded by the Uganda National Bureau of Standards through a technical committee with the participation of all major stakeholders.

Key Indicators	Project Level	National/Market Level (estimated)
1. Number of systems installed/sold for households and typical system installed	2,600 (50 Wp systems)	10,000–15,000 systems installed. Only 1% of the rural population has access to grid-based electricity
2. Number of systems installed/sold for institutions/ social services and typical system installed	300 (200 Wp systems)	
3. Total installed kWp and delivered Wh/year	76 kWp 380 kWh/year	
4. Price per system	US\$750 for a 50 Wp system	US\$750 for a 50 Wp system
5. Total value of private investments	PV supplier/dealers spent about US\$2,600,000 to procure and install PV systems.	
6. Percentage of public and/or GEF funding per system	Public/GEF funds were used only for technical assistance and credit guarantee.	
7. Improvement of awareness of PV among producers and users; type of instrument (e.g. capacity building); number of people reached; replication effects triggered etc.	Conducted public awareness through mass media, workshops and public gatherings. Over 40 public workshops held attended by over 3,000 people. Trained 96 technicians in design, installation and maintenance of PV systems.	Public awareness carried out nationwide via the mass media.

Key Indicators (continued)

Project Level

National/Market Level (estimated)

8. Development of power sector policies that support project goals (e.g. subsidies, rates and tariffs, taxes)	Helped formulate energy policy favourable to development of renewable energy and emphasizing the use of PV for remote rural areas. The policy establishes the use of smart subsidies and removes taxes on PV components.	Favourable energy policy and removal of taxes
9. Emissions avoided (estimated)	73 kilotonnes of CO ₂ over the 20 years	

Delivery Mode

The project implemented both the direct sale and end-user financing delivery models. In the direct sale model, PV suppliers/dealers procured the systems and sold them directly to the consumers on a cash basis. Sometimes, dealers extended credit for 3 months with the consumer making a down payment of 70 percent. The dealer was responsible for installation and provided a one-year warranty on service and equipment.

The project implemented two end-user financing mechanisms. The first mechanism was through the Uganda Women Finance Trust, an urban-based MFI. In this mechanism, the project provided a guarantee fund of US\$50,000 to leverage the risks. However, the financing institution used its own funds and applied normal lending conditions. Because of unfavourable lending conditions, the mechanism was unsuccessful.

The second mechanism involved lending to consumers through village banks (see below). This financing mechanism resulted in the installation of over 500 systems in one year. Six private PV companies were involved in the supply of the systems. There are 15 PV suppliers/dealers actively involved in the direct sale of PV. These companies have established 22 sales outlets in major trading centres in the pilot area.

Financing Structure

The project established financing mechanisms for vendors and end users of PV systems. The vendor financing mechanism was established with Centenary Rural Development Bank (CERUDEB) to offer PV suppliers/ dealers financing for equipment procurement. The project provided the bank with a credit guarantee fund of US\$150,000 to leverage certain risks and reduce interest rates from 30 percent to 12 percent. Apart from the interest rates, the bank applied normal selection criteria and lending conditions.

The end-user financing mechanism was established with 6 local MFIs commonly referred to as village banks. The village banks were given a revolving fund of US\$350,000. Interest rates were lowered from 48 percent to 18 percent and the repayment period increased from 6 months to 2 years. The repayment schedule accounts for the seasonality of the consumer's income. The system forms part of the security for the loan in

addition to two guarantors. The consumer is required to deposit 15 percent of the cost before the system is installed.

A private PV supplier, Incafex Solar Systems Ltd has sourced funds and is replicating the village bank end-user financing model. Also a commercial bank (DFCU) in partnership with Shell Foundation is implementing a PV lease arrangement with village banks along the same lines. The government will provide more funds to replicate the model nationwide under the 10-year Energy for Rural Transformation Programme.

Key Successes and Key Failures: Lessons Learned

- Despite massive public awareness campaign the direct-sale delivery mechanism reaches a limited market due to the high upfront costs and inadequate supply network.
- Consumer financing is needed but normal high interest rate (40 percent) and short repayment period (6 months) makes PV systems to expensive for the target group. Softer terms and longer repayment periods (2–3 years) are desirable and can increase the market.
- Consumer financing should have flexible repayment terms taking into account the seasonality of the incomes of the consumers.
- Competition between suppliers reduces the cost of the system. Systems installed under the village bank financing mechanism were 15 percent below market cost.
- PV supply and service infrastructure are needed to make the product and after-sale support more accessible.
- Enforcement of PV system installation standards drastically reduces system failure and increases confidence in the technology.

Executing Agency: Ministry of Energy and Mineral Development, Government of Uganda

Implementing Agency: UNDP

Cost of Full Project US\$1,756,000 UNDP-GEF Co-financing US\$500,000 UNDP, US\$200,000 Government of Uganda

ZAMBIA

Project Title: Providing Electricity Services Through Energy Service Companies (ESCOs) in the Eastern Province of Zambia

Stage: Pilot project Phase 2

Project Duration: 1997–2003

Project Summary

The aim of the project, initiated by the Department of Energy, Ministry of Energy and Water Development, Lusaka, is to provide solar electricity to households and small businesses. Three (initially four) companies were offered training and hardware was provided as a credit. Start of credit repayment for the first electricity supply company (ESCO) was scheduled for August 2003. Numerous surveys have been carried out among clients and ESCOs.

After more than two years, most customers are satisfied with their systems and keep paying their service fees. Each ESCO has several hundred prospective clients on its waiting list. However, the mechanism for supplying more systems has not yet been finalized. Project implementation was delayed by tender procedures and long delivery times. The tender procedure and strict regulations impaired the ability of the ESCOs to operate as independent market actors and excluded several local suppliers.

The major technical problem has been maintenance of batteries, almost 25 percent of which have been replaced after 2–3 years. A supplier to one ESCO (Siemens) is suspected of providing substandard batteries from the beginning, and full replacement has been demanded. At this location, prepayment devices (which were not field tested before installation) were often faulty. Some tampering with equipment

has occurred, but no vandalism and only three cases of theft. In one of these cases the equipment was retrieved.

The inflation eroding the service fee is another problem. The fee has been increased from ZMK 20,000 (US\$8) per month in 2000 to 35,000 (still US\$8) 2003, but increases barely keep pace with inflation. Clients complain but do not opt out of the scheme. In order to start repaying the capital for hardware, service fees need to be increased by another ZMK 15,000–20,000.

Discussions are under way for creating a national programme with the ESCO mechanism as its base. Further experience from credit repayment is needed, as well as a functional mechanism for ESCO selection and hardware supply. Decisions by government on subsidy levels and rural electrification policies are needed.

The major beneficiaries of the project have been households in the target rural areas. PV companies benefited through increased business opportunities during supply and installation.

The institutional arrangement is such that the ESCOs are the service providers while the government provided both the initial financing and support services (training, technical back-up, etc).

Key Indicators	Project Level	National/Market Level (estimated)
1. Number of systems installed/sold for households and typical system installed	350 (50 Wp)	1,500 (various)
2. Number of systems installed/sold for institutions/ social services and typical system installed	50 Wp	Not known
3. Total installed kWp and delivered Wh/year	20 kWp	Not known
4. Price per system	US\$900	Not known

Key Indicators (continued)	Project Level	National/Market Level (estimated)
5. Total value of private investments	Nil	Insignificant
6. Percentage of public and/or GEF funding per system	Public – 100%	Public – close to 90%
7. Improvement of awareness of PV among producers and users; type of instrument (e.g. capacity building); number of people reached; replication effects triggered etc.	Great awareness created due to much publicity given to project. Actual details not assessed yet.	Information on other efforts at national level only now being compiled.
8. Development of power sector policies that support project goals (e.g. subsidies, rates and tariffs, taxes)	These are being developed and will be in place by end of 2003 or early 2004	These are being developed and will be in place by end of 2003 or early 2004
9. Emissions avoided (estimated)	Not assessed	Not assessed

Delivery Mode

The SHSs are provided to households on a fee-for-service concept. Households do not invest in hardware but pay a monthly tariff to ESCOs. The ESCOs themselves are provided the hardware by the government and must pay most of the cost.

Since the funding is provided from public funds, the procurement of the hardware is through public tenders. The regulations of these tenders, however, were unsuitable for small local companies that cannot put forward bid and performance securities, which are respectively 2 percent and 10 percent of the contract price.

Financing Structure

SIDA provided grant support to the government, which in turn lent hardware to the ESCOs. No micro or bank financing has been involved so far. Sustainability is therefore of concern.

ESCOs are to repay the borrowed capital (excluding an initial 10 percent subsidy) over 20 years. This repayment period is considered too long, however, and may be reviewed. The repayment will be slightly above the rate of inflation (at least 20 percent) plus a margin for management (1 percent).

Key Successes and Key Failures: Lessons Learned

One success has been the demonstration of an alternative to grid extension for rural electrification. The project showed that rural people are willing and able to pay for commercial/modern energy services. Interest in PV as soared among both consumers and PV equipment suppliers. The government now pays attention to details of rural policy in matters such as subsidies.

Issues related to the repayment period and subsidy levels remain unresolved, and resolution will require policy direction. A clear lesson is that rural energy provision requires strong policy support.

Executing Agency:

Ministry of Energy and Water Development

Implementing Agency: Department of Energy assisted by Stockholm Environment Institute

Cost of Full Project (incl. project preparation):

Phase 1: 1998–2001: SEK* 4 million (project support 3 million, hardware 1 million)

Phase 2: 2001–2003: SEK 6 million (project support 3 million, hardware 3 million) Co-financing K100 million (SEK 160,000) in kind support by Government of Zambia (* 1 US\$ ≈ SEK 10)

Z I M B A B W E

Project Title: Photovoltaics for Household and Community Use

Stage: Full project completed

Project Duration: 1993–1997

Project Summary

The GEF project was a pilot solar PV project to install 9,000 solar lighting systems during 1993–1997. The project was designed to enable Zimbabwe to:

- Enhance and upgrade the indigenous solar manufacturing and delivery infrastructure through technical assistance, technician training.
- Develop an expanded commercial market in rural areas for affordable domestic solar electric lighting systems by improving the access of householders to such technology through a low-interest financing scheme (revolving fund mechanism)
- Establish specially tailored financing mechanisms at the grassroots level to benefit lower-income groups in rural areas

Specifically, the project was conceived to address barriers to the use of PV power:

- Lack of locally produced components, trained manpower and data for PV system design

- Lack of private sector capacity in serving PV market due to the cost of PV
- Inadequate financing programmes and limited availability of foreign exchange
- Inappropriate taxes and duties
- Lack of institutional structures for renewable energy and clear government commitment
- Lack of public awareness of the technology

The project installed its target of 9,000 PV systems and project personnel were responsible for inspecting the newly installed systems and also for continual monitoring. There was easy access to foreign exchange through imported solar components; low-interest credit was being extended to consumers; community activity through NGOs, district councils and cooperatives was encouraged, in addition to development of training modules for installers and end users.

Key Indicators

Project Level

National/Market Level (estimated)

1. Number of systems installed/sold for households and typical system installed	8,552 (45 Wp equivalent) 42% of these were SHSs
2. Number of systems installed/sold for institutions/ social services and typical system installed	Schools 11% Clinics 29% Small businesses 15% Households 42% Others 3%
3. Total installed kWp and delivered Wh/year	384 840 Watts
4. Price per system	US US\$600.00 – US\$1000.00
5. Total value of private investments	6%

Key Indicators (continued)

Project Level

National/Market Level (estimated)

- | | |
|--|---|
| 6. Percentage of public and/or GEF funding per system | GEF/AFC Credit Scheme 54%, Donor funded 40% and cash funded 6%, 45 Wp equivalent systems. |
| 7. Improvement of awareness of PV among producers and users; type of instrument (e.g. capacity building); number of people reached; replication effects triggered etc. | The GEF Outreach subcommittee conducted training courses in schools, colleges, companies and end users |
| 8. Development of power sector policies that support project goals (e.g. subsidies, rates and tariffs, taxes) | There were negotiations on the removal of sales taxes and tariffs, there was no policy to address these issues. |
| 9. Emissions avoided (estimated) | The assessment was not done |

Delivery Mode

Four delivery modes were used: commercial, donor-driven, ESCO and NGO-type. There were about 57 participating companies but only one ESCO, 5 major donors and 3 NGOs.

The project supplied all companies with needed equipment, including panels, lights, batteries, charge controllers, measuring equipment, and was repaid later. Equipment cost was recovered from the company on presentation of the buying order to the Agricultural Finance Corporation (AFC).

Financing Structure

UNDP was the custodian of the funds while the AFC managed the credit scheme. The customer applied for a loan from the AFC, and upon qualification a buying order was issued by the AFC. The buying order enabled the AFC to disburse funds to the installing company. When the installation was completed the customer signed a completion of work (COW) form, which was counter-signed by the project manager. The company then presented the signed COW form to the AFC for payment. The customer would repay the loan monthly to the AFC over a period of 3 years with an interest rate of 15 percent per annum. Farmers would normally have installments once a year after harvest.

Key Successes and Key Failures: Lessons Learned

In addition to reaching its installation target, the project stimulated demand for PV systems and the number of local manufacturers increased. Capacity building among industry personnel for sustained solar energy use was another success. However, the product delivery system was poor

because monitoring and inspection of installed solar components and systems did not continue post-project. Many solar companies later collapsed, partly due to poor planning and financial management on their part. Also, many key technical personnel from solar companies left to enter other types of business. Moreover, at prevailing interest rates (120 percent p.a., vs. the 15 percent p.a. offered during the project) acquiring a PV system through a hire purchase arrangement is impossible for many.

One important lesson is that financial management and business planning training should have been included in the project. The project also demonstrated the importance of using high-quality equipment from reputable PV dealers. Because of the use of reliable equipment, 90 percent of project systems were still functioning at the end of the project.

Executing Agency:

Ministry of Transport and Energy and Department of Energy Government of Zimbabwe.

Implementing Agency: UNDP

Cost of Full Project (incl. project preparation):

US\$4,563,800 UNDP-GEF; Co-financing Z\$2,120,000 Government of Zimbabwe

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