Center for RESOURCE SOLUTIONS

FINANCING OFF-GRID PV

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Written by JP Ross, Consultant to Center for Resource Solutions

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Introduction

There are many barriers to the widespread diffusion of renewable energy technologies in the rural environment. One of the main barriers is financial, as many rural families have little expendable capital and lack access to credit. This memorandum outlines schemes that have been utilized to finance solar photovoltaic projects.

Background

China has an extremely valuable solar resource that can be utilized to provide electricity to rural populations unserved by the national/regional electricity grid. The sun shines 2200 hours/year over 66% of the country, and the country produces more than 5.5 MW of photovoltaic panels per year[1]. The resources and technology are available to the rural population, but there are barriers to the widespread implementation of solar photovoltaic (PV) projects. One of these barriers is the initial cost of PV systems. Although the cost of electricity from PV systems is competitive over the long term with conventional sources of energy in the rural environment; kerosene, candles, dry cell batteries and battery charging services, the initial cost of PV systems is high. Rural families do not necessarily have expendable capital for purchasing PV systems. Therefore, schemes for financing off-grid electrification are just as important as technological innovations for the widespread diffusion of PV systems. Please note that these schemes can be used to finance other forms of renewable energy, as all renewable energy suffer from the same issues – high initial cost and low operational cost in an environment where long term credit is difficult to acquire. PV projects are the focus of this memorandum because there is more data about PV projects than any other type of renewable energy technology.

Financing Schemes for Solar Home Systems

Cash financing

Direct sales

Direct sales of PV systems through cash purchases will generally be the means by which a PV retailer first enters a rural market. The technology will generate awareness in the community as a few of the wealthy households purchase systems and people see the advantages of the PV generated light; no fumes, better light and fewer respiratory problems. However, the market for direct purchases is often small. Studies by Enersol have shown that only 5% of rural households

[1] Hamburger, Jessica. 1995. China's energy and environment in the roaring nineties: A policy primer. Pacific Northwest National Laboratory.

can afford to purchase a system directly, whereas other financing methods would allow another 50% of households to purchase PV systems.

Case Study: Kenya

The Solar home systems market has been successful in Kenya without government support or subsidies. 150,000 systems have been installed over the past two decades with 20,000 more going in each year[2]. The Kenyan market for solar home systems has been operating from a base of 100's of small shop owners who sell photovoltaic systems. These shop owners may or may not be trained technicians who can also install and service the systems. Most of the solar systems purchased in Kenya over the last decade have been in the 10-14 Wp range[3]

Lessons Learned

1) Direct sales of systems will often lead to the purchase of the cheapest components and a system that is too small for the required needs. Shop owners are often more concerned with selling the system than assessing household energy requirements.

2) Direct sales are not always properly installed, leading to dissatisfaction from the start due to low system performance

3) Self-installed systems are frequently not properly maintained because the owner/installer is not educated about correct maintenance procedures- this leads to early battery and system failures.

Credit Financing

As stated above the direct sales market for solar systems is rapidly saturated, as there are few families that can afford to purchase systems outright. Financing schemes for solar home systems becomes an important step in facilitating solar system purchases. However, lending to poor rural families with little "collateral" is viewed as a risky venture by most institutions, resulting in very high interest rates or a simple refusal to extend credit. The following schemes are now in use to provide credit for solar system purchases.

Small-Scale Lending Models

Multilateral lenders provide wholesale loans to intermediate, in-country institutions for retail lending at the village level. The multinational lender faces lower risk by lending to a secure institution such as a local bank, an NGO or a large retailer. This model reduces transactions costs for the large institutions by consolidating the loan. Many institutions are attempting to use this model to accelerate photovoltaic dissemination including: U.S. Export-Import Bank, Overseas Private Investment Corporation, USAID, U.S. Trade and Development Agency

Case Study: Photovoltaic Market Transformation Initiative (PVMTI)

The PVMTI is executed by the International Finance Corporation (IFC) and the Global Environmental Facility (GEF). This project will provide technical assistance and financial capital to the manufacturers and dealers who sell, install and maintain PV systems in three countries, Kenya, Morocco and India. In Kenya, the PVMTI will provide $5 million in capital to local banks. The local banks will pay retailers for solar home systems on an individual basis and the retailer will install the system. The end-user of the solar system will then pay the local bank

[2] Ybema, J. R., J. Cloin,(2000) Towards a Streamlined CMD Process for Solar Home Systems: Emission reductions from implemented systems and development of standardized baselines, ECN.

[3] Duke, R.D., Jacobson, A.,and Kammen D.M. (2001), "Product Quality in the Kenyan Solar Home Systems Market," submitted to Energy Policy. see: http://socrates.berkeley.edu/~rael/papers.html

over the course of the loan (see figure 1). Systems in the 20 to 60 Wp will be eligible for loan financing.

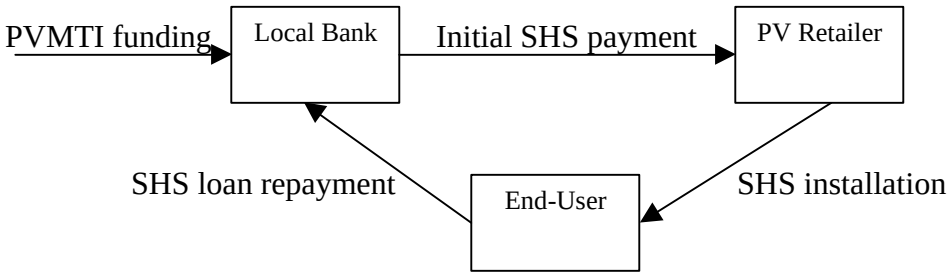

Figure 1: PVMTI organization

Lessons Learned:

1) The Kenya PVMTI project is entering into a well-developed PV market with thousands of players. It is still unknown how the program will affect the existing market. PVMTI is singling out a few players for receiving loans, which will give these few distributors and retailers a competitive advantage over their peers. The question is what will happen when the PVMTI program leaves the country. Will many of the smaller players who have developed without government intervention be driven out of the market by the advantage wielded by PVMTI loan recipients only to make the market less competitive when PVMTI finishes in three years?

2) The systems eligible for loan funding are considerably larger than the systems that have dominated the market over the last decade. A concern is weather or not the PVMTI systems will be too large and expensive, even with financing, for the rural population to afford.

Retailer Provision of Sales/Service/Credit

Credit is not always available from multilateral institutions, in which case a retailer may provide a credit plan on it's own. This model may not result in large infusions of capital (such as with PVMTI), but has proven successful in Indonesia.

Case Study: Sudimara Solar in Indonesia

Sudimara Solar has sold over 30,000 solar systems in Indonesia. The company retails and installs the solar systems, provides 1-year maintenance contracts as well as financing for the 2/3 of the cost of the system. The systems come with 50 Wp solar modules, long-life deep cycle batteries and 5 lamps for $130 USD. The financing for the systems is for 48 months, with an average monthly installment of $10USD/month. Sudimara has been very successful, achieving greater than 95% payback on financed solar systems.

Lessons Learned

1) Although Sudimara has maintained very high rates of loan repayment they have not been successful at attracting larger lending institutions into the market for financing rural energy electrification projects. Banks still view lending to rural population as too risky.

2) There are important reasons for Sudimara's success. Sudimara professionally installs the systems, so they are properly functioning from the start. The maintenance contracts keep the

systems running smoothly and customers are willing to pay back their loans because they are receiving reliable clean electricity. There are good collections rates from the service centers themselves because the service teams receive a personal bonus each month that collections are made on time.
3) Costs are kept low by a combination of factors. All system components, except for the solar laminates, are manufactured in Indonesia. The cost of maintaining the systems has been kept low by situating the service center in territories with a customer base ranging from 5,000 – 30,000 people. This is a large enough customer base to provide enough solar systems to maintain, while also being small enough in area that transportation time to and from maintenance calls is not prohibitively long.

Revolving Loan Funds

Revolving loan funds are set up by a community to provide low interest loans to individuals. The terms of the loans are often less strict than they would be from a financial institution and people can borrow from the funds without formal types of "collateral". Instead of the financial collateral required by banks, revolving loans utilize the social capital that exists in small communities to enforce loan payment and exert pressure on people who are late on their payments. This model is being used successfully by the Gansu Solar Electric Light Fund for financing solar home systems in China.

Institutionally Owned and Maintained Systems

Leasing Solar Systems

A third party buys the systems at bulk rates and then sells them through long term contracts to consumers. This system may or may not include maintenance contracts, though most will include maintenance of some sort.

Case Study: SOLUZ Dominicana

SOLUZ Dominicana was able to procure enough outside financing to start a leasing program for 200 solar home systems. Systems were installed and as payments came in the system was expanded. SOLUZ now services over 1,000 systems, has become cash positive, and is expanding the model into other countries. The Solar Electric Light Fund is using the same model for many of its programs as well. End-users are required to pay a start-up fee and then a monthly payment equivalent to $20/month, this is less than they would pay if they purchased the system outright. SOLUZ installs the 50Wp systems and provides all maintenance under a maintenance contract. The only part of the system that is not owned by the end-user is the fluorescent light bulbs. Any changes that are made to the system are made by SOLUZ technicians, which keep the systems from being broken or overloaded. Collections have been extremely high, as consumer confidence is strong.

Lessons Learned

1) One of the main reasons for success is that SOLUZ has a large incentive to maintain the systems. Because SOLUZ owns the systems it is in the companies best interest to maintain the systems well so that the batteries have a long life and the user remains satisfied with the system. Consumers are not obligated to pay if their system is not functioning, so maintenance calls are responded to quickly and efficiently.
2) System owners are well educated about the limits and requirements of their solar systems because owner knowledge is one of the best ways to maintain system integrity. SOLUZ has the

incentive to educate owners, because it is the company who will have to purchase new parts if the owner abuses the system.
3) Payment collections are made in lock boxes located where owners are likely to pass by on their normal routes, therefore making payments is not onerous.
4) Collections agents are rewarded when collection rates are high. If there is a problem with loan repayments SOLUZ is notified immediately before the problem become serious. If lessees continue to default on payments the solar system is removed quickly and visibly to show the community that defaulting is not permitted.

Government Granted Renewable Energy Concession

When grid extension is not a viable option for a particular population a government my grant a concession to a private institution to serve the community with distributed power. The government may continue to regulate the actions of the company by setting electricity tariffs, overseeing maintenance, mandating service coverage and/or subsidizing renewable energy installations. This system is particularly useful when the service area is deemed to be too dispersed or lightly populated to allow multiple companies to compete for the provision of services within the community.

Case Study: South Africa Rural Electrification Program

There are estimated to be 1-2 million people in South Africa who live in areas too remote to ever be serviced by the grid. The government has begun to utilize private-public partnerships to serve these communities. In 1999 solar electrification was started in earnest with the collaboration of Shell Renewables and the South African utility ESKOM in the Eastern Cape. The plan is to electrify 50,000 homes with solar home systems of 50 Wp capable of powering a small black and white television, a radio and three to four lights. The company is selling electricity as a utility would and maintaining ownership of the hardware. The systems are created as "black boxes" to reduce owner tampering and theft. If the system is moved it will cease functioning. Payment is incorporated into the solar system with a prepayment meter integrated into the charge controller. This will ensure payment for electricity services, as the system will not provide power without payment of fees. Owners pay a connection fee of $30 and a monthly service fee of $8. Installation, maintenance, prepayment card sales and marketing will all be performed by community owned and operated centers. The government will be subsidizing the program, granting $450-$500 for each system to cover 50% of the investment costs.

Lessons Learned

1) South Africa had an active solar market prior to the rural electrification program of 1992. This electrification program stifled the solar market by creating the hope that all households would be served by the electricity grid. People were hesitant to invest in costly solar systems when they believed that the grid would come to their home in a matter of years. It is imperative that governments and utilities are honest and realistic about grid extension plans; otherwise the fledgling renewable energy markets can be severely impacted.
2) Customer satisfaction will directly affect the private companies bottom line, as systems that are broken will not be used and revenues will not be collected. It is therefore in the best interest of the company to maintain systems well.

Energy Service Company (ESCO)

An ESCO sells energy services but retains ownership of the system providing energy. The system is neither sold nor leased to the end-user. Cooperatives, NGO's, electric utilities and

private companies can be ESCO's. The ESCO purchases components in bulk to reduce system costs and installs and services the systems. The ESCO is then responsible for financial management and administration. System costs are reduced because of the bulk buy, and the ESCO is seen as a less risky investment to financiers, leading to better interest rates. ESCO's can receive the low interest loans and government backing that individual rural consumers are not eligible for. These larger loans have less transactions costs than the many small loans that would be required to service the rural population individually, leading to lower costs. Lower costs can then be passed onto the consumer in the form of lower fees. Energy service costs are akin to grid energy services, because the end-user pays for the systems in smaller increments over a longer time frame (10 years or more). It is important to make sure that there is a large enough concentrated demand for electricity, to reduce costs associated with services and repairs.

Case Study: The Tuvalu Solar Electric Cooperative

The Tuvalu Solar Electric Cooperative (SEC) is an ESCO in the Pacific Islands. The SEC has installed 300 systems with funding from Japan and the European Union, which have been operational since 1992. Consumers pay a $40 connection fee and the monthly fee rages from $7 for a basic system to $40 for a system with refrigeration and video equipment. The fee rate was established to cover routine maintenance and battery replacement, but does not collect enough money to purchase more systems and expand the consumer base. For expansion, more capital is needed from outside sources, such as the government or international donors. The consumer owns all system components after the battery, including wiring, lights and appliances while the SEC owns the solar modules, battery and charge controller. This was the first model to focus on servicing solar energy systems in an institutional context. A technician visits each household on a monthly basis to perform routine maintenance and collect monthly fees, while a senior technician visits each district once a year to audit the local technician's performance. The senior technician is also available by radio contact to assist with any problems that are above the ability of the local technician.

Lessons Learned

1) The minimum size for an installation must be 50 houses, if less than 50 systems are in the same community the maintenance and servicing of the systems becomes prohibitively expensive.
2) Training of technicians and owners is the key to a successful program. When people have the proper training the solar systems are maintained and remain in service for a long period of time.
3) It is important to have a technician visit the site regularly to maintain the systems, when technicians are only available when there are problems with the system technical difficulties are exacerbated (i.e. battery death) and consumer satisfaction is low leading to reduced fee payment.

Conclusions

Financing mechanisms for PV systems is a critical element in the electrification of rural areas. There are several themes that are consistent in successful PV electrification projects. Financing schemes should include installation and maintenance of the systems, if not systems will degrade, people will be dissatisfied with their service and stop paying monthly fees. Financing schemes must also incorporate money for extensive training of technicians and system owners, ensuring proper care for the systems at all levels. Fee collections must be prompt and fee collectors tend to do a better job when they are personally rewarded for high collection rates. The national utility must also be honest about grid extension plans; no financing plan can be successful if people have unrealistic expectations about receiving cheap grid powered electricity.