ACCELERATING PV MARKETS IN DEVELOPING COUNTRIES*

MICHAEL PHILIPS
Energy Ventures International
P.O Box 5844
Takoma Park, MD 20913
301-891-2729; e-mail@mphilips@digex.net

BROOKS H. BROWNE
Environmental Enterprises Assistance Fund
1901 N. Moore St., Suite 1004
Arlington, VA 22209
703-522-5928; eeaf@igc.apc.org

ACCELERATING PV MARKETS IN DEVELOPING COUNTRIES

I. INTRODUCTION

The developing world offers a huge potential market for solar photovoltaic (PV) systems. In the near-term, the primary market for solar PV systems in developing countries will be off-grid applications—mainly individual solar home systems (SHS). Eventually, though, a far larger market in developing countries is expected to emerge for grid-connected solar PV systems, which currently are not cost-competitive with other power generation sources.

Despite the large market potential for solar PV systems in developing countries, the successes of PV manufacturers and dealers to date have been few. Manufacturers and dealers do sell some of their products directly to end-users, but most solar PV sales in the developing world have been made possible by donor-funded procurement programs, which provide the PV systems on a concessional basis to users. Very few PV manufacturers or dealers provide financing to users or work with private lending institutions to do so. With a handful of notable exceptions, they have little experience with PV microcredit and leasing.

Opinions about the prospects for accelerated implementation of PV in the developing world vary. Some observers believe the prospects are quite positive. They note that annual sales of PV modules are climbing steadily, increasing by a startling 43% in 1997; industry representatives believe that the manufacturing costs of PV modules will fall from their current $6 per peak watt to less than $3 per peak watt within 4 years; and the number of developing country PV projects is also on the increase. Furthermore, these observers note, there are two billion people in the world without electricity, and these individuals constitute a potential off-grid PV market. According to one estimate, in China alone there is a need for 200 MW to 1,000 MW of solar PV.[1]

There are also new and expanding bilateral and multilateral initiatives for renewable energy such as the World Bank's Solar Initiative, the International Finance Corporation's Photovoltaic Market Transformation Initiative, and the Inter-American Development Bank's Sustainable Markets for Sustainable Energy Program; as well as increased funding from the development banks, the Global Environment Facility (GEF), and anticipated mechanisms such as the Solar Development Corporation sponsored by the World Bank and charitable foundations. Finally, there is the near-term prospect of increased private investment in PV as a result of the "Clean Development Mechanism" (CDM), which promotes investment in clean-air technology in developing countries under an emissions trading regime that was recently approved by the Conference of the Parties to the Framework Convention on

[1] Douglas Arent, *Creating Renewable Energy Markets: Global Challenges, Local Implementation*, Golden, Colo., National Renewable Energy Laboratory Web site: http://www.nrel.gov/business/international/documents/nesea.pdf.

Climate Change. The World Bank may help facilitate emissions trading as well with the rollout of its Carbon Investment Fund.

On the other hand, some observers are less sanguine about PV's prospects in developing countries. They emphasize that field experience with the implementation of PV in developing countries has been extremely mixed—and there are few instances in which PV projects in developing countries have achieved institutional and financial sustainability. Virtually all PV projects in developing countries have relied largely or even entirely on grants or concessional financing at their inception—and very few of them have managed to attract private capital, despite the fact that private investment in conventional energy has been booming in these countries. Furthermore, skeptics argue, the PV market—at least the off-grid market being pursued by the vast majority of PV project sponsors—is quite small relative to the size of total future demand for energy services in the world. It is not likely that carbon emissions trading will be a panacea for PV, these observers say, because PV projects are difficult to establish and difficult to monitor for their contribution to carbon emissions reductions. The market for carbon trades will involve a broad range of technologies and practices—and PV will have to compete with energy efficiency, other renewable energy technologies, and a host of agriculture, forestry, and transportation projects to offer lower costs per ton of carbon emissions reduced.

We believe that there are major opportunities for accelerating the implementation of PV in developing countries. But given the few success stories to date, the small size of PV projects relative to other energy projects, and the general unfamiliarity with PV projects by private and multilateral investors, the challenge of accelerating PV investment and implementation in the near term without losing lots of money is a somewhat daunting one. Still, if the past experiences with PV projects are applied to new projects by PV dealers and project developers, multilateral and bilateral agencies, and host governments, then PV's future could be bright.

II. PV IN THE DEVELOPING WORLD: THE CURRENT STATE OF AFFAIRS

A. Applications of PV in Developing Countries

The dominant application for PV in developing countries is the solar home system (SHS). This involves the installation of PV systems of 30 to 50 peak watts (Wp), costing about $300 to $500 (U.S.) each, in individual homes, mainly in rural areas. Apart from SHS, other applications of PV in developing countries include 1) PV-powered remote telecommunications equipment; 2) rural health clinic refrigerators; 3) rural water pumping; and 4) PV battery-charging programs, which allow rural residents to purchase or rent batteries to provide electricity to their homes, and then recharge them at PV-powered charging stations. A few attempts have been made to establish PV-powered village power grids in developing countries.

Grid-connected PV systems are rare because at the moment PV is not economically competitive with other grid-connected energy sources. Still, grid-connected PV does have localized applications in utility transmission and distribution (T&D) systems (e.g., augmenting air-conditioner loads at overloaded commercial district substations, or providing supplemental power in hybrid energy systems

at larger load centers). The benefits of such T&D applications include avoided or deferred T&D upgrades, lower transmission line losses, and improved reliability. If, as some observers in the PV industry believe, the imbedded cost of PV modules drops to under $3 per peak watt (Wp) within 4 years, then grid-connected PV will be economically competitive with conventional fuels on select utility systems. When this occurs, the on-grid PV market will be far larger than the off-grid market.

For the present, however, the main strategic application for PV in developing countries continues to be the off-grid market. Because large-scale, grid-connected PV applications in developing countries are nascent, we limit much of our discussion in this paper to off-grid PV applications—essentially, SHS. The SHS approach has become the favored application for off-grid PV project developers, international donors, and the PV industry.

Despite our focus on SHS and other off-grid PV applications in this paper, we believe that the central observation of this paper—the key role of the private sector in development of off-grid PV businesses—is also applicable to the development of grid-connected PV markets. Specifically, unless developing country governments are prepared to provide large and continuing subsidies to PV, the private sector will be essential to the future growth of markets for PV applications. Government subsidies are currently stimulating a surge in grid-connected applications in industrialized countries such as Japan, but the PV industry cannot rely on such subsidies to create sustainable markets in developing countries. There will never be enough subsidy money available in these countries to allow PV to out-compete other energy sources, both conventional and unconventional. In the developing world, the private sector will be critical for PV market development.

B. Getting PV Programs and Businesses Off the Ground in Developing Countries

The discussion below focuses on getting PV programs and businesses off the ground in developing countries. Selling solar home systems (SHS) is not easy, although some countries and regions lend themselves to SHS sales more than others. The best markets are countries/regions that meet three criteria:

- First, the countries/regions must have either an insufficient grid or a grid so unreliable as to create demand for supplemental power sources.
- Second, the rural population should be readily accessible within a region so that the systems can be serviced cost-effectively. (One of the problems encountered in Indonesia has been that in some areas, populations are so dispersed that there is no cost-effective way to properly service the systems.)
- Finally, it helps to have a majority of the population in the cash economy with an income level that supports the minimum payments required by a custom financing vehicle. If a country is so poor, or if enough of a country's residents simply have insufficient cash income, then unsubsidized SHS sales—even with a consumer financing program—are infeasible.

1. Establishing a PV Program in a Developing Country

It is both costly and risky for PV manufacturers or dealers to try to establish markets for their products and services on their own. Thus, most PV sales are facilitated—at least in their early implementation—by government or donor technical assistance programs. In some cases, these programs are initiated by the PV manufacturers themselves. An example is BP Solar's program in the Philippines. Developing country host governments are usually involved to some degree in initiating these projects or passing on international donor funds to them. An intermediary organization such as a nonprofit corporation is often involved in the design and management of the pilot program.

Private PV system dealers who wish to participate in such programs submit bids for the sales of PV systems to the host government. They often must first go through a prequalification process to certify that they are not "fly-by-night" operators. For example, their products must meet the program's technical specifications. Also, they must provide warrantees and show that they are able to service their PV systems. In some cases, a portion of the PV system's purchase payment is withheld from the dealer and is escrowed until the warranty expires, thus ensuring the dealer honors the warranty.

The preparation of a PV electrification program can take up to several years and be quite costly.[2] It involves several steps:

- performing a demographic/market and preinvestment analysis to assess demand for PV systems and determine where and how to target end-users;
- completing a technical analysis to determine appropriate performance standards for the PV systems;
- developing a program design that specifies roles, procedures, and costs for marketing, selling, installing and servicing the PV systems;
- providing warrantees; and
- developing a plan for monitoring and evaluating the program.

If, as is often the case, existing microfinancing systems in a country are incompatible with PV financing, additional steps must be taken to set up a new financing program (e.g. establishing the mechanics of user marketing, credit analysis, disbursement, and collections).

Although each SHS program has unique characteristics, there are two general approaches to bringing PV to customers in the developing world:

- ***Open market approach***. In the most common approach, described by the World Bank as the open market approach, there is a roughly unrestricted market in which PV dealers and developers can conduct direct sales and—with government, donor, and nongovernmental organization involvement—establish PV microcredit, leasing, or direct sale programs.

---

[2]Heinz-Wolfgang Behnke, "The Experience of GTZ in Disseminating PV Technology in the Philippines," *Proceedings of the Regional Workshop on Solar Power Generation Using Photovoltaic Technology* (Manila: Asian Development Bank, 1997), p. 99.

- ***Dispersed area concession approach.*** In the dispersed area concession approach, applied chiefly in Argentina and the Philippines and planned for northeast Brazil, a private electric utility, rural electric cooperative, or other institution is granted a concession for providing electricity services to unserved populations and does so in part through establishing a PV program.

Few PV programs in developing countries, regardless of approach, have achieved independent financial sustainability. Although they are aiming eventually to become financially sustainable, most of these programs—while perhaps successful by other standards—have been unable to wean themselves from grant support.

The few success stories on record—that is, PV programs in developing countries that have managed to become financially sustainable without continuing to rely on subsidies—involve a comprehensive, phased approach toward stimulating the market for PV, creating a financing program, and providing servicing for the installed systems. In the Dominican Republic, for example, SOLUZ has established a 1,000 or more unit leasing program, which is now cashflow positive (see details in the section on leasing and fee-for-service approaches below).

Why have so few PV programs in developing countries achieved financial sustainability? There are several reasons. The most common problem is extra costs arising from unanticipated maintenance, component replacement, outreach efforts, and training. In cases where extra funds are available to cover these activities, the "human software" to provide the maintenance or training often is not. In Kenya, a PV program did not address the middle-market consumers—i.e., consumers who cannot afford to pay the entire cost of a PV system up-front in cash but who are not so poor that they need the PV system price subsidized; the program in Kenya focused only on the cash market, thereby preventing the next level of penetration and precipitating a long-term decline in sales. In Sri Lanka, the lack of working capital and slim margins at the dealer level prevented the PV program from thriving, let alone expanding. A program in the Philippines suffered from, among other things, poor financial management and a lack of understanding of the terms and conditions of its own loan program on the part of key officers in the implementing institution.[3]

In some countries, well-meaning government subsidies for PV have undercut the existing private PV industry, so that while an individual program may be successful, the sustainability of the overall PV market is damaged. This unintended outcome occurred, for example, with a United Nations-sponsored program in Zimbabwe**.** Subsidies, while certainly stimulating near-term PV sales, can work against financial sustainability in the long term. The Agricultural Development Bank of Nepal provided 50% subsidies of SHS hardware costs;[4] and some donor programs continue to provide large subsidies for PV and other products in order to promote sales of domestically manufactured products.

---

[3]Eufemia C. Mendoza, "Development Bank of the Philippines Window III Experience on Financing PV SHS," *Proceedings of the Regional Workshop on Solar Power Generation Using Photovoltaic Technology* (Manila: Asian Development Bank, 1997), p. 368.

[4]RSVP (Renewables for Sustainable Village Power), National Renewable Energy Laboratory, Golden, Colo., Web site: http://www.rsvp.nre.gov.

2. Establishing a PV Business in a Developing Country

Like many businesses, a PV business is tough to manage. Many variables need close attention throughout each business stage:

- research on markets and customer demographics,
- design of the system,
- raising equity and managing working capital,
- training and oversight of both technical and sales staff,
- development of a microfinance approach that is appropriate for the customer base,
- management of the microfinance process (or strategic alliances with microfinance organizations),
- management of after-sales service,
- recycling of batteries,
- repossession of units from nonpaying customers,
- accounting and record-keeping.

In addition, there must be enough profit at each step of the value chain to provide incentives to PV entrepreneurs and to attract equity capital investment. If PV entrepreneurs go into business without the potential to achieve adequate profit margins, their companies will not be sustainable in the long run.

Access to working capital is key for PV firms. Even if technical assistance is available to research the markets, there will be a need for working capital to pay for advertising and cover early start-up costs, inventory, and accounts receivable. Growth businesses consume working capital as they grow to finance larger inventories and accounts receivable. A shortage of that working capital will choke a business.

Furthermore, PV businesses cannot rely on cash markets indefinitely. In time, any geographically efficient cash market will become saturated. At that point, PV businesses must finance middle-market consumers—i.e., consumers who cannot afford to pay the entire cost of a PV system up-front in cash but who are not so poor that they need the PV system price subsidized. But if the PV business becomes stalled in its middle-market financing stage before it achieves breakeven system installations (up to 1,000 units, depending on finance margins), it will collapse. Thus, customer financing instruments and service/collection infrastructures will be needed.

In sum, to operate an SHS assembly, distribution, or retail sales business in a profitable manner, an entrepreneur must have sufficient operating capital as equity; must be successful in making sales to customers in the cash market; and soon thereafter must be able to reach a breakeven point via sales to middle-market consumers who rely on customer financing instruments to make purchases.

In some countries, system design and balance-of-system requirements have not been addressed—that is, PV systems have been sold in smaller sizes than what was really needed by customers, or the customers were left to buy the lighting or other components, do the rest of the wiring, etc. The result was that the whole system did not perform because some components were poorly integrated, incompatible with the rest of the systems, or had poor battery controls. The best approach to these risks is for a company to design a system that can withstand some abuse, and which is carefully tailored to what people want to use it for.

So far, successful SHS companies have tended to "own" their markets—that is, they are dominant in a region to a point where they have little meaningful competition. This dominance helps them protect margin and optimize SHS installation, servicing, and collections. A monopoly is not in the best interest of consumers or the marketplace in the long run, but market dominance appears to be extremely helpful in getting a PV business operation successfully off the ground in the short term until the market matures.

C. Financing Mechanisms for PV Systems in Developing Countries

The type of financing mechanism employed by PV dealers and program developers varies by country, depending on the maturity of the financial sector and the regulatory environment. The simplest approach is direct sales of PV systems by dealers to households able to afford to purchase a PV system. The number of households in developing countries who have no electricity, yet can afford to purchase a PV system outright, is limited. To increase PV penetration rates beyond the levels achieved through direct sales in the cash market, however, additional financing mechanisms are needed. Such mechanisms include microcredit and leasing arrangements.

1. Direct Sales of PV Systems

For dealers and developers, the cash market should be considered the logical entry point for the start-up of new solar PV industries within a country or particular subregion of a country.[5] Indeed, for at least one U.S. PV developer operating in developing countries, Arizona-based Photocomm, direct sales is the sole approach. [6]

Direct sales enables the establishment of a force of PV installers and after-sales support technicians. It also provides for much greater awareness of PV as a few of the wealthier households in each village use PV and demonstrate its benefits (e.g., better light, no fumes with fewer accompanying respiratory problems for children, or ability to conduct better village retail operations at night if the PV is installed in a small shop).

[5]A subregion is any area where, within an efficient distance, there is sufficient rural population with purchasing power or in the cash economy, to be able to afford solar PV systems in one way or another. Within such a region, there will always be a segment of the population, perhaps 10% to 15%, who can afford to pay for a complete solar PV home system using either cash or very short-term (e.g., 1-year) financing.

[6]Henrick Ahlgreen, Photocomm, personal communication, September 1998.

A company's ability to generate revenues from the cash market may only last a few years in a given location before that sales territory becomes saturated. Thus, while direct sales facilitates the penetration of a broader market, this approach has limitations that can only be overcome by alternative financing mechanisms.

2. Microcredit Arrangements for PV Systems

Some form of microcredit is essential to increase PV penetration rates beyond the levels achieved through direct sales in the cash market. Otherwise, the high initial cost of a PV system is going to be beyond the reach of the average rural consumers who, though perhaps in the cash economy, can only afford the equivalent of the $8 to $12 per month that they already pay for lighting supplies (candles, kerosene, dry cells or battery charging).

The SHS industry in developing countries is comparable to the automobile industry in industrialized countries in that consumer financing vehicles can help greatly increase market penetration and sales. In industrialized countries, the vast majority of automobile users either finance their cars with installment loans, or lease them, because the high initial cost of a car makes it otherwise unaffordable. Financing is one of the essential contributors to the success of the global automobile industry, and the capital markets in many industrialized countries have developed specialized instruments for the automobile industry—including the straightforward bank-financed car loan, manufacturers' credit schemes such as GMAC or Ford Motor Credit (financed by these companies in part through the issuance of commercial paper), securitization, leasing, etc.

The key for the SHS industry, therefore, is to develop and establish specialized financing vehicles for potential customers of PV products. To date, the use of financing vehicles with market-based returns in the PV industry is not widespread at all.[7] Many informal "captive finance programs"—under which SHS dealers offer financing strictly for the purchase of the goods and services they themselves provide—offer financing for up to 2 years, but in the majority of cases, such arrangements are not going to be a long-term solution to affordable financing. For a $500 system with a 2-year loan at 15% , the monthly payments are $24.24. By comparison, the monthly payments for 5 years at 15% are $11.89, which is closer to the top end of what is currently affordable to the average rural household in the developing world. To get the monthly payments for an SHS system down to a lower level—in the $8 to $12 range—a smaller, lower wattage system would be required: For an SHS system that costs only $350, for example, the monthly payments would be $8.33 over 5 years at 15%.

Microfinancing arrangements for projects in areas such as housing and small business development are growing in some developing countries—including India, Bangladesh, and several Latin American countries—and have proved successful. While some people in these countries are still able to find sources of capital provided by softer, nonmarket organizations, the trend is to access capital that is truly market-based, and to earn returns that are fully competitive, if not superior, to the returns on equity of the more traditional commercial banking industry.

In other words, performing microfinance networks exist in many of the markets for financed SHS packages—thus, a marriage between an SHS distribution industry and microfinance networks seems

[7] The only example of significant size is Indonesia-based Sudimara, which claims to have installed 5,000 SHS through its own credit system prior to Indonesia's economic crash.

to be the logical way of creating a customized finance vehicle that will help achieve broader market-based SHS penetration. If microfinance networks are already in place and operating profitably, why should a dealer embark on the complex and difficult process of developing a custom financing instrument, raising outside capital for it, and then establishing and maintaining a collections infrastructure with some accompanying defaults and repossessions?

The answer is that microfinance networks are not yet uniformly in place in most countries, or if they are, they do not lend themselves to PV financing. In Indonesia, for example, some direct sales of SHS are taking place on a small scale, and the World Bank has sought to establish a microcredit system for PV. Initially, existing microcredit institutions such as BRI, a large state-owned rural development bank, were solicited to participate in the program. But Indonesia's existing microcredit institutions provide only 6- to 8-month terms; also they tend not to provide financing to specific projects but rather working capital to the individual owner of a company. Thus, the World Bank staff thought that working with Indonesia's existing microcredit institutions would not result in a very high penetration rate for PV. To increase the penetration rate of PV, a hire-purchase program has now been established in Indonesia—although it is currently on hold because of the country's financial crisis—wherein commercial banks will on-lend World Bank funds (and eventually their own funds) to certified PV dealers; the dealers, in turn, will provide microcredit loans to their customers.

Only a few examples can be cited to illustrate a successful marriage between established microfinance organizations and the SHS industry. The best known cases operating on a meaningful scale are the Grameen Bank in Bangladesh and Genesis in Guatemala. The Grameen Bank, which has financed 376 PV installations, provides loans for 2 years at 8% interest, and requires a 25% down payment; risk is reduced by marketing the PV loans to clients who have already borrowed and successfully serviced loans from Grameen in the past. Genesis, which has financed 86 installations, provides 3-year loans at 15%; a local electric utility is now competing with Genesis by offering a slightly lower interest rate.

Experts in the microfinance industry suggest that difficulties in marrying microfinance and SHS industries center around three concerns:

- ***Loan amounts***: Microfinance organizations typically prefer to start small with their borrowers—perhaps extending an initial loan of only $100—to establish credit at this level with a borrower who has no formal credit record. Thus, the existing customer practices of many microfinancing organizations would not allow them to make an initial SHS loan of $500.

- ***Loan maturities:*** Most microfinance organizations look for much shorter repayment maturities for their microloans, perhaps 6 months to 2 years. The 5 years often needed for SHS is too long for most of the established microfinance organizations. With higher down payments, the terms can be reduced somewhat. For example, in a new program in Sri Lanka, rural consumers will pay about 25% of system costs up front and the remainder of the costs over 2 years.

- ***Credit philosophies:*** Many, if not most, microfinance organizations operate credit mechanisms that depend on peer responsibility rather than collateral security. The original Grameen Bank model is one which provides credit to networks of five borrowers, one at a time for each group, until each of the five borrowers is performing satisfactorily on interest and principal repayments. If any one person in that five-person network defaults, then the

other four members of that group lose their credit privileges with Grameen until the problem is fixed. In Bangladesh and some other countries, this model seems to have achieved great success (though in some cultures elsewhere, peer dynamics are much less effective). Indeed, according to one analysis of renewable energy financing, group financing activities with an element of compulsory participation have a greater degree of success.[8] Although, there is no reason why a peer pressure approach should not work in the SHS context, the approach may run counter to the collateral-based approach. Specifically, the threat of repossession of the SHS module undermines the peer dynamics and overall lending philosophy. If one member of a peer group believes that the lender will be fully repaid by the collateral liquidation of a repossessed unit, then the incentive to maintain payments in tougher times is weakened. Unfortunately, the value of such repossessed solar modules covers closer to 50%, rather than 100%, of the credit loss. It does not cover the other costs of sales commissions, installation and balance of system. This issue is not well appreciated by microfinance borrowers.

3. Leasing and Fee-for-Service Approaches for PV Systems

In developing countries where consumer awareness of PV is strong—such that there is high pent-up demand for financed units—leasing and fee-for-service approaches have worked, but with only a very few examples of success. In the Dominican Republic, SOLUZ-Dominicana has established a 1,000 or more unit leasing program, and is now cash-flow positive.

SOLUZ-Dominicana was able to secure enough capital to test the leasing program on a smaller scale (200 units), make corrections, and then continue to finance the rollout to reach a cashflow breakeven level. Lock-boxes located in prominent buildings which customers are likely to visit anyway are used to make collections. Local, independent collection agents are rewarded when collection levels are high, and these collection agents let SOLUZ know about SHS lessee family credit problems before they become serious. In addition, SOLUZ has a credible repossession program, where lessees who do not pay their installments lose their units quickly and visibly, sending out the signal to other lessees that nonpayment is not acceptable. Finally, SOLUZ is able to provide excellent maintenance and after-sales service on its PV units. It has the incentive to do this, because it owns the systems. Just as important, if the systems do not operate for any reason—even poor customer education or overuse—SOLUZ cannot collect lease payments; this gives SOLUZ an incentive to educate its lessees well at the front end, and then to call on them periodically to make sure that the system's operation is not being hurt by poor customer operating practices, a phenomenon which has been a real problem for the SHS industry in a number of countries.

The leasing program established by SOLUZ-Dominicana is a good model for programs now being undertaken by SOLUZ affiliates in other countries, and the financing credibility at the distributor level is now growing, such that the distributor can attract increasing amounts of capital at market-based pricing. However, despite its success, the SOLUZ model in the Dominican Republic is not one that would be easy to replicate. The SOLUZ CEO, Richard Hansen, was particularly effective in persuading some initial soft-money investors and foundations that they should support his trial efforts to prove the model. Now that this has been done, private capital will support the continuation of SOLUZ's growth. Entrepreneurs in other countries who lack Hansen's connections in the North

[8] Jenniy Gregory, et al., *Financing Renewable Energy Projects: A Guide for Development Workers* (London: Intermediate Technology Publications, 1997), p. 59.

American foundation community would face a tough challenge in attracting the necessary start-up capital.

D. Human Capital Constraints on PV in Developing Countries

Two human capital constraints affect the penetration of solar PV in developing countries: 1) the insufficient quantity and quality of PV industry entrepreneurs, and 2) the stock of PV installers/maintenance technicians.

1. PV Developers/Entrepreneurs

In most developing countries, despite an abundance of qualified entrepreneurs in traditional sectors, there are insufficient PV entrepreneurs. Why is this?

- First, there is a lack of general knowledge/awareness of the PV industry and its possibilities and profitability. There are few if any precedents or models of private sector entrepreneurs who have launched successful PV businesses and who are making money. It stands to reason that entrepreneurs would instead devote their limited investment capital to better known businesses.

- Second, the stock of entrepreneurs interested in SHS often involves individuals who do not have the track record, credibility, and capitalization that is generally sought by traditional sources of debt or equity financing.

The lack of outside capital support for solar PV entrepreneurs is due in part to the risks involved. These include both macroeconomic risks and microeconomic risks. Even if an entrepreneur starting a solar PV business has done all the right homework (i.e., studied the demographics, mapped out a staged business plan, raised debt and equity financing, and started in the cash market business), he or she will still face major macrolevel risks, among them: 1) politically driven changes in fuel subsidies before an election; 2) the unanticipated extension of the grid (or just the promise thereof) into the operating territory of the company; 3) the imposition of additional trade barriers (for example, import duties) on imported components; 4) the deterioration of capital markets which impedes access to critically important growth capital to reach breakeven; 5) the loss of needed technical assistance because of some dispute between a host country and a donor country; and 6) the launching of a subsidized solar PV program in the same market territory. In addition, the entrepreneur will face the microeconomic business risks associated with any new business and new industry, namely: 1) improper system or balance-of-system design; 2) poor cost accounting; 3) failure to package the sale to include needed after-sales servicing; and 4) loss of technicians to competing industries after these technicians have already been trained.

2. PV Installation and Maintenance Personnel

Apart from the shortage of entrepreneurs willing to enter the high-risk PV business, there is a shortage of trained technicians familiar with PV systems. The availability of trained PV installers and service technicians is essential to maintain continued operation of financed systems so that payments can be made. But people take time to be trained; then, even if they are successfully trained, they can get recruited away.

For these reasons, it is essential that training programs for PV installation and maintenance personnel be ongoing. A number of countries have established permanent training courses. In Tanzania, the Karadea Solar Training Facility, with a permanent staff of four, provides basic and advanced training for students from Tanzania, Uganda, Kenya, and Nigeria on how to install and maintain PV systems. It also provides guidance on PV projects for nongovernmental organizations, businesses and relief agencies.[9]

E. Sources of Investment Capital for PV in Developing Countries

So far, most of the investment capital for PV projects in developing countries has been provided by multilateral development banks (MDBs) and bilateral agencies through host governments. Private sector institutional investment in PV projects or enterprises in developing countries has been minimal. Private institutional investors tend to view PV projects as too small and too risky. Even where debt is available, the maturities tend to be too short.

1. Bilateral and Multilateral Institutions That Provide Capital for PV

Most of the investment capital for PV projects has been provided by bilateral agencies in host countries and by institutions such as MDBs. Bilateral institutions, in particular, have been active in providing training for PV system installers, project staff for designing and administering PV programs, and PV equipment for demonstration projects. Bilateral and multilateral institutions often take steps that they hope will make PV projects financially sustainable. One example is providing seed funding to establish a revolving fund. However, efforts to establish revolving funds often fail, and the revolving funds become "dissolving" funds—they do not charge high enough interest to cover normal level of defaults, they have insufficient community participation and thus high defaults, and they have inadequately trained staffs.

One new program sponsored by the International Finance Corporation (IFC) and the Global Environment Facility (GEF)—the Photovoltaic Market Transformation Initiative (PVMTI)—will offer technical assistance and risk capital to the manufacturers, dealers and other private players who provide, install and maintain PV systems. The PVMTI will provide working capital loans on a competitive basis to PV businesses in the target countries of India, Morocco, and Kenya.

The U.S. Export-Import Bank has provided both export credit insurance and working capital loans for U.S. PV businesses with overseas operations or distributors. In order to qualify for the loans, the firms must show, among other things, an order for a large number of units. For most PV companies, if a single large order were to materialize at all, it would come only after a substantial period of business development and historical sales. The Export-Import Bank's loans are thus mainly applicable to already-established distribution companies. The Export-Import Bank also will provide intermediary loans (up to maximum principal amount of $5 million and maximum repayment term of 5 years) to fund intermediaries who loan to foreign buyers of U.S. capital and quasi-capital goods and related services. The application of intermediary loans to PV credit entities has not been explored.

---

[9] Frank Jackson, "East Africa's First Solar Training Centre," *The World Directory of Renewable Energy Suppliers and Services 1997* (London: James and James, 1997), p. 108.

The Overseas Private Investment Corporation (OPIC) provides U.S. companies seeking to invest overseas with investment services and political risk insurance, as well as direct loans and loan guarantees. Project financing is also provided. Participation by small and medium-sized businesses and corporations has recently been encouraged. In 1996, two OPIC-backed country funds invested in a PV dealership in India.

Among grant-making agencies, both the U.S. Agency for International Development (AID) and the U.S. Trade and Development Agency provide funding for U.S. firms to carry out feasibility studies, consultancies, and other planning services related to major PV projects in developing countries. AID supports a number of training activities as well.

Prospective sources of investment capital include the funds that would flow from implementation of the Clean Development Mechanism of the Climate Change Convention that promotes investment in clean-air technology in poorer countries, as well as from implementation of the Solar Development Corporation (SDS) being established by the World Bank and nonprofit foundations:

- ***The Clean Development Mechanism (CDM) of the Climate Change Convention.*** Investments made pursuant to the CDM will not be limited to PV and could even bypass PV altogether. The many kinds of energy, transportation, agriculture, and forestry projects that will presumably be approved for carbon credits under the CDM will likely compete with each other to attract CDM investment. Many alternative carbon emission reduction activities are cheaper and/or easier to pursue than PV projects. Adding to the difficulty is the fact that carbon emissions reductions must be monitored and verified. This may be extremely difficult and expensive for remote, off-grid SHS projects.

- ***The Solar Development Corporation (SDC)*** is intended to provide working capital and financing to PV dealers operating in developing countries. It is envisioned as a combination technical assistance and investment fund. Of its anticipated $50 million capitalization, $18 million will be in grant form from the GEF for business advisory services. The remaining $32 million will be investment capital used to capitalize the investment fund. Of the total, the World Bank, IFC, GEF, and nonprofit foundations have committed $30 million, so the SDC will have to raise another $20 million from private institutional investors, mainly for capitalizing the investment fund. That fund will invest on a quasi-commercial basis in local PV ventures and financial intermediaries. The business advisory services, funded by grant monies, will provide technical assistance to PV companies and charge them a small fee where appropriate.

2. Private Institutions That Provide Capital for PV

A few environmentally oriented private investors have provided small amounts of equity and some debt for PV developers. At least three private institutional investors—Gaia Capital (Germany), Swiss Reinsurance Company (Switzerland), and Triodos Bank (Netherlands)—have invested several million dollars in PV development companies.

- Gaia Capital and Swiss Reinsurance Company have provided equity capital to PV project developers operating in developing countries.

- Triodos Bank has established a $3 million Solar Investment Fund, capitalized by the Dutch government and the Dutch power utility ENW. In Sri Lanka, the Solar Investment Fund is

providing a loan to the private Renewable Energy Services Company of Asia (RESCO), which provides SHS loans to rural households. It is also providing a partial guarantee on the first 600 PV systems, thereby helping to attract local lenders to participate in the project. In Bolivia, the Solar Investment Fund is funding Co-Operativa Rural de Electrificación LTDA (CRE), an electric cooperative utility that hitherto has provided electricity through the national grid, but which is now aiming to provide solar energy for rural customers on a fee-for-service basis.

Private institutional investments in PV such as those made by Gaia Capital, Swiss Reinsurance Company, and Triodos Bank are rare. From the PV industry's perspective, the capital markets have largely bypassed PV.

Domestic capital markets in developing countries can help or hurt the establishment of a viable SHS industry. Obviously, local capital is less essential if an PV entrepreneur can attract offshore capital, as has been the case in the Dominican Republic. Unfortunately, offshore capital is hard to access mainly because of the unacceptably high foreign exchange risk faced by capital providers.

In many of the developing countries that are the most likely hosts for SHS investments, there is virtually no venture capital or other long-term institutional risk capital financing available. And even if local capital markets are relatively developed, SHS investments often involve technologies and structures that are new to the country and are therefore considered exotic. Furthermore, SHS projects tend to be more capital intensive than their conventional counterparts, even if operating costs for SHS are lower. When compared with the diesel generation alternative, the capital costs seem out of proportion.

As noted above, the development of any SHS project, especially in a developing country, can take 2 to 5 years. At its inception, it requires equity capital investment for the working capital needed to penetrate the cash market. Then, debt can be used to finance perhaps a modest portion of working capital, and then a portfolio of consumer finance or lease paper. But to attract debt, the relatively small size of SHS projects is a problem. Unfortunately, classical international project financing approaches dictate the need for relatively large projects—with minimum financing requirements of, say, $15 million. Financiers may consider SHS entrepreneurs too small to obtain debt financing without strong outside (i.e., nonproject-related) collateral. When prudently financed, SHS projects are capitalized in rollout stages: first to exploit cash market; then to do a pilot program to research and test optimal financing vehicles, for say 200 units; then to get enough financing to carry one region of a country to reach cashflow breakeven level; then to replicate those programs in other regions, etc. There is no real reason for any particular stage of financing to require more than $1 million.

One private company seeking to finance PV projects by packaging them with other energy projects is the Energy Capital Holding Company (ECHCO) based in Washington, D.C. ECHCO has announced a plan to close on $1 billion worth of energy projects which will include some PV. In addition to packaging the projects to meet the application requirements of funders, ECHCO provides project sponsors with an integrated set of legal, engineering, insurance, fiduciary, and financial advisory

services, as well as sourcing equity capital. At the time of this writing, ECHCO had not yet closed on its first package deal, so the viability of its approach, while promising, is still theoretical.[10]

F. Lessons Learned from PV Projects in Developing Countries

From the many PV projects in the developing world—both the few successful projects and the many less successful projects—there are lessons to be learned about how to successfully establish PV in a developing country. The successful rollout of an SHS distribution program in emerging market countries has several dimensions, including 1) demographic mix and access to the grid; 2) national-level policies on trade, fuel subsidies, and the like; 3) technical assistance and foreign aid programs; 4) access to capital markets financing; and 5) business practices.

The experience to date indicates there are five requirements for an SHS program in a developing country to succeed:

- ***Significant private sector participation.*** The entire SHS program must be executed with significant private sector participation and as little reliance on government subsidies as possible. At the outset, dealers should make direct sales to cash-paying customers. Eventually, though, they should try to link up with microcredit institutions that can provide financing to customers for their PV systems. Broad market penetration will necessitate the development of consumer financing vehicles.

- ***Profit at each step of the value chain.*** There must be profit at each step of the value chain to attract entrepreneurs and capital investment. If entrepreneurs go into business without the potential to achieve adequate profit margins, their companies will not be sustainable in the long run. Furthermore, investors will not be willing to invest capital in businesses that are not profitable. A failure in any one part of the chain—for example, after-sales support or credit collections—can spell disaster for the whole sector.

- ***Sale/finance of the SHS system as one package.*** It is best if an entire SHS system can be sold or financed as one package.

- ***Availability of a customized financing vehicle.*** A customized financing vehicle for a PV system should be designed by the PV dealer or distributor handling PV systems with two major considerations in mind: 1) demographics and 2) allied collection and servicing mechanisms.

- ***Availability of good after-sales service of the PV system.*** For a PV financing vehicle to work, the availability of good after-sales service of the PV system is critical. Consumers won't make installment of loan installments and lease payments for a service that does not work.

[10] Michael Philips, "ECHCO to Close on $1 Billion Package, Including Renewables," *Clean Energy Finance*, Volume 3, Number 1, Spring 1998 (Winrock International and Energy Ventures International), p. 3.

III. WHAT IS NEEDED TO ACCELERATE IMPLEMENTATION OF PV IN THE DEVELOPING WORLD

PV will become a viable alternative to fuels currently in use in developing countries—whether on-grid electricity, minigrid diesel, or off-grid kerosene—only if it can compete economically with them. Furthermore, the competing fuels already in use are not static—for example, new gas microturbines are coming on the market in rural areas and will compete directly with PV.

Only a few PV programs in developing country are now economically competitive with little or no subsidy. In order to increase the number of PV programs in developing countries that are economically competitive, 1) there must be improvements in the policy environment of host countries; 2) the human capital infrastructure in developing countries must be developed; and 3) the availability of investment capital for PV must be improved.

A. Improving the Host Country Policy Environment

For the private sector to earn profits in PV, there must be profitable opportunities available in the first place. Government policy can have a huge influence on whether such opportunities are available. To create a policy climate that supports SHS growth, host country governments should minimize the use of subsidies for energy; they should also reduce import tariffs and customs duties on imported components of PV systems (such as solar modules) so that such systems are more affordable to the middle-market customers who will need to lease them or finance them over time. Some host governments may want to consider using rural electricity concessions such as those used by the government of Argentina (see Section 3 below).

1. Elimination of Subsidies

If a host country subsidizes fuels that are competing with PV, such as kerosene, there is less likelihood that a PV-financing vehicle will succeed because the subsidy automatically lowers the amount that people are currently paying for light.

Admittedly, it is highly political and often extremely difficult for developing country governments to remove subsidies that reduce the prices that consumers have to pay for conventional sources of energy. It may be easier—though more expensive in the near term—for governments to provide one-time transitional subsidies to PV and other clean energy sources as they phase out conventional fuel subsidies. This type of transitional subsidy for PV has been recently approved in northern Brazil, where high government subsidies for diesel fuel have so far blocked otherwise economically viable PV sales.

Ultimately, however, providing transitional subsidies for PV equipment or PV financing vehicles will prove counterproductive for market penetration. In the short term, such subsidies may accelerate the spread of SHS in the economy, but unless the whole PV spectrum—from equipment installation to microfinance—is functioning and profitable in its own right, it will not end up producing an economically viable lighting alternative to kerosene.

Donor funds provided by bilateral and multilateral institutions are needed primarily to pay for technical and managerial training and initial program administration. After being used for those needs, donor funds could be used to support some PV equipment subsidies, but the subsidies should be modest and temporary, similar to the World Bank/Global Environment Facility (GEF) subsidies in Indonesia.[11] Large subsidies will distort the market and will detract from the long-term financial sustainability of a PV program. In sum, host governments should provide an environment largely free of subsidies to create a climate which is supportive of SHS growth.

2. Fiscal Incentives: Import Tariffs and Domestic Manufacturing Incentives

Reducing import tariffs on PV modules and associated equipment is a relatively simple and straightforward step national governments have taken to reduce the cost of PV systems. It can be a difficult step for those governments that rely heavily on import tariffs for government revenues. As an alternative, most governments prefer—and usually provide incentives to encourage—domestic manufacturing or assembly of products such as PV systems. Developing country governments seeking to promote PV should do both: 1) reduce import tariffs on PV modules and equipment, and 2) offer incentives to domestic PV manufacturers.

Most PV projects in developing countries initially rely on imported PV modules. From the manufacturer's viewpoint, there is no reason to build a manufacturing plant in a country until there is a market there (or in nearby countries) for PV modules. Lowering import tariffs will keep imported module prices down in order to catalyze the development of a domestic PV market, after which the manufacturer may well decide that opening a manufacturing facility makes economic sense. Both reduced import tariffs and domestic manufacturing incentives should be temporary measures. In order to prevent inefficiencies, they should be phased out once a local industry is commercially functioning.

Some governments, including India, have provided tax incentives for PV or for renewable energy generally. Such incentives have encouraged the rapid proliferation of SHS units in some places. But the experience in some countries is that when the tax incentives are withdrawn (because the government needs the revenue base), the industry suffers a precipitous decline, and the profits needed for SHS servicing decline, thereby harming both prospective sales and existing installations.

3. Concessions for Rural Electricity: Argentina's Approach

Argentina has pioneered the use of concessions for the provision of electricity in rural areas as a way to both provide energy services to rural areas and stimulate domestic PV sales. As part of the electric utility privatization process in Argentina, provincial governments are bidding out concessions for the provision of electricity in rural areas where there is no grid power.

So far, two provinces—Salta Province and Jujuy Province—have sold rural concessions to bidders who also purchased the on-grid power concession. The private utilities are now starting to provide electricity, mainly with solar PV home systems, to the unserved populations. They charge the households for the electricity in the same manner as they would charge on-grid customers—that is, the

[11] The subsidies will be temporary and will amount to about $100 per system. They will be given to the PV system dealers, who have the option of providing all or part of it as a rebate to consumers. Once the program has been in operation, the dealers will find ways to cut costs and will no longer need the subsidy, according to the World Bank.

households do not enter into loan or lease agreements, but pay a monthly fee to the utility for the electricity for as long as they have the systems. The utilities own the PV systems and are responsible for all maintenance.

In order to accelerate the establishment of the program and give the utility some operating experience, the government of Salta Province is guaranteeing that it will purchase 450 PV systems from the utility for various public facilities. The government in Jujuy Province has established a fund to subsidize modestly each PV installation, thereby keeping monthly consumer fees down while allowing an adequate return for the utility. It is not clear whether this subsidy approach will be sustainable.

So far, there is insufficient operating experience to gauge how well the rural concession approach is working. Nonetheless, other countries, most notably Brazil, are already preparing to implement some variation on it. One of the potential problems is that even though the program is being run by private institutions, the provincial governments have a strong regulatory role. It may be reasonable for a provincial government that regulates on-grid retail tariffs to also set the off-grid tariffs and specify minimum quality and service standards. However, a problem arises that if the tariff is set too low, the utility will earn an insufficient return and will not adequately promote, market, or service the PV systems. This problem is already materializing in Argentina's Salta Province.

B. Building the Human Capital Infrastructure for PV

As discussed earlier, there are human capital constraints on PV in developing countries, including shortages of both PV developers/entrepreneurs and shortages of PV installation and maintenance personnel.

1. PV Developers/Entrepreneurs

The challenges in identifying and supporting good solar PV entrepreneurs in developing countries are illustrated by the fact that only a small number of entrepreneurs in the PV business in developing countries appear to be profitable (and in some cases this fact is not even definite). Furthermore, two SHS businesses in developing countries that have achieved healthy growth involve foreign partners (SOLUZ in the Dominican Republic and Sudimara in Indonesia).

It is premature to assume that local entrepreneurs in developing countries are not up to the opportunity. There are PV businesses in place in a number of countries that have achieved some success in both the cash market and captive finance markets. In India, there are also independent financing mechanisms in place.

The fact that there are so few proven models of successful PV programs, however, really does accentuate the need for more technical assistance in the area of management development and support. Mechanisms for providing such assistance are discussed in the "Action Recommendations" section at the conclusion of this paper.

2. PV Installation and Maintenance Personnel

Entrepreneurs are more likely to go into the SHS business and invest their own capital for this purpose if, at the outset of the business, they are confident that they will be able to find technicians who can work for the business to install systems and then maintain them. SHS technician training can be specifically targeted through particular programs like ENERSOL, or this can also be achieved through the establishment of vocational or university training programs.

But as has been emphasized above, there have been plenty of SHS programs that eventually failed in countries like India, Kenya, and Zimbabwe, in part because the front-end consumer education and after-sales support was inadequate. In other words, trained technicians are an indispensable part of a successful SHS business, and technical assistance can reduce the risks of failure on this issue through programs offered to all industry participants.

3. Intermediary Institutions: PV Project Developers/Packagers/Arrangers

Several nonprofit organizations, such as the Solar Electric Light Fund (SELF) and E&Co, have served in catalyzing, arranging, packaging, prodding, and educating roles. With grant support from foundations and donor agencies, these activities are often essential to getting PV programs off the ground and improving the conditions for the establishment of PV markets. They are also activities that neither host governments nor private PV companies have the ability or willingness to undertake.

C. Increasing the Availability of Investment Capital for PV

As noted earlier, there is hardly any long-term risk capital available to the SHS industry in developing countries. Between them, Sunlight Power International and the Solar Electric Light Company (SELCO) have raised perhaps $5 million of risk capital in Europe and the United States, most of which is targeted to solar applications in developing countries. But $5 million is a minuscule amount when one considers overall financing needs.

A number of factors remain as obstacles to raising capital for new or growing solar PV projects in developing countries: local unfamiliarity, unfamiliarity among financiers, small program size, capital intensity relative to cashflow, higher breakeven levels, and overall perceived high risk. What little risk capital that is available in local capital markets is usually employed in larger projects, and is usually drawn to the financially fashionable sectors such as privatizations, telecommunications, broadcasting, and private infrastructure development, where there is strong international support and high pent-up demand from local consumers with high levels of purchasing power.

There appear to be no examples of nonrecourse project financing for PV projects—that is, a project sponsor financing a project by issuing equity securities and debt securities that are to be self-liquidating from the revenues derived from project operations.[12] The few private equity providers who have supported renewable energy—for example, the Environmental Enterprises Assistance Fund (EEAF)

[12]The term nonrecourse financing is applied to investments like power plants or toll roads, for which revenue from project operations is to be used as the source of funds to service loans. In the event of a project failure, investors in the project have no "recourse" to go after the assets of the sponsoring corporation that are not part of the project. Nonrecourse financing varies from recourse financing—generally referred to as corporate financing—wherein the corporation's entire asset base and balance sheet stand behind the investment.

(USA), E&Co. (USA), Preferred Energy Investors (Philippines), and Triodos Bank (Netherlands)—have done so on a corporate finance or working capital basis rather than a project finance basis. That there have been some successes in this regard proves that there are viable models out there that can achieve positive cashflow, even with captive customer financing programs. More flows of both private capital—such as the capital raised by Sunlight Power International and SELCO—and multilateral development bank/bilateral debt and grant capital are needed for these private sector financing entities to support the successful players, and to try new approaches.

Regardless of the type of financing sought, all PV project sponsors face the problem of their projects being too small to attract private institutional investors and even multilateral development banks (MDBs). No private equity or bank debt financing provider would allow major disbursements of capital in such a new industry without requiring staged drawdowns of that capital. Overall PV project sizes can be large and be disbursed in pieces; however, given project breakeven levels of between $500,000 and $1,000,000 and given the small number of proven players, investors are not going to commit to larger projects until they see better performance by the small projects. In short, for the time being, PV project sizes will continue to be small.

Some observers have discussed the possibility of bundling several energy projects, including PV, into one to address the size problem. Bundling has theoretical appeal, but in practice it only occurs where there are proven operators, reasonably uniform underwriting criteria for the financing provided, and a third party (e.g., a rating agency) that will certify the risk level. The PV industry is simply not yet at that stage. It will get there in the future, but for the time being, bundling or securitization is not yet a practical answer. An alternative is bundling PV projects with conventional energy projects for nonrecourse financing, thereby diversifying the risk of the PV investment. If financed on a recourse basis (conventional corporate financing), this is possible, but such financing is often less attractive for those investing capital in the conventional projects.

Alliances with existing microcredit institutions still need to be explored further. The capital markets are constantly innovating to address inefficiencies. Multilateral development banks (MDBs) and bilateral agencies could help with some pilot program financing in this regard. One approach they could consider is instituting a use-of-proceeds requirement with the microcredit organizations they assist. The requirement designates that a portion of the funds be used to finance SHS pilot tests.

IV. ACTION RECOMMENDATIONS: ACCELERATING PV MARKETS IN DEVELOPING COUNTRIES

Bilateral and multilateral institutions, host governments in developing countries, PV project developers and sponsors, and nonprofit organizations all have important roles to play in expanding PV markets in developing countries. Each of these actors should assist in developing a fair policy environment, sufficient human capital (particularly local dealers, developers, and technicians), and adequate investment capital to nurture a healthy private PV industry. Ultimately, the PV industry must be freed from subsidies that artificially distort markets and doom the industry's long-term commercial development. In general, funds provided by donors in developing countries should be used to foster the establishment of PV markets in developing countries that do not require continuous infusions of grant funds.

A. Action Recommendations for Bilateral and Multilateral Institutions in Developing Countries

Nonprofit bilateral and multilateral institutions such as multilateral development banks (MDBs) can play a key role in the identification, design, and administration of pilot PV projects in developing countries. Our action recommendations for these institutions are summarized immediately below and discussed in more detail in the sections that follow.

⇒ ***Multilateral and bilateral institutions should limit their roles in supporting PV projects in developing countries to providing technical assistance and facilitating financing.*** They should discontinue, or at least sharply scale down, their traditional role as grantmakers and financiers of PV procurement programs administered by host governments. This does not mean that multilateral and bilateral institutions such institutions should abandon PV. To the contrary, given the fact that conventional energy projects can increasingly attract capital from the private sector, such institutions should focus their energy-related actions on PV and other nonconventional energy projects. Technical assistance should include support for vocational training for installers and support personnel; background education for potential consumers of PV; and PV-oriented business training for potential entrepreneurs—for example, through assessments of promising financial models and business plans. Financing should include partial loan guarantees to MDBs and to private lenders, so as to buy down the risks of lending to PV projects and PV loan pools. Multilateral and bilateral institutions should also fund local development banks and private equity/venture capital funds so they can provide working capital at close-to-market rates.

1. Providing Technical Assistance in Developing Countries

a. Primary Recommendations

⇒ Bilateral and multilateral institutions should make technical assistance available to SHS projects in emerging markets, through international and host-country nongovernmental organizations and industry participants, to develop model or demonstration projects.

⇒ Bilateral and multilateral institutions should fund the study and initial creation of SHS financing windows in host country commercial or national development banks.

⇒ Bilateral and multilateral institutions should promote specific consumer awareness programs in areas which have been researched to demonstrate likely potential for SHS programs, based on demographics and government policies.

⇒ Bilateral and multilateral institutions should provide demonstration units to reinforce the education programs, but also provide for their ongoing support and servicing, so that they don't become examples of failure. Demonstrations can be discontinued after consumers have confidence in SHS.

⇒ Bilateral and multilateral institutions should provide support to nongovernmental organizations (both national and foreign) for industry-wide technician training programs.

⇒ Bilateral and multilateral institutions should fund nongovernmental organizations to administer "walking around money" and preinvestment programs to help resolve feasibility concerns and business plan development.

⇒ Bilateral and multilateral institutions should fund pilot projects at the entrepreneurial level of a small number of installed units to test both cash market mechanics and financing vehicle possibilities, as well as to test system design, etc.

b. Secondary Recommendations

⇒ Bilateral and multilateral institutions should provide assistance to evaluate and monitor the impact of demonstration projects.

⇒ Bilateral and multilateral institutions should provide technical assistance support for host countries to become involved in joint implementation activities.

⇒ Bilateral and multilateral institutions should provide funding and support to host country universities to set up solar engineering programs and technical vocational training.

⇒ Bilateral and multilateral institutions should provide scholarships for solar entrepreneurs to attend international conferences and training programs.

⇒ Bilateral and multilateral institutions should provide host country entrepreneurs with the training and support needed to benefit from joint implementation participation and carbon emissions trading schemes.

c. Additional Considerations

⇒ Consumer training is also desirable, and this may or may not be something that can be covered by technical assistance. Consumers need to know what demands they can and cannot place on the system. They need to be taught to shut the system down before batteries become damaged. Consumer training brings with it consumer confidence, which again leads to greater customer demand.

⇒ While multilateral and bilateral support for vocational/technical training for installers and service support personnel are recommended, private firms can also finance this activity where distribution companies are used to provide the training. Many companies find that people trained by one company then go into business for themselves, or go work for another company There is not a major risk of favoritism towards one company or another that receives training support from technical assistance providers. But training is essential to avoid some of the mistakes seen in places like Kenya or Zimbabwe, where SHS programs did not achieve full success due to system failures, which in turn contributed to poor performance in the development of consumer finance programs.

⇒ Foreign aid can be a useful source of funding for technical assistance, provided there are not tied-aid requirements that require the purchase of systems that are not a good fit with the requirements of the local market.

2. Facilitating Financing in Developing Countries

The provision of subsidized credit for PV units in developing countries should be rare and limited. There may be value in providing modest subsidies for a limited number of units to get a PV program off the ground. However, temporary subsidies have a tendency to become permanent subsidies because people get used to them and rely on the low prices for equipment or financing. Subsidized

credit can also lead to low margins for credit organizations, which make it difficult to sustain the organizations; avoided repayments; and major slumps in the market when the subsidy is removed.[13]

Although subsidized credit programs should be avoided, the initial PV program capitalization can certainly benefit from concessional financing from MDBs, export credit agencies, and others. Such below-market, early-stage financing is certainly available to conventional energy projects. And the funds are certainly available. Because of their lower cost of capital, MDBs as a matter of course provide loans at far more attractive rates than those provided by many countries' commercial banking sector. MDBs also have concessional windows for the poorest countries whereby the interest rates and terms are bought down with donor government contributions. And export credit agencies provide concessional financing in order to promote exports. Although not usually referred to as subsidies, these funds are certainly priced below-market, and if they are available to conventional energy projects, they should be available to nonconventional energy projects as well. In fact, there is an argument to be made that since most conventional energy projects do not rely on much, if any, MDB financing any more, MDBs should focus their loans (and loan guarantees) on nonconventional energy projects such as PV programs.

a. Primary Recommendations

⇒ Bilateral and multilateral institutions should provide grant funds to microenterprise finance institutions to study, design, and seed programs tied to SHS financing.

⇒ Bilateral and multilateral institutions should provide market-based lines of credit and or equity to microfinance organizations to actually finance SHS. They should target specific amounts of capital for new financing vehicles, such as consumer lease programs for off-grid home power systems; or securitization or credit enhancement of a class of smaller SHS loans in one of the more advanced countries such as Mexico, India, or the Philippines. Financing could even target higher risk tiers of capital, perhaps without the usual returns, to leverage the risks and returns of private sector lenders and investors. For example, where there is subordinated debt in an investment, the financing agency might exclusively provide capital to the junior-most category of subordinated debt.

⇒ Bilateral and multilateral institutions should provide market-based equity and debt capital to banks and private equity funds to support investment in the PV industry by both host country nationals and foreign partners.

⇒ Bilateral and multilateral institutions should finance the same institutions to create working capital lines of credit for the distribution chain.

⇒ Bilateral and multilateral institutions should support local development banks and equity/venture capital funds to establish special PV financing windows.

⇒ Bilateral and multilateral institutions such as GEF should provide partial loan guarantees to buy down the risk faced by both multilateral and private lending. Guarantees should not exceed 75% coverage or else underwriting criteria tends to become undisciplined.

---

[13] A. Derrick and J.A. Gregory, "Financing Schemes and Dissemination Modes for Photovoltaics: A Strategy," in *Proceedings of the Regional Workshop on Solar Power Generation Using Photovoltaic Technology* (Manila: Asian Development Bank, 1997), p. 341.

⇒ Bilateral and multilateral institutions should establish (or expand) project preparation facilities for PV and renewable energy projects generally.

⇒ There is little reason for bilateral or multilateral donors to continue funding projects solely for the purpose of demonstrating PV technology. Although such projects may demonstrate the technology, they may also inadvertently demonstrate that no additional PV installations will take place without more donor money.

⇒ Donors should not fund standard PV procurement projects—in which donors supply grant money to host country agencies to set up a competitive bid for the supply and installation of a finite number of PV units. While it is an easy way to do business, it does not create a PV market because it overlooks the need for both investments in human capital, value chain profitability, and the need to create a customized financing vehicle.

⇒ Donors, with host countries, should ensure that the PV projects they support include some kind of sustainable microcredit or leasing system for consumers.

b. Secondary Recommendation

⇒ Bilateral and multilateral institutions should assist electric utilities and their supervising ministries or regulatory agencies to incorporate PV schemes into rural electrification plans and activities. Donors need to be careful, however, not to "push" PV electrification schemes that are beyond a country's managerial and financial capabilities to handle.[14]

B. Action Recommendations for Host Governments in Developing Countries

⇒ ***Host governments in developing countries should create a nondiscriminatory policy environment for PV.*** To create a nondiscriminatory policy environment, host governments should take the following steps: 1) incorporate PV schemes into rural electrification plans and activities as the government of Fiji has done (paying for most installation costs of SHS systems just as it pays most of the costs of grid extension); 2) incorporate PV into the utility privatization process, exploring off-grid electric concessions such as those used for rural areas in Argentina; 3) phase out subsidies on competing fuels such as diesel and kerosene; 4) reduce import tariffs on PV cells, modules, and assembled systems; 5) reduce withholding taxes and other charges on foreign financing for PV; 6) enact temporary tax incentives for domestic manufacturing of PV cells, modules, and assembled systems; 7) form alliances with nongovernmental organizations and private developers to create projects; and 8) promote education programs that increase consumer awareness of the benefits of SHS.

[14] Maderson K. Ramon, "Solar PV Experience in the Federated States of Micronesia," *Proceedings of the Regional Workshop on Solar Power Generation Using Photovoltaic Technology* (Manila: Asian Development Bank, 1997), p. 243.

C. Action Recommendations for PV Developers/Project Sponsors in Developing Countries

Apart from providing unending subsidies for PV, the only way to achieve widespread penetration of PV in the developing world is to create markets for PV in which there exist both 1) public demand for PV home systems and consumer financing available; and 2) profit-making opportunities for private businesses, from PV manufacturers and assemblers of PV systems to PV dealers, distributors, installers, and individuals who service PV systems. The private sector's role is thus critical to accelerating the implementation of PV in developing countries.

⇒ ***PV project developers and sponsors should prepare themselves to compete in an open market.*** They must have access to capital, and to strong local partners who can insulate a project from political risk. They should wield financial and project development skills specific to developing nations, technical and managerial knowhow, and the ability to transfer their knowledge to a working project.

⇒ ***PV project developers should not necessarily look to funding from the emissions trading regime under the "Clean Development Mechanism" (CDM) to close financing gaps, since PV will have to compete with other potentially cheaper activities such as energy efficiency and forest preservation.*** However, it is possible for project developers to use CDM money to leverage other funding sources, and offer carbon-emission reductions for a low price. For example, if CDM funds are used in the form of loan guarantees and the project is successful, then the CDM guarantee funds are not triggered and can be returned to the CDM provider. The cost of the carbon reductions to the CDM investor would thus be zero (plus some transaction costs). Alternatively, if the CDM funds are used in the form of subordinated debt or quasi-equity, the investor will earn a return on the PV project. Instead of paying for the lowest-cost carbon reductions he/she can find, the CDM investor could make money on them