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World Bank/GEF Solar Home Systems Projects: Experiences and Lessons Learned 1993-2000

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Executive Summary

Twelve World Bank Group projects provide basic "energy services" such as lighting, radio, television, and operation of small appliances to rural households without access to electricity grids through the use of solar home systems. Among other objectives, projects are designed to develop markets for solar home systems and to overcome the key barriers to their widespread and accelerated dissemination. Project designs continue to evolve with increased understanding of best practices. Most projects are just beginning implementation; none are yet completed.

This paper reviews key features of these projects, experience from early implementation, and emerging lessons applicable to future project design and evaluation. Projects incorporate a combination of six basic features:

1. Pilot private-sector and NGO delivery models. Projects employ two basic models for delivery of solar home systems: "dealer sales" and "energy-service company." With dealer sales, qualified dealers receive project support in the form of business finance, capacity building, and/or market assistance. For energy-service concessions, projects also develop regulatory and selection/bidding frameworks. The review suggests that solar-home-system delivery firms face a myriad of difficulties operating in rural areas; those with rural experience and/or distribution infrastructure will do better. Most will benefit from training and support in obtaining business finance and other business skills. And all need project flexibility in allowing them to develop good business models.

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[1] Project experience is very dynamic and lessons are just emerging. Further versions of this paper will improve upon the views expressed here. In addition, substantial experience with solar photovoltaic projects from the joint UN Development Program/World Bank Energy Sector Management Assistance Programme (ESMAP) has not been reviewed for this version of the paper; future versions will contain additional material describing this experience and the linkages between ESMAP and the evolution of the Bank's portfolio. This version has been prepared with support from the World Bank Climate Change Thematic Group, the Asia Alternative Energy Program and the Global Environment Facility. This paper will be a web-based document; hyperlinks are underlined. Views expressed are solely those of the authors and do not necessarily reflect World Bank or client countries' views or policies.

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2. Pilot consumer credit delivery mechanisms. For dealer sales, consumer credit makes systems more affordable to rural households. Consumer credit is provided by three mechanisms: through dealers, through microfinance organizations, or through development finance institutions. The review suggests that credit risk is a serious concern of both financiers and dealers and makes credit sales particularly challenging. Dealers are reluctant to extend credit to customers with little credit history, and credit administration and collections may be costly. Local financiers need to take some commercial risk to increase project sustainability but have the same concerns. Partial credit guarantee schemes, microfinance lending, and partnering promise viable models to reduce risks. Longer credit terms stimulate demand by poorer households but increase risks.

3. Pay first-cost subsidies and offer affordable systems. Some projects incorporate per-system subsidies to make systems more affordable and to reduce initial and/or monthly payments by households. Some projects also allow smaller system sizes or simpler components to improve affordability. The review suggests that customers desire a range of component options and service levels and can benefit from even small systems. Even with subsidies and smaller systems, customers in early market phases may still be limited to the wealthiest rural households.

4. Support policy development and capacity. Projects support or influence policy in several ways: technical assistance to regulatory agencies for energy-service concession bidding, contracting, monitoring and regulation; influence on government planning and policy related to rural electrification and power sector reform; industry participation in policy and planning; and reduced import duties for components. The review suggests that concession tariff-setting, bidding and regulation require substantial time and resources. Projects must recognize the link between rural electric-grid extension and solar home system demand; clear, open and realistic rural electrification policies will help create and/or stabilize market demand.

5. Enact codes and standards and establish certification, testing, and enforcement institutions. Poor-quality equipment and installation and exaggerated performance claims hurt markets. Most projects develop or establish equipment standards and create or strengthen certification and testing institutions to ensure quality, safety and long-term reliability. Projects also provide capacity building for dealers to meet standards and for agencies to verify compliance. The review suggests that establishing reasonable equipment standards and certification procedures for solar home system components that ensure quality service while maintaining affordability is not difficult. Few technical problems have been encountered with systems.

6. Conduct consumer awareness and marketing programs. Most projects conduct some type of consumer awareness and marketing program and may also conduct detailed market surveys. The review suggests that marketing campaigns can be extremely costly and time consuming in rural areas, often requiring door-to-door and direct contact. Simple consumer awareness is usually insufficient by itself. Dealers benefit from marketing assistance in early phases of new market development until a “critical mass” of customers develops that makes marketing easier.

Five leading projects in Bangladesh, Dominican Republic, India, Sri Lanka and Vietnam have installed more than 8,000 systems. Installation targets from all projects total more than 500,000. But commercial sustainability and replication of viable models has not yet been achieved or

conclusively demonstrated in any project. A key challenge is to demonstrate business models in which all firms in the supply and service chain make profit. Other challenges are to demonstrate regulatory models for energy-service concessions and to integrate rural electrification policy with solar-home-system delivery. Future projects need to draw from these lessons, incorporate flexibility and adaptation, and allow sufficient time to develop and test viable models.

Introduction

Since 1992, the World Bank Group has approved twelve projects that provide basic "energy services" such as lighting, radio, television, and operation of small appliances to rural households that lack access to electricity grids through the use of "solar home systems" (see Table 1).[3] A solar home system consists of a photovoltaic solar panel, a storage battery, a battery charging controller, and various end-use equipment like florescent lamps (see Photos 1-4). Solar home systems can eliminate or reduce the need for candles, kerosene, LPG, and/or battery charging. Direct economic benefits include avoided costs of battery charging and LPG or kerosene purchases; other significant benefits include increased convenience and safety, improved indoor air quality, a higher quality of light than kerosene lamps for reading, and reduced CO2 emissions. Solar home systems already provide basic electricity services to more than 500,000 households in developing countries (see the World Bank's Solar Electricity web page {http://www.worldbank.org/html/fpd/energy/subenergy/solar/solar_pv.htm}; see also Foley 1995; Cabraal et al 1996; Kammen 1999; Loois and Hemert 1999; Kaufman 2000).

In the early 1990s, the World Bank recognized that solar-home-system technology was maturing, costs were declining, and commercial markets were developing. At the same time, population growth was outpacing the ability of electric utilities to extend rural electricity grids and developing countries were increasingly recognizing the economic difficulties of achieving full grid-based rural electrification. The World Bank and many governments began to perceive that solar home systems could provide least-cost rural electrification and could supplement grid-based electrification policies (World Bank 1997). Because of the many obstacles to delivering solar home systems in rural areas, and because of the development and environmental benefits, the World Bank and Global Environment Facility (GEF)[4] have considered assistance for solar home systems to be highly relevant and have jointly supported these projects. In many projects, solar home systems are but one component of a larger project with a variety of development objectives like power sector reform, rural electrification, and rural development.

Solar-home-systems project designs have continuously evolved with increased understanding of best practices. In general, projects are designed to overcome barriers to the widespread and accelerated dissemination of solar home systems in a given country context (see Box 1). The key elements of a sustainable rural PV market include customer satisfaction, affordability, dealer profitability, and effective supply and service chains. Considering these elements, most projects incorporate six basic features:

1. Pilot private-sector and NGO delivery models
2. Pilot consumer credit delivery mechanisms
3. Pay first-cost subsidies and offer affordable systems
4. Support policy development and capacity
5. Enact codes and standards and establish certification, testing, and enforcement institutions
6. Conduct consumer awareness and marketing programs

[3] Some of these projects also target other applications of PV, such as agricultural, commercial and village power applications, which are beyond the scope of the present paper.
[4] For more information on the GEF, see Martinot and McDoom 1999 and the GEF web site {www.gefweb.org}.

Each project feature is intended to overcome a specific set of barriers. Projects take many different approaches to incorporating these features; some projects take more than one approach simultaneously to determine which approach is more effective or viable in the country concerned (see Table 2). Projects are essentially experimental because there simply isn't enough accumulated experience yet from any institution, government, or firm to provide definitive answers about the best approaches (see references for related materials). Nevertheless, most project designs will face four basic design questions that can be addressed with a combination of project features (see Table 3). Elaborations of the six project features and emerging lessons from initial implementation experience are described in the following sections.

In all projects, demonstration of a viable business model, whether that business is public or private, is key to achieving project sustainability and replication. Viability means clearly showing expenses and receipts, cashflow, profits (or required subsidies), and management arrangements that demonstrate a business can continue to exist and function. "There is a high value-added [by projects] in terms of developing and improving business models...you want to stimulate markets based on these business models" said a dealer in one project. For commercial firms, profit is the ultimate measure of whether a business model is viable and whether to operate in a given market. For non-profit organizations or public firms (i.e., public utilities), ongoing subsidies may be part of the business model based on public objectives (e.g., rural electrification and development). All projects in some way help firms maximize income (related to demand, pricing and affordability) and minimize expenses (for marketing, service, training, and operations).

Solar-home-system installations as a direct result of projects supported by the World Bank Group could total more than 500,000 systems. But most projects are relatively new and offer little implementation experience so far. The five leading projects are in Bangladesh, Dominican Republic, India, Sri Lanka and Vietnam. Through these projects, by the end of 1999, approximately 8,000 systems had been installed—3500 systems in the Dominican Republic, 2000 in India, 1000 in Sri Lanka, 1100 in Bangladesh, and 500 in Vietnam.[5] Beyond these direct results, indirect market impacts are more difficult to judge but also important (Martinot 1998).

All projects can offer pilot experience of potentially effective approaches, and the five leading projects mentioned above are closest to doing so. But commercial sustainability and replication of successful models has not yet been achieved or conclusively demonstrated in any project.[6] It is simply too early in the evolution of the portfolio. Further implementation progress for all projects is needed before more definitive conclusions can be drawn about experience, lessons, and effective project designs. The development, evolution and testing of successful approaches

[5] Most of these installations are stand-alone solar home systems, except in India, where 1500 solar lanterns provide light to rural households and five village-power schemes of 25 kWp each are supplying electricity to 500 families.
[6] There are several examples of successful commercialization of solar home systems that have occurred without much direct donor assistance, notably in China, Indonesia, Kenya and Zimbabwe. These cases also illustrate alternative delivery models that are not dedicated solar PV businesses, like battery companies and sellers of household goods in Kenya and household furnishings chains and hardware/electronics stores in Zimbabwe. Additional assistance from UNDP/World Bank ESMAP and other donors has further facilitated some markets. See for example GTZ 1995; van der Plas and Hankins 1998; Kammen 1999; ESMAP 1999.

requires time, money, flexibility and risk-taking, elements which are sometimes missing in existing projects but are essential for future projects.

1. Pilot Private-Sector and NGO Delivery Models

Projects have employed two basic private-sector models for delivery of solar home systems: "dealer sales" and "energy-service company." A dealer-sales model means that a dealer purchases systems or components from manufacturers and sells them directly to households, usually as an installed system, and sometimes on credit (as in **Indonesia**, **India**, **Sri Lanka**, **Vietnam**, **Bangladesh** and **China**). The household owns and is responsible for servicing the system, although the dealer may provide service contracts or guarantees. An energy-service-company (ESCO) model means that the ESCO owns the system, charges a monthly fee to the household, and is responsible for service. The ESCO may be a monopoly concession regulated by the government to serve specific geographic regions (as in **Argentina**, **Benin**, and **Togo**), or it may operate competitively without any explicit monopoly status (as in the **Dominican Republic)**. Combinations of these two forms of ESCO start with monopoly concessions and progressively open up markets to competition after some years (as in the **Cape Verde**).

The **India** project has promoted sales of photovoltaic systems through large industrial enterprises, which could take advantage of favorable government tax credits, but these enterprises have focused on commercial markets. At the same time, small dealers financed through the project began to develop rural distribution systems and sell to rural households. ESCO models are also being employed. In **Indonesia**, a dealer-sales model has been employed. Dealers can participate in the project based upon eligibility criteria, such as existing business competence, sales/service infrastructure in related rural markets, and a credit agreement with a participating bank. The **China** project also uses a dealer-sales model and supports the development of local dealers similar to the Indonesia project. Any dealer in China who passes the project's eligibility criteria will be able to participate in the project (at least 10 dealers are expected initially; others may become eligible later). An ESCO concession model was considered unworkable in China and was rejected early in project design, partly because no appropriate authority exists, in either the electric power or agricultural/rural sectors, to regulate concessions.

In **Argentina**, the regulated ESCO concession model is used, partly because Argentina already had substantial experience with regulatory frameworks for concessions in other sectors (see Box 2). Also, the low percentage of households which remained unelectrified led the government to believe that the "bundling," economies of scale, and lower transaction costs possible with rural energy concessions were necessary to attract the private sector. The World Bank project is part of a broader, nationwide rural electrification program, in which rural energy concessions were already established in two provinces. Under the project, eight provinces have agreed to participate. For each of these eight provinces, the government awards a monopoly concession based upon a competitive selection process. The concession provides and maintains solar home systems (or other technologies it chooses) for households and collects a monthly fee-for-service. Concessions will be committed and obligated to provide electricity services (upon request from customers) to populations in a specific province over a period of at least 15 years.

Potential advantages of the concession approach are:

- can attract larger, better organized private companies with their own sources of financing;
- has the potential to serve a large number of customers in just a few years;
- has the potential to reduce equipment costs (through volume discounts), transaction costs, and operation and maintenance costs (through economies of scale); and
- ensures service to the customer over a long period (e.g., 15 years).

Potential disadvantages include:

- regulation may be costly and require substantial regulatory capacity;
- lack of competition may stifle innovation, new products and services, and cost reductions;
- technological change can undermine regulatory and contractual conditions;
- quality of service may be difficult for regulatory agency to ensure; and
- monthly fee collection costs may be high.

The Argentina government is still exploring how best to regulate concessions and the project will help to pilot regulatory models and approaches. Two key issues are tariff structures (including tariff levels, government subsidies, negotiation procedures, and how often tariffs are reviewed and renegotiated) and the question of how to regulate the quality of services provided to customers by the concessions (i.e., provisions in contracts between concessions and their customers).

Following Argentina, three more recent projects in **Benin, Togo, and Cape Verde** also use the ESCO concession model. The Benin and Togo projects each attempt to establish financially viable private-sector installation and service companies by the project's completion. Like Argentina, monopoly concessions would be granted for 15 years in targeted regions to the winners of a competitive selection.

The **Sri Lanka** project was designed to accommodate both dealer-sales and ESCO models. Both types of firms, as well as NGOs, were allowed to apply for business financing from commercial banks under the project. Early in the project one firm tried to operate as an ESCO for awhile but found the costs of monthly collections among the highly dispersed and remote rural populations to be high. The firm did not have sufficient rural infrastructure and standing in rural communities to handle collections effectively and efficiently. Rather, this firm and one other firm are focusing on direct sales facilitated consumer credit from a microfinance organization (see next section on consumer credit delivery). Initially, an NGO also attempted to sell systems on credit it supplied, but ceased operations when it was unable to satisfactorily service and maintain the systems it had sold (Martinot, 1999).

Availability of business financing is an important element of all private-sector delivery models. In **Sri Lanka**, dealers, NGOs and cooperatives are eligible to borrow from commercial financiers participating in the project. The two primary dealers in that country have had no difficulty in obtaining business financing under the project. That situation could change after the project, but the dealers don't expect much trouble because they believe commercial financiers' perceptions have changed about the profitability and risk of the business. Under ESCO delivery models, financing for ESCOs comes from either government or multilateral sources, but may be

channeled through commercial financiers; in **Argentina**, ESCO concessions receive financing from provincial and federal government sources.

Two IFC projects are also providing business financing for solar home systems businesses, which may deliver systems under a variety of models. The photovoltaic Market Transformation Initiative provides business financing for companies in PV markets in **India**, **Kenya**, and **Morocco** through a competitive solicitation and selection of business plans. The Small and Medium Scale Enterprise Program (SME) is providing business financing for dealers in **Bangladesh**, the **Dominican Republic**, and **Vietnam**. The SME program also provides added incentives for firms to demonstrate sustainability; if firms generate profits they receive partial debt forgiveness. In Vietnam, the dealer has been selling systems on cash and credit terms, but as rural grid extension continues in Vietnam, the dealer is looking to an ESCO concession approach and hopes the government may consider supporting such an approach in the future.

In the **Dominican Republic**, the dealer has been developing a successful fee-for-service business model that targets 50% of the rural population and charges $5 to $20 per month for electricity service from solar home systems. Through continuous tuning of its business model to maximize income and minimize expenses, this firm is approaching profitability and "proof of concept" for an installed base of 5000 systems. The firm is attempting to scale-up the business model to 25,000 systems but recurring overhead costs and slim profits make expansion difficult: "this is a lean margin business; you don't want to burden a $1 million company with the overhead costs of building a $10 million company" the firm said.

There is also a need to develop the commercial skills of delivery firms. Delivery firms may be small, inexperienced ventures. Or existing firms operating in rural areas may decide to expand their product lines to include solar home systems but need training in PV technologies. In **Indonesia**, because dealer cash flow was a key constraint in selling solar home systems on credit, dealer training focused on how to develop business plans and approach banks for business financing. In **Sri Lanka**, grants to dealers covered up to 50% of external consultant costs for preparing project finance proposals for commercial financiers. The Sri Lanka project also has provisions for business support, but dealers have not requested much assistance under the project. In **China,** the project helps dealers to improve system quality (through cost-sharing of design, testing and certification), market their products, and provide warrantees and after-sales service. In **Cape Verde**, project assistance to ESCOs covers business planning, technical training for staff and managers, distribution infrastructure, and market development and research.

Lessons Suggested by Early Implementation Experience

- Private dealers with prior experience in rural markets and NGOs with close ties to local communities will find delivery easier.
- The difficulties of operating a PV business in rural areas and making a profit can easily be under-appreciated by project designers. Small dealers face huge challenges.
- Developing good business models (operations, servicing, and financing) and fine-tuning them are critical to the success of these low-margin businesses.

- Energy-service concessions require the existence of a government agency at an appropriate level that can serve as an effective regulator.
- Initial cash sales to wealthier customers are one way to financially strengthen smaller dealers.
- Flexibility to experiment with and change delivery mechanisms and models during the project is crucial. Project implementation units must be able to manage flexibly.
- Companies may benefit from additional business support and training, but may be working so hard to operate the business that they don't recognize their needs or request assistance.
- Projects can have indirect influences on attracting other potential distribution channels into the solar PV business, like department stores, retailers of household goods and appliances, and providers of other rural services.

2. Pilot Consumer Credit Delivery Mechanisms

With a dealer-sales model, consumer credit is important for making systems affordable to rural households. Market studies associated with World Bank projects have revealed that majorities of rural households with incomes less than $250/month and not connected to rural electricity grids typically pay $3 to $15 per month for energy, in the form of candles, kerosene, battery charging and disposable batteries (GEF 1998a, 1998b, 1998c, [China Market Study]). These surveys have revealed a household willingness to pay for energy to meet the end-uses valued most, such as entertainment, information, and high-quality lighting. In a fee-for-service arrangement, monthly fees can be regulated or set to levels competitive with these expenditures. But dealer sales of solar home systems must overcome the first-cost barrier--their high initial cost relative to these conventional alternatives--and provide a means whereby households can continue to pay amounts roughly equivalent to their conventional energy purchases. Long-term consumer credit is one means to make monthly payments more comparable to conventional energy expenditures.

Consumer credit is provided through three primary mechanisms in World Bank projects: dealer-extended credit, credit through a microfinance organization, and credit through a local development finance institution.[7] Consumer credit through commercial firms was first tried in **India**. This project provided credit through IREDA to commercial firms. The firms were supposed to purchase systems from manufacturers (realizing substantial government tax credits in the process) and then sell the systems to rural households on credit. A separate service firm, under contract to the manufacturer, was supposed to provide marketing, installation, commissioning, and after-sales service. This approach proved infeasible because the commercial firms were unwilling to lend to rural households due to credit-risk and collection concerns.

In **Indonesia**, a dealer-credit model was introduced partly because of the prior success of a private dealer in Indonesia selling systems on credit. This entrepreneur was able to sell more than 4000 systems on credit. In the original project concept, business financing would be extended by commercial financiers to dealers, and then in turn dealers would extend consumer

[7] For more on microfinance see Dicter 1999 and Ledgerwood 1999.

credit, at terms of up to four years, to their customers. The commercial banks would bear the dealer credit risk, and the dealer would bear the consumer credit risk. Dealers sales of 200,000 systems were targeted through this model. Unfortunately, the project was never implemented because of Indonesia's macroeconomic crisis and will now be canceled. So the expected experience with dealer-supplied credit there has not materialized.

The **Bangladesh** project demonstrates an initially successful application of the dealer credit model. The (non-profit) dealer, Grameen Shakti, performs marketing, sales, service, credit provision, collections, and guarantees. Before receiving an IFC loan under the Small and Medium Scale Enterprise Program, Grameen Shakti could obtain financing for terms of one year only, so was able to extend consumer credit only for one year terms. This greatly limited customer demand. With the IFC loan, Grameen Shakti is able to extend three-year credit to customers, which has made a large difference in its business. Grameen Shakti's credit terms and customers are quite different from traditional Grameen Bank microfinance terms and customers. Grameen Bank members, typically poorer households, receive microenterprise loans (for income-generation purposes only) of $100 or $200, for terms up to one year, at 20% interest. In contrast, Grameen Shakti loans are roughly $500 for terms up to three years, at 12% interest. Grameen Bank loans are regularly repeated, while Grameen Shakti loans are one-time. Thus there is a clear distinction between "business microfinance" by the Grameen Bank for its members, and "consumer credit" by Grameen Shakti for customers purchasing solar home systems.

Dealer credit was tried early in the **Sri Lanka** project but soon rejected by the dealers themselves. Dealers found collections too difficult and time consuming and favored (and led) the shift away from a dealer-credit or fee-for-service model to a microfinance model. Building a rural "service infrastructure" with technicians is a very different business from building a rural credit delivery and collection infrastructure, said the suppliers. "The success of credit depends on local connections, knowledge and institutions already in place" said one industry observer.

So the **Sri Lanka** project has instead turned to microfinance organizations for extending consumer credit, with one large national microfinance organization participating so far in the project. This microfinance organization borrows from the commercial financiers participating in the project and lends to customers. Customers purchase solar home systems from the dealers, who are responsible for marketing, sales, and after-sales service. The microfinance organization is responsible for collections. The microfinance organization and dealers coordinate expected sales and credit delivery. The credit provided by the microfinance organization for purchase of solar home systems is similar in kind to that provided for enterprise development. The microfinance organization typically offers microenterprise loans from $100 to $600 with terms of up to four years at 24% interest; terms for solar-home-system loans are similar: $500 with 20% down payment, terms of up to five years, and 24% interest rate. Sri Lanka has a long history of rural microfinance, which has greatly helped the viability of a microfinance model there.

In **Vietnam**, sales by a private dealer are assisted by a complex credit delivery scheme involving the Vietnam Women's Union (VWU), an NGO, and the Vietnam Bank for Agriculture and Rural Development (VBARD), a development finance institution. VWU markets the dealer's systems

and performs collections for consumer loans provided by VBARD. The dealer installs systems and is responsible for service. VBARD provides credit, assuming risk for 75% of the purchase price. The dealer provides a collateralized guarantee to VBARD for 5-10% of the purchase price and the customer covers the remaining 15-20% as a down-payment. In case of loan default, the dealer repossesses and refurbishes the system and VWU finds a new buyer. VBARD can recover any losses involved with repossession from the dealer's collateralized guarantee. Credit terms to consumers are only 6 to 18 months, however, which limits demand. Despite instructions from the head office, some conservative branch managers of VBARD have been reluctant to participate; where this has happened, the dealer has extended consumer credit itself.

A cash sales model without credit is employed in **China.** Extending credit to rural households was not considered feasible given the almost complete absence of experience with consumer credit in general in China. However, the project provides flexibility so that dealers may also offer innovative payment mechanisms to increase affordability.

Lessons Suggested by Early Implementation Experience

- Local financiers should be encouraged to carry some of the credit risk, not simply act as administrative conduits, in order to increase post-project sustainability and replication.
- Commercial financiers may be reluctant or unwilling to provide consumer credit to rural households because of the credit risk.
- Small dealers face sufficient business and technology risks that they are reluctant to assume consumer credit risks and incur the costs of credit administration and collections.
- Small private dealers should be encouraged to work with local microfinance organizations and/or partner with larger firms that can extend credit.
- Microfinance may work in countries that have well established microfinance institutions, but NGOs do not necessarily have the commercial orientation or business skills necessary for rapid delivery of credit. Scale-up and outreach can become problematic.
- Credit collection can be costly if rural customers are dispersed over large territories with poor transport infrastructure. Business organization for marketing, installation and service may not be suited for credit collection.
- Projects should allow dealers flexibility to innovate new ways to make systems affordable.
- Adequate after-sales service is key to credit repayment performance.
- Some customers with seasonal income (i.e., paddy farmers with semi-annual harvests) may require credit repayment schedules tied to income (i.e., semi-annual rather than monthly).

3. Pay First-Cost Subsidies and Offer Affordable System Sizes

Besides providing consumer credit, some World Bank/GEF projects incorporate first-cost subsidies to reduce high-first-cost and affordability barriers. These subsidies are intended to

reduce the initial payment and/or the monthly payments households have to make, with the objective of making monthly payments as equivalent to current monthly payments for conventional energy (e.g., kerosene and batteries) as possible (see Box 3). Grants are paid to delivery firms, to commercial financiers, or to microfinance organizations upon installation and proper inspection and documentation of a solar home system. Certification of installation is either done by the project or by commercial financiers. Subsidies are used in different ways in different projects. For example, in **Sri Lanka**, the microfinance organization providing consumer credit reduces the amount of each monthly credit repayment by a share of the subsidy. Subsidies are incorporated into projects in **China**, **Indonesia**, **Argentina**, **Benin**, **Togo**, **Cape Verde**, and **Sri Lanka**.

Some projects offer fixed cash grants for each system installed. In **China**, a cash grant equal to $1.50/Wp of installed capacity is paid directly to the dealer. In **Sri Lanka**, a $100 grant is paid to the commercial financier. In **Indonesia**, grants of $75 in Java and $125 elsewhere are paid directly to dealers after the project receives documentation of customer acceptance of installation and a completed hire-purchase contract between the customer and dealer. Originally only 50 Wp systems were eligible for these grants in Indonesia, but in consideration of customers who want to purchase smaller, more affordable systems, the grants were extended to cover 30 Wp systems as well. The Indonesia project required that dealers offer credit to their customers as a condition of eligibility to receive the grant, which caused problems among dealers who didn't want to borrow or extend credit. This requirement has become a problem in **Sri Lanka** as well, where one dealer was purchased by a large multinational corporation and thus no longer needs commercial financing, but must obtain financing under the project in order to qualify for grants.

Declining cash grants on a sliding scale over the life of the project are built into more recent projects. The idea of declining grants is that as the project gets closer to completion, existing businesses will be able to offer cheaper systems to customers, and thus smaller grants are needed for the same levels of affordability. For example, in **Argentina**, the ESCO concessions are given a variable cash grant for each system installed during the initial five years of the project, upon certification by the provincial government that the system has been installed in accordance with pre-established standards and conditions. The cash grant declines for installations made in later years of the project and also depends upon system size. The grants decline gradually to zero by the end of the project. In **Benin, Togo, and Cape Verde**, declining grants also were enacted similar to Argentina. One drawback to providing grants on a sliding scale is the added administrative complexity of tracking systems in terms of when they are installed and thus for what level of subsidy they are eligible.

Many projects specify a minimum system size of 50 Wp. However, some projects allow sales of smaller-size systems or lower-cost components initially, and provide trade-in or resale mechanisms for consumers to "trade up" to more expensive systems. The **Sri Lanka** project has modified systems specifications to allow more affordable systems of capacity 30 Wp and less to be eligible for GEF grants under the project. Most sales in Sri Lanka have in fact been of 32 Wp systems (selling for about $450). **Indonesia** also modified specifications to allow 30 Wp systems. In **China**, systems as small as 10 Wp are allowed as long as components meet the relevant standards. Sales of 50 Wp systems predominate in **Bangladesh**, where the dealer has

been able to achieve very low system costs of roughly $500 for a 50 Wp system because of cheaper domestically produced components and favorably-priced PV module purchases.

Lessons Suggested by Early Implementation Experience

- Customers desire and are able to benefit from smaller systems, such as 30 Wp or even smaller, so project should allow flexibility to specify and deliver smaller systems with a greater range of consumer choice as to components and service levels.
- In smaller or less established markets, individual dealers may have difficulty negotiating favorable prices from PV module suppliers.
- Even with subsidies, smaller systems sizes, and consumer credit, the bulk of customers in early market phases may be among the wealthiest rural households, who purchase solar home systems for reasons of convenience, aesthetics, lighting quality, and/or novelty, rather than for economic benefits.

4. Support Policy Development and Capacity

Several policy-related issues have factored into project design and experience:

Regulatory assistance for concessions. For projects using the ESCO concession model, technical assistance to national regulatory agencies is also included for concession bidding and contracting, training of agency staff, and monitoring and regulation of concessions. Examples of regulatory agencies are the provincial governments in **Argentina**; the national energy agency (INERG) in **Cape Verde**; and the Agence d'Electrification Rurale (AER) in **Benin** and **Togo**. In Argentina, sustainability is enhanced by strengthening provincial regulatory functions and institutions and appropriate incentives and returns for the concessions.

Rural grid extension planning and policy. Projects indirectly or directly influence government planning and policy related to rural electrification. For example, in **Sri Lanka**, the project has encouraged the national electric utility and the government to more explicitly recognize and incorporate solar home systems into rural electrification planning, and to recognize that unrealistic political promises and uncoordinated grid extension harm the market for solar home systems. Such encouragement may lead the national electric utility to admit to populations in specific rural areas that "the grid isn't coming; consider a solar home system instead" (or even, "we will provide you with electricity, it just won't be grid-based").

Electric power sector reform. Power sector reform activities associated with other World Bank projects bear on future solar home system markets. For example, power sector reform in **Sri Lanka** will result in the establishment of an "independent utility regulator" accountable to parliament. When this happens, the World Bank expects to see more realistic grid expansion plans for rural areas, greater accountability, and fewer false promises by politicians. This should help stabilize and solidify geographic areas of solar home system demand.

Industry participation in policy and planning. In **Sri Lanka,** a project workshop led to the creation of a solar energy industries association, with eligibility limited to dealers who have a proven sales record. In part this association formed to act as a unified voice for companies to interact with the World Bank, the government, and the national electric utility on project matters and rural electrification policy and planning.

Import duties. Reduced import duties on PV components can remove market distortions and make solar home systems more affordable for rural households. The government of **Sri Lanka** reduced import duties in conjunction with the project from 30% to 10% (10% is duty for all other non-protected goods). (Ironically, the 30% import duty was originally designed to protect a domestic PV manufacturing plant, but when that plant was closed (prior to the project), the import duty served to depress the emergence of a PV dealer industry using imported components.) In **China,** import duties were eliminated for PV components in conjunction with China's policy that all government-approved renewable energy projects can import materials duty free (although most components are expected to be produced domestically because China has a large PV industry).

Lessons Suggested by Early Implementation Experience

- The influence of customers' perceptions of future rural electric grid extensions, whether based upon concrete government plans or merely unrealistic political promises, has a much greater detrimental effect on demand for solar home systems than projects have expected.
- Consumers are going to prefer being connected to the grid rather than receiving energy services from a solar home system, all else being equal. But there is additional value from solar home systems if customers have to wait some years for the grid to arrive.
- There are numerous issues that must be resolved in concession tariff-setting, bidding, award, and regulation. Resolution of these issues may not be straightforward and projects should allow sufficient time and resources to address them adequately and completely.
- If import duties are lowered during or prior to a project, the threat of rebound after the project casts a shadow on future market development, project sustainability and replication.

5. Enact Codes and Standards and Establish Certification, Testing and Enforcement Institutions

Historically, the reasons for failure of solar home systems projects included poor quality products, poor installation and maintenance, and systems being "oversold" (marketing claims that raise expectations higher than the technology can deliver). Codes, standards and certification (and marketing restraint) are important elements to address these issues, as well as reduce commercial risks.

Enforcement of standards, including associated institutional capacity, is equally important. During a World Bank project, the project itself can ensure that standards are enforced. After

project completion, this task will be left to the government and/or institutions created or strengthened during the project. Since no projects have been completed yet, post-project enforcement of standards (and voluntary adoption by firms) has yet to be tested.

Most projects develop and establish PV component and systems standards to ensure quality, safety and long-term reliability. Dealers who wish to participate in the project must then get their equipment certified at an approved testing laboratory. For example, in the **Benin** and **Togo** projects, the rural electrification agency issues and enforces a "PV code of practice" and technical standards. In **Indonesia**, dealers are required to furnish certifications from acceptable testing facilities that their components meet or exceed the selected specifications before they can sell. Assistance is provided to participating dealers to get equipment certified by international laboratories. The **China** project hopes to develop and disseminate equipment standards so they are adopted outside the project, as a proposal for national standards National certification in China could indirectly encourage certified Chinese products to be sold internationally, similar to what is happening in Indonesia--products certified under the World Bank project are being sold to other countries.

Sri Lanka at first adopted the standards used in Indonesia, but then modified the standards to allow smaller systems (down to 20 Wp) better suited to Sri Lanka consumer demand and solar insolation characteristics. Later, in both **Indonesia** and **Sri Lanka**, minimum requirements were further reduced due to consumer demand and dealer capabilities.

In **Sri Lanka**, equipment certification held up the project for the first year as there were no certified products available to sell. The project design didn't expect that it would take nearly this long to get certified products into the hands of suppliers, perhaps because the project originally thought the systems would be imported from Indonesia, where presumably a market based around World Bank approved standards was to have developed in parallel with the Sri Lanka project. Even then, batteries would not meet the established specification and the Sri Lanka project had to declare a moratorium on the battery specifications for several additional months.

Domestic certification and testing agencies are also important. The **Indonesia** project provides technical assistance for strengthening capabilities of the Agency for the Assessment and Application of Technology for solar PV testing and certification. In **China**, grants provide equipment and training to create a national PV Testing and Certification Center. Assistance is also provided to strengthen PV module and balance-of-system testing and certification agencies, as well as strengthening the capabilities of a design-assistance center.

Most projects also provide capacity building to ensure quality systems are installed. This assistance is important not only to protect consumers under the project, but also the reputation of an industry striving towards large scale commercialization. In **Sri Lanka**, assistance to dealers was planned for testing and quality improvements, but dealers did not appear to need or be interested in such assistance. In Sri Lanka, grant funds are also available to commercial financiers to verify that solar home system designs meet project specifications and that systems are installed properly. Grant funds also maintain a facility for investigating unresolved consumer complaints against dealers and seeking appropriate solutions. In **China**, capacity building is provided for quality assurance and consumer protection. In **Benin** and **Togo**, the rural

electrification agency will develop the capability to spot check installed systems and conduct regular consumer surveys to ensure good technical performance of private operators.

Lessons Suggested by Early Implementation Experience

- Establishing reasonable equipment standards and certification procedures for solar home system components that ensure quality service while maintaining affordability is not difficult, and few technical problems have been encountered with systems.
- Projects should allow flexibility in standards-setting, so that if initial standards are too high for local dealers/ESCOs to meet, the standards can be relaxed.
- Projects should use standards only to the degree to which they contribute to adequate consumer satisfaction and thus a sustainable market, but do not excessively stifle the market. The potential for standards to increase costs and reduce market demand must be weighted against expected improvements in customer satisfaction and longer-term market growth.
- Installation of quality products lowers future marketing burdens and costs and lowers future service costs.
- Project schedules should allow sufficient time for dealers or ESCOs to establish suppliers and procure supplies of certified products before anticipating the beginning of sales or service. In some cases several months may be required before products can actually be sold or delivered.
- Consumer education in proper maintenance and operating procedures, during sale or installation of a solar home system, is important for minimizing maintenance costs and enhancing battery life and overall system reliability.

6. Conduct Consumer Awareness and Marketing Programs

Most projects conduct some type of consumer awareness and marketing program. Such programs are usually preceded by a market survey conducted as part of project preparation activities (such as in **India** and **Indonesia**) or by an existing market survey done by others (such as in **Sri Lanka**). The **China** project conducted an extensive survey of rural consumers{document link} to better understand the market because there was very little existing demographic data (including population, income, expenditures, household structure, etc.) available on which to base project strategies. Surveys of a sample of 2000 households, including existing owners of solar home systems, revealed important information about affordability and household budgets [report now being written]. The China project also provides grants to dealers to assist them with sales and marketing activities.

In **India**, IREDA has been conducting promotional campaigns for photovoltaic technologies in the media, but these campaigns may not have reached rural households. Within the **Sri Lanka** marketing program {link to Sri Lanka marketing program}, the project hired a consultant specifically to lead village-level workshops throughout the country to promote solar home systems. In these

workshops, dealers are able to demonstrate their products and village leaders learn about the technology. In addition, potential local microfinance organizations have learned about the project and gauged local interest in solar home systems, and have been invited to participate in the project and provide consumer credit to the local community. Such workshops were being conducted twice monthly and were considered moderately successful, although dealers felt the workshops did not sufficiently attract the actual customers of solar home systems.

Projects also support ESCO concessions in their marketing and consumer awareness activities. In **Argentina**, provincial governments assist concessions by preparing detailed market studies, conducting information dissemination workshops, and preparing studies on how to improve the availability of DC appliances compatible with solar home systems in dispersed rural areas. In **Benin and Togo**, the rural electric utility conducts marketing activities to support the ESCOs; the utility polls communities on their interest in solar home systems and willingness to pay, and collects information on the demographics of these villages. In addition, ESCOs can conduct market surveys themselves using project grants.

Further details of consumer awareness and marketing programs are available directly from project implementing agencies but have not been collated for this report.

Lessons Suggested by Early Implementation Experience

- Consumer awareness does not by itself create a larger market. Other factors, such as affordability, demonstrations, opinions of neighbors, service presence, and trust in technological performance are equally important.
- Marketing campaigns can be extremely costly and time consuming in rural areas, as potential customers may live far from village centers, may not be able to read, may be very skeptical of the technologies, and may require direct person-to-person contact through community gatherings or even door-to-door marketing.
- Marketing campaigns should be sure to target potential customers in rural areas, not just village leaders and potential commercial participants.
- Marketing becomes easier once a “critical mass” of customers exists in specific rural areas.
- Door-to-door and direct contact is much more effective than TV or radio campaigns.
- It may be quite difficult to assess the impact or effectiveness of marketing campaigns in rural areas.

Table 1: World Bank Group Projects with Solar Home System (SHS) Components

Project Name	Approval dates and status	Bank/GEF funding & total project cost	SHS component description	Implementing agencies
India Renewable Resources Development Project {http://www.worldbank.org/astae/lcg.htm#credit24490-IN}	GEF: 1991 Bank: 1992 *under implementation*	GEF: $26 m. Bank (IDA): $115m. Bank (IBRD): $75m. Total: $450 m.	2.5 MWp of PV in various applications, (commercial, water pumping and SHS)	India Renewable Energy Development Agency (IREDA)
Small and Medium Scale Enterprise Program {http://www.worldbank.org/pics/ifcspi/l1s07327.txt}	GEF: 1994/1997 IFC: 1995 *under implementation*	GEF: Vietnam: $0.75 m. Bangladesh: $0.75 m. Dominican Republic: $75,000	Finance commercial SHS business ventures	Financial intermediaries and recipient firms
Indonesia Solar Home Systems Project {http://www.worldbank.org/astae/lcg.htm#loan35544-IND}	GEF: 1995 Bank: 1997 *will be cancelled*	GEF: $24 m. Bank (IBRD): $20 m. Total: $118 m.	200,000 SHS sold and installed by private dealers/ entrepreneurs	Project management unit and participating firms
Sri Lanka Energy Services Delivery Project {http://www.worldbank.org/astae/lcg.htm#credit2938-LK}	GEF: 1996 Bank: 1997 *under implementation*	GEF: $5.9 m. Bank (IDA): $24 m.	30,000 SHS sold and installed through dealers and microfinance organizations	Ceylon Electricity Board and project management unit
PV Market Transformation Initiative {http://www.gefweb.org/wprogram/1096/pvmti.doc}	GEF: 1996 IFC: 1998 *under implementation*	GEF: $30 m. Total: $90-120 m.	Finance commercial SHS business ventures in India, Kenya and Morocco	"External Management Agent" and recipient firms
Lao PDR Southern Provinces Rural Electrification Project {http://www.worldbank.org/astae/lcg.htm#credit30470-LA}	GEF: 1997 Bank: 1998 *under implementation*	GEF: $0.7 m. Bank (IDA): $1.5 m. (for off-grid component only)	20 solar battery charging stations by national utility and village electricity associations as demonstrations	Electricité du Laos (EdL)
Argentina Renewable Energy in Rural Markets Project{http://www.gefweb.org/wprogram/nov97/ar-pcd.pdf} [need PAD]	GEF: 1997 Bank: 1999 *under implementation*	GEF: $10 m. Bank (IBRD): $30 m. Total: $121 m.	66,000 SHS in households through regulated energy-service concessions	Secretariat of Energy and provincial governments
Cape Verde Energy & Water Sector Reform and Development {http://www.gefweb.org/wprogram/mar98/worldbank/capeverde/capever.doc	GEF: 1998 Bank: 1999 *under implementation*	GEF: $4.7 m. Bank (IDA): $17.5 m Total: $48 m.	4,000 SHS in households through regulated energy-service concessions	Ministry of Infrastructure and Housing, national electric and water utility (ELECTRA)
China Renewable Energy Promotion Project {http://www.gefweb.org/wprogram/mar98/worldbank/china/china1.doc} [PAD]	GEF: 1998 Bank: 1999 *under implementation*	GEF: $35 m. Bank (IBRD): $100m Total: $444 m.	10 MWp of SHS and PV-wind hybrid systems installed through private dealers	State Economic and Trade Commission
Global Solar Development Corporation {http://www.worldbank.org/pics/ifcspi/1ws09137.txt}	GEF: 1998 IFC: 1999	GEF: $10 m. IFC: $6 m. Total: $50 m.	Finance PV-related businesses and provide technical assistance and business services	Triodos PV Partners (fund manager) and recipient firms
Benin Off-Grid Electrification/Traditional Energy{http://www.gefweb.org/wprogram/Oct98/Wb/benin.pdf}	GEF: 1998 Bank: to be approved	GEF: $1.1 m. Bank: $2.2 m. Total: $5.7 m.	5,000 SHS through regulated energy-service concessions	Ministry of energy, mines and water
Togo Off-Grid Electrification/Traditional Energy{http://www.gefweb.org/wprogram/Oct98/Wb/togo.pdf}	GEF: 1998 Bank: to be approved	GEF: $1.1 m. Bank: $2.2 m. Total: $5.7 m.	5,000 SHS through regulated energy-service concessions	Ministry of mines, industry, transport, post and telecommunications

Table 2: Project Features and Approaches

Project Feature	Summary of Project Approaches	Key Barriers Addressed
1. Pilot private-sector and NGO delivery models	Private dealers or NGOs sell systems (Indonesia, India, Sri Lanka, Vietnam, Bangladesh, China). Energy-service companies (i.e., monthly fee-for-service) operate as regulated concessions (Argentina, Cape Verde, Benin, Togo). Energy-service companies (i.e., monthly fee-for-service) operate in an open market (Dominican Republic, India). Provide business information, training, and consulting services to private dealers, ESCOs and NGOs (Indonesia, Sri Lanka, China, Cape Verde, Argentina, Benin, Togo).	Lack of established market Lack of successful business models Lack of business financing Lack of business skills Unwillingness of utilities to provide off-grid electricity services High transactions costs
2. Pilot consumer credit delivery mechanisms	Offer consumer credit through dealers (India, Indonesia, Sri Lanka, Bangladesh, Vietnam). Offer consumer credit through established microfinance (microenterprise) organizations (Sri Lanka). Offer consumer credit through local development finance organizations (Vietnam).	High first-cost and affordability Lack of consumer financing High transactions costs
3. Pay first-cost-subsidies and offer affordable system sizes	Pay one-time-per-system subsidies, at levels either constant over life of project (Indonesia, Sri Lanka, China) or declining over life of project (Argentina, Benin, Togo, Cape Verde). Specify and sell smaller, more affordable systems, (Indonesia, Sri Lanka, China, Cape Verde, Benin, Togo).	High first-cost and affordability Lack of an installed base ("critical mass") that would enable after-sales service activities to be profitable and would lower marketing costs
4. Support policy development and capacity	Provide technical assistance to national regulatory agencies for concession bidding and contracting and regulation of concessions (Cape Verde, Argentina, Benin, Togo). Build capacity of public renewable energy agencies (India) Incorporate solar PV into rural electrification policy and planning (Sri Lanka). Lower import duties (Sri Lanka, China)	Lack of experience regulating rural energy-service concessions High import duties Unrealistic political promises of grid extension Uncertain rural electrification policies
5. Enact codes and standards and establish certification, testing, and enforcement institutions	Develop equipment standards for use in project-financed installations (Indonesia, Sri Lanka, China, Benin, Togo). Provide support for certification and testing agencies and laboratories (Indonesia, China). Provide capacity building for dealers to meet standards and for regulatory agencies or financiers to verify compliance with standards (Indonesia, Sri Lanka, China, Benin, Togo).	Poor system quality Uncertain technological track record Lack of information about product quality and performance
6. Conduct consumer awareness and marketing programs	Conduct promotional ads on TV and radio. Distribute information at local fairs and community events. Conduct door-to-door marketing.	Uncertain technological track record Lack of information about products, costs, and benefits

Table 3: Project Design Questions and Relevant Project Features

Project Design Questions	**Relevant Project Features**
(a) How to effectively deliver and service quality systems to households that suit consumer preferences? *(private dealers, energy-service concessions, business finance, marketing, codes and standards, regulatory development)*	Private-sector and NGO delivery models (#1) Policy development and capacity (#4) Codes, standards, certification, enforcement (#5) Consumer awareness and marketing (#6)
(b) How to make systems affordable to households? *(market competition, fee-for-service, bulk purchasing, subsidies, smaller system sizes, consumer credit, economies of scale, lower transaction costs)*	Private-sector and NGO delivery models (#1) Consumer credit (#2) First-cost subsidies and systems sizes (#3)
(c) What forms of consumer credit, if any, are most viable in a given context? *(dealer credit, microfinance, development financiers)*	Consumer credit (#2)
(d) What is the proper role of SHS within rural electrification policy and planning? *(geographic determinants of service cost, least-cost planning, planning processes and institutions, role of private sector, subsidies and income considerations)*	Private-sector and NGO delivery models (#1) Policy development and capacity (#4)

Box 1: Barriers to the Widespread and Accelerated Dissemination of Solar Home Systems

Lack of established market. Without an established market, many commercial firms are reluctant to enter the solar home system business and commercial financiers are uncertain about the profitability and viability of this type of business.

Lack of successful business models. As yet there are no clearly successful business models for delivery of solar home systems in developing countries, so any solar home system business is by nature experimental.

Lack of business financing. Solar home systems businesses may have difficulty obtaining business financing from commercial banks, who may be uncertain about the profitability of this type of business and may be unfamiliar with the technology.

Lack of business skills. Small solar home systems firms in developing countries may lack sufficient business skills for obtaining business financing, marketing, service, and management.

Unwillingness of utilities to provide off-grid electricity services. Without government regulation, utilities accustomed to servicing urban and rural grid-based electricity may be unwilling or unable to provide off-grid electricity services, such as with solar home systems, for a variety of reasons.

High transactions costs. Project identification may be expensive and time consuming, especially for urban-based PV companies or financiers. Numerous small-scale installations may make project implementation challenging. Pre-investments risks associated with the costs of marketing, contracting, and information collection may be high. Costs of credit collections may be high if customers live in very dispersed and remote areas.

High first cost and affordability. Solar home systems represent an initial capital investment that reduces or eliminates a stream of future payments for fuels and batteries. But the high "first cost" of this capital investment may make affordability an important constraint.

Lack of consumer financing. Credit can improve affordability but there may be a lack of credit access and credit delivery mechanisms. Financiers may perceive the credit-worthiness of rural households as insufficient. Lack of practical collateral or legal enforcement of contracts may inhibit financing.

Uncertain technological track record. There may be an insufficient technological "track record" to dispel misconceptions about SHS costs, benefits and performance among users, financiers and dealers. Experience may exist elsewhere, but must become accessible, visible and credible to a specific locality.

Uncertain or unrealistic grid expansion plans. Unrealistic political promises for future electric grid expansion can reduce demand for SHS if households believe "the grid is coming." But such promises may lack substance or financial backing. The lack of coordination between SHS market development and rural electrification programs and policies can impair markets. "Our main competition is the false promise…not each other " said one supplier when asked about competition between the different suppliers in the market.

Other policy constraints. Conventional-fuel subsidies, inappropriate tariff structures, import duties for renewable energy equipment, lack of attention to environmental externalities and other policy conditions can be serious obstacles.

Lack of objective market, business and quality information. Information may be lacking about the financial condition and business track record of entrepreneurs, or about the technical characteristics and quality of their systems. Market information may be needed about potential households, their incomes, their interest in SHS, and their current expenditures on candles, kerosene and other forms of energy. Information about solar resources may also be lacking.

Box 2: Rural Energy Service Concessions in Argentina

The World Bank/GEF "Renewable Energy in the Rural Market" project aims to supply electricity to 66,000 households with individual solar home systems (of size 50Wp to 400Wp), 1,100 public facilities with solar photovoltaic systems, and 3,500 households with village-power systems (using mini-hydro or hybrids such as solar/wind, wind/diesel or solar/diesel) through province-level energy service concessions. Concessions are free to select which technology to apply in any given situation, including diesel-only village power systems. Concessions will be obligated to:

- provide electricity services to rural off-grid customers anywhere in the province for a period of at least 15 years, upon request;
- carry out all necessary maintenance, repairs or replacement of components as needed to ensure the continuity of the electricity service to each and every customer;
- provide "state-of-the-art commercial service standards" for connection requests, billing, collection and claim handling; and
- provide the provincial utility regulatory agency (ENRESP) with periodic reports on the status of the concession including but not limited to performance indicators such as number of connections by type of consumer and method and technology supply, outages statistics, and financial results.

Concessions are eligible to re-bid for their business every 15 years up to a total of 45 years, competitively against other eligible firms. The 15-year period was seen as a compromise between the need for a short period for the quasi-monopoly and a long period for the annuity calculations of the concession. After 15 years, the government can modify the concession rules to account for new technological developments, or may even decide to abandon the concession system and open the market to competition. During the 15 year period, the concession, provincial government and provincial utility regulatory agnecy renegotiate the tariffs every 2 years.

Eight provincial governments (out of 22 total) are eligible to participate in the project. Each of these provinces has privatized or is in the process of privatizing its power sector, or at least has made a legal commitment to privatize. Four of these provinces have existing private concessions serving the concentrated (urban) market that are regulated by the provincial governments. Under the project, these governments will first try to negotiate a rural concession contract with their existing concessions (as an amendment to the existing contract). If such negotiation fails, or if there is no existing concession for that province, then a new concession contract will be awarded according to international competitive bidding procedures.

Source: Martinot and Reiche 1999

Box 3: GEF Justification of First-Cost Subsidies

GEF subsidy payments are generally justified as the "incremental costs" of a solar home system, which in most projects are assessed as the difference between the lifecycle costs of the solar home system and the baseline costs of kerosene, candles, and other fuel sources displaced. First-cost subsidies are justified on the basis that cost reductions are expected over the life of the projects due to several factors, which should eliminate the need for subsidies in the long term in order to make continued installations commercially viable. These factors include:

- larger market volume and increased competition
- improved financial strength of individual dealers after an initial volume of sales
- refinement of procurement methods and bulk purchasing
- economies of scale in sales and service networks and assembly of balance-of-system
- standardization of components and installation processes
- general cost reductions in PV module costs internationally
- increases in rural household income as economic conditions improve
- increased familiarity of commercial banks' with the SHS business (lower risk premiums)
- improved quality and acceptance of technology with introduction of technical standards and certification

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