# A MODEL OF COMMERCIALIZATION OF SOLAR PHOTOVOLTAIC SYSTEMS

*Faizullah Mahar**


## ABSTRACT

*In commercialization of Solar photovoltaic system, one of the financial issues to address is the high cost that the rural household would have to pay, up-front by buying 20 years (the expected life of a PV module) worth of electricity services. To disseminate solar photovoltaic technology in the rural areas, it is essential to create a rural-credit system, which can assure the availability of capital at concessional and commercial terms to the end-user.*

*Energy priorities in the developing nations have been strongly induced by commercial interests and cultural influence of the industrial nations. The issue is not the question whether developing countries have the right to follow Western models of energy-development. The issue is whether or not developing countries are interested in, and have the resources for developing the models. The paper describes the commercialization-model of solar photovoltaic systems for the purpose of rural electrification in the developing world.*


## THE PHOTOVOLTAIC MARKET POTENTIAL

One of the recent estimates of this potential market is presented in Table-1. It is seen that by 2015 solar technology has an enormous potential as a tool of sustainable development in the context of rural electrification. Currently, the size of the solar photovoltaic world-market is enormous (60 million people, at present, not served by electric grids but are living in locations endowed with sufficient areas (1000-1500 per square meter per year). By assuming a demand of 250 W per family (of 5 persons), a land availability of about one square meter per inhabitant, and an over all PV efficiency of 10%, one arrives at the conclusion that the required installed power is about 140 GW. Even assuming that we install in ten years only a fraction of such power, the PV production-capacity required would be about one GW per year i.e. 10/20 times the present world-capacity. It is evident that free market-dynamics alone results in limited driving force for rural PV-system expansion. The intervention of governmental and international institutions will be necessary for planning, funding and managing an adequate expansion of the current PV market.

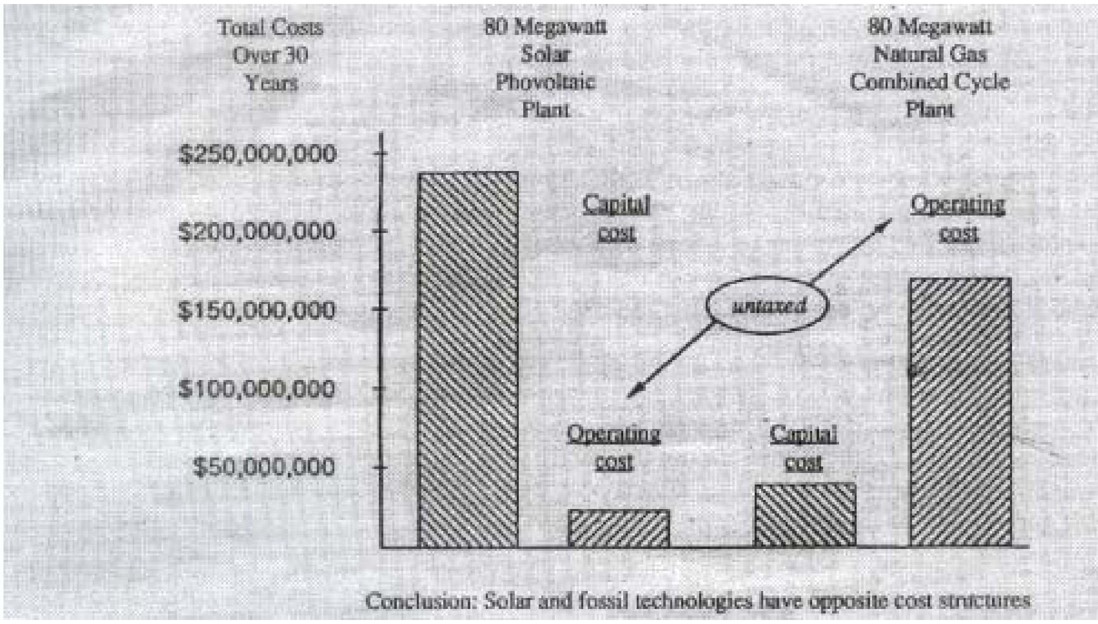
## FINANCING SOLAR PHOTOVOLTAIC RURAL ELECTRIFICATION

One of the most critical barriers to rural electrification through solar PV systems has been the high capital-cost associated with this energy-technology, in comparison to the conventional fossil-fuel based approach. The cost-comparison presented in Figure-1 visualizes the difference in costs-structure between a 80 MW Photovoltaic plant and a 80 MW natural gas combined-cycle plant; and although the example would probably fit better in the energy infra-structure of a industrialized country, it serves here to underline the opposing cost-structures.

Going back to the most critical barriers of the Solar Photovoltaic systems commercialization, one of the finical issues to address is the high cost that the rural household would have to pay, up-front, by buying 20 years (the expected life time of a Photovoltaic module) worth of electricity-services. Within the conventional and centralized energy-path, the energy-producer (utility) copes with the infrastructure statements (i.e. refineries, power plants and power grid) and, given its large capital demand, is usually able to bargain for low interest-rates – while the end-users pay only the energy-services fees; in the case of decentralized and individually owned solar-energy systems, instead, the end-user has to bear the entire capital cost of the solar photovoltaic equipment. Thus, to disseminate solar photovoltaic technology in the rural areas, it is essential to create a rural credit system, which can assure the availability of capital at concessional and commercial terms to the end user.

A large part of the population in rural areas of developing countries is actually able to pay small fees for the energy-services; they often pay for the use of kerosene lamps, diesel-generated electricity, car batteries that need the weekly recharge, dry cells and candles. These expenses summarized together can range from US $ 5 to 20 per month (Hankans, 1992). Thus, the essential

* Balochistan University of Engineering and Technology, Khuzdar - Pakistan. Email: faiz@meher.qta.sdnpk.undp.org




**Source:** *U.S. DOE, 1992*

**Figure - 1: Comparison of Solar and Fosil-Fuel Plants' Capital and Operating Costs**

point is to provide them with appropriate financial means to buy solar photovoltaic systems at equivalent terms with those offered to the conventional supply options.

A *second critical issue* to face in financing the solar photovoltaic rural electrification is the low propensity of lending agencies to finance small-scale projects. The traditional approach of the World Bank and other Multilateral Development Banks (MDBs) has been to finance a small number of large-scale projects in the conventional energy-supply area. However, the renewable-energy sources, like solar photovoltaic electricity that could be harnessed with great benefit for indigenous people, are inherently decentralized and small-scale. One of the difficulties of financing small – scale energy-projects is the high administrative and overhead cost that the MDBs, the national utility or the private industry (funding and managing these projects) have to take into account; hence their preference for large conventional (or hydro electric) energy projects. A shift in focus of energy-policies for developing countries has to be based on the recognition, from both the south and the north, that increasing the energy-supply isn't necessarily the rational choice for assuring higher standards of living and energy/economic welfare. What is needed is a major focus on the financial services provided by energy-use and, therefore, reforms which assume the need to eliminate the obstacles to an integrated energy planning: as identified by Nicholas Lenssen, these obstacles include " enriched special interests with a bias towards large supply–side projects, and consumers who are ignorant of, or unable to finance-efficient alternatives" (Lenssen, 1992).

Changes in funding procedures are therefore very much needed, to meet the needs of rural energy-demand. International lending agencies: a) need to learn more about the potential gains of a rational energy-demand management, and b) must be provided with new tools for administration of integrated renewable-energy programs, which (specially in the case of rural developing areas), need to encompass a large number of decentralized individual projects.

## FINANCING AND MARKETING

Generally, three avenues can be followed in financing and marketing solar photovoltaic rural applications, although the distinction is not too obvious and rigid.

**First,** solar photovoltaic investments can take the form of technical assistance program. In this case, when

**Table - 1: Potential Capacity (GW) for Off-Gird Solar Photovoltaic Systems in Selected Geographic Areas**

| Area | Population (millions) | Population Off-grid | PV product (kWh/y/m²) | Potential capacity (GW) |
|---|---|---|---|---|
| Africa | 310 | 90% | 150 | 15 |
| North Africa | 135 | 56% | 150 | 3.8 |
| South Africa | 35 | 17% | 150 | 0.4 |
| Nigeria/Gabon | 95 | 63% | 150 | 3 |
| Latin America | 190 | 40 | 120 | 5.25 |
| Mexico | 80 | 20% | 150 | 0.8 |
| Brazil | 145 | 23% | 140 | 2.3 |
| Middle East | 110 | 45% | 150 | 2.53 |
| China | 1070 | 37% | 120 | 28 |
| India | 770 | 78% | 150 | 42 |
| Indonesia | 175 | 80% | 150 | 9.8 |
| South Europe | 80 | 15% | 140 | 0.85 |
| World | 4935 | 44% | --- | 142 |
| **Source:** *Lovejoy (1992)* | | | | |

the recipient rural region is very poor and the technology-adaptation raises particular complexities, the donor-funds (by a bilateral, multilateral donor-agency or by the local government) are typically provided in form of a grant. These are usually demonstration-projects, which are completely given away under development corporation efforts and which intend to test the technology, provide training and educate local people.

**Second,** a local energy-service enterprise, with direct incentive from a government's program or with special loans offered by commercial banks or by an international development-agency, enter the rural market for photovoltaic "stand–alone" systems and manage delivery, installation and maintenance services, as well as a rural credit system. This approach finds examples in several countries like Sri Lanka, Kenya and Zimbabwe, and the private business provides credit to end-users for the purchase of photovoltaic equipment over a time-frame of 3 to 5 years. A slightly different approach-implemented in Zimbabwe – is one in which the public-utility programs the tasks of the primitive enterprise: the title of the solar photovoltaic equipment remains with the utility (also leasing-schemes are implemented) to which the end-users pay small monthly fees throughout the life time of the system. The disadvantage of this method is that the longer payment period (20 years) raises the administrative cost and the risk of the fee-collection activity. In addition, it does not allow (unlike the private-enterprises model) to reuse capital for short-term funds, which could make credit available to other potential photovoltaic end-users.

**A third** Avenue is based on the establishment of a rural cooperative association for solar electrification. In this model, the donor-funds, mostly in form of grants from an international development agency (but also highly concessional loans can be considered), are used by the rural association, often in partnership with a national or international NGO, to create or expand rural revolving-credit funds. This approach is attractive, as it is managed by grassroots organizations within the rural community.

## MANAGING RURAL CREDIT SYSTEM

The success of photovoltaic-systems commercialization largely relies on the establishment of sound and adequate rural-credit system. This should be designed to allow rural customers to pay for their solar photovoltaic equipment in small amounts: typically equal to the collective costs already being incurred by the use of fossil fuels (i.e. diesel or kerosene), car batteries, dry cells and candles. It is essential that the credit-system offer affordable loans, not grants that generally subsidize the entire cost (or most of it) of photovoltaic systems, to rural customers. This approach, indeed, fosters more responsibility in

**Table - 2: Estimated Solar Photovoltaic System for Rural Household Use in Several Developing Countries**

| Country | Average PV System Size(W) | Number of System(Estimate) | Down payment Monthly Payment | Main Funding Source/Aid Scheme |
|---|---|---|---|---|
| Bolivia | 47 | 1000 | 480+1/month | Spanish aid |
| Brazil* | | 20000 | | Government |
| China | 20 | 100 | Cash($300) | Commercial |
| CILSS[3] | 45-300** | 583 (1991-94) | Maintenance + repair fees | ECC grant (34 M ECU) |
| Colombia** | 60 | 30000 | Monthly fee | Rural bank |
| Dominican Republic | 20-100 | 4000 | $50/month | Rural NGOs |
| French Polynesia | 40-100 | 2500 | $50/month | French aid |
| India*** | 24000 | | | Government |
| Indonesia | 40 | 15000 | $12/month | Rural bank |
| Kenya | 40-100 | 10000 | Cash | Commercial |
| Mexico | 20-50 | 12000 | | Government |
| Philippines | 50 | 1500 | $10/month | Cooperative |
| Sri Lanka | 18-58 | 4000 | Cash or monthly fee | Commercial Rural bank |
| Zimbabwe | 15-50 | 3000 | Cash | Commercial |
| Zambia | 40 | 1700 | | Government |

**Note:** * For Brazil, the number installed system includes lighting, refrigeration, electric fans, telecommunication and signaling system

** In the case of Colombia around200 systems have been installed for house hold lighting and most of the rest is used for telecommunication and battery charging stations. The CILSS program w ill includes community size lighting system, battery charging stations and systems for refrigeration of medical equipment (180-300 W)

*** For India, the number of installed systems refers to lighting, w ater pumping and communication.

**Source:** *Hankins (1993)*

the management and maintenance of the system and helps to build a sustained local photovoltaic-market. It has been demonstrated that, if the financing activity is managed by local rural agencies, a successful dissemination of photovoltaic rural electricity is very likely for the following reasons:

a) Rural electrification associations, by working directly in a limited geographical area, mobilize rural communities, thus allowing for more active participation and involvement of their members;
b) The proximity of the association enables efficient extension of credit to rural customers, which helps to build the trust and continuity needed to establish a sustainable scheme of monthly fees-collection;
c) The local management of credit translates, together with the implementation of a service infrastructure, into a new rural business and employment opportunities. Individuals in buying photovoltaic systems and allows them to repay over time at terms that are interested.

A revolving loan funds an effective financing mechanism which provides credit usually more favorable than those offered by commercial banks. The regular payments of monthly fees (which include capital and interest payments) enable the replenishment of the revolving fund, which can then provide credit to new potential photovoltaic-systems customers. This approach has been positively experimented for solar photovoltaic electrification-projects in rural areas of several developing countries, including the Dominican Republic, Sri Lanka, and Zimbabwe. In most of the cases, the customers pay most of the cost of photovoltaic-systems and donor-agencies contribute only with subsidy of the interest and the technical-training activities (Williamans, 1992). Figure-2 Schematically represents the various steps and actors involved in the management of a typical rural revolving-loan fund. Initially, a seed-capital for creation of fund is earmarked, often with the mediation of an NGO, within the community of international donor-agencies and foundations. Then, with the coordination of the

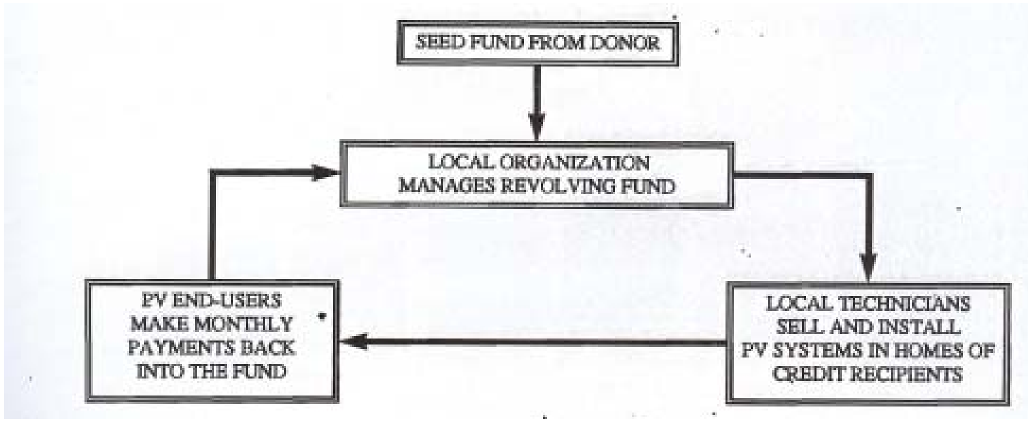



**Figure - 2: Revolving Loan Fund Implementation**

sponsored NGO and/or through host-country government officials, an existing or a new local association is provided the technical assistance to ensure successful management of credit-scheme. Through promotion and education, households become aware of solar photovoltaic alternative, and then contact is made with the newly created loaning agency, which facilitates the communication between the household and a local small enterprise. These families solicit loans from the local agency, to cover 65 to 90% of the cost, and contribute the reminder as initial input. This combined sum is paid to the local enterprise, to carry out the installation of solar photovoltaic system. The loan amount is then reimbursed to the agency through monthly or three monthly payments (the timeframes vary between a few months to 5-7 years) that go to replenish the fund. If the fund is well managed, it is steadily replenished, making further credit available to new customers.

Following is the analysis presented by Enrsol Assoc., Figure-3. Reproduce the potential outcome of a $100,000 revolving fund, resulting in the commercialization of 817 solar photovoltaic systems in 5 years. The cost of the installed solar photovoltaic system per household is assumed to be $ 500, the

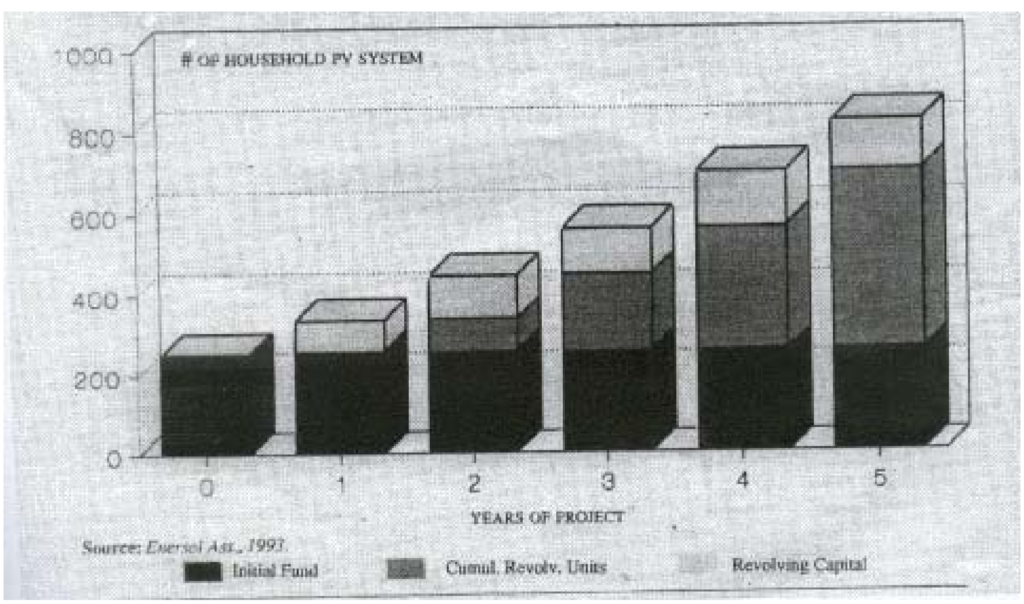



**Figure - 3: Effect of $100,000 Revolving Loan Fund for Solar Rural Electrification (3 year period loans)**

**Table - 3: Benefits of International Cooperation and Financing of Solar PV Technology-Transfer**

| Issues/Areas | Industrialized Nation | Developing Nation |
|---|---|---|
| Environment | Global Warming (+) | Global warming (-)<br>Reduced stress on natural resource base |
| Technology | Patent and development of industrial process<br>Economies of scale | Technology market<br>Local industry devl.<br>S/S Tech. Transfer |
| Security | Higher global political stability<br>Less dependence on fossil fuel exporting countries<br>Lower immigration | Less dependence on fossil fuel exporting countries |
| Economic Development | Export increase<br>Higher industrial competitiveness | Economic rural development<br>Lower external debt burden |
| Social Development | | Higher employment. Increase in health and education<br>Lower rural migration |

loan per customers is $ 400 with a three years period and an interest rate (in the Dominican Republic, 18 to 24 %) to cover the administrative cost of the fund and the local currency depreciation-risk.

An important phenomenon related to availability of solar photovoltaic loans is the “ multiplier effect” that generally takes place **after** a rural village has been electrified with solar systems (Williams, 1992). This is especially true when solar photovoltaic technology is dispersed throughout the local community, which promotes the natural trust and acceptance of the new technology.

This leads not only to a large number of requests for participation in the credit-scheme from households in villages of the same region, but also may remove remaining doubts among households of the upper-income class, who have the ability to pay in cash for their solar electricity, thus adding to growth of the local solar photovoltaic enterprises.

Table-2. Summarizes the solar rural electrification achievements to date in several developing countries, with the kind of predominant financing scheme followed. Due to the obvious difficulty in keeping records of the solar photovoltaic systems technology-dissemination for small applications, the numbers presented below rely on estimates and soft data of various sources. The funding sources and schemes of the last column are indicative of major efforts but not exhaustive.

## MANAGING A SUSTAINABLE SOLAR PHOTOVOLTAIC SERVICES INFRASTRUCTURE

Providing affordable credit-channels to rural households is only the first step for the commercialization of solar photovoltaic systems. In an assessment of previous field experiences, it has been pointed out that “ the choice of a local entrepreneur with sufficient capital, a reputation for service, and good technical capability was important to success” (Waddle et al, 1989). When this choice is not available due to the particularly rural nature of the local economy, then the NGOs must act to: a) create the opportunity to develop such local management and technical skills through training programs, b) boost the organization of a network of local business with dedicated before and after sales service. Different players can organize and manage a sustainable rural service infrastructure. Sometimes the public utility, after receiving the donor-funds to install the solar photovoltaic systems, takes also the task of operation, maintenance and after-sales service. The centralized nature of this scheme, though, renders much more difficult the growth of a competitive market of small local enterprises. The solar photovoltaic marketing and commercialization process, in these cases, is more decentralized and implies local people’s responsibility.

Local participation can supply an essential role in the management of the technical and marketing components of the solar rural electrification-model. Rural entrepreneurs and local grassroots organizations (and even religious organization) seems to be best understand (and consequently responds to)

a. what are the local energy needs on which to a build a local market;
b. how to process this information so that it results in a timely technical adaptation of the solar photovoltaic system technology.

A first example of the strategic value of local input in PV system design (and in creating sustainable market) comes from the Dominican Republic (Stevens, 1993). Industria Electrica Bella Vista is the first small solar enterprise, which sells locally produced control boxes. At the age of fourteen, solar technician Carlos Durin designed a control box, which is much less expensive than the sophisticated imported models. Moreover, the locally designed control-box becomes a simple tool for educating the rural customers on how to manage their PV energy consumption. A second example comes from Kenya (Hankins, 1993): Solar Shamba is one of the first Kenyan companies serving the rural market and, knowing that most of rural houses in Kenya have tin roofs, this company designed and sold a simple rotatable pole tracking mount for the PV panels. With this simple and effective adaptation, Solar Shamba avoided placing panels in contact of heated roofs, which reduces their electric output, and gave the possibility to rural household to gain 25%of extra electricity.

Creating a solar photovoltaic market infrastructure based on local participation also translates in higher rural development. Many rural people can find an employment opportunity in every component of the service –oriented solar photovoltaic market. They can, for instance, be trained as solar electricians in a few weeks and then participate in the installation, maintenance and marketing of the products or can participate as trainers themselves, fee collectors, dealers of spare parts; these activities, together with the availability of rural electricity, in turn, attract and simulate more rural business.

Once a local solar photovoltaic market infrastructure has been created and /or strengthened, the solar technology-transfer can be focused on the longer term global aim of self-reliance. In other words, efforts should be made to support the building of a local photovoltaic industry that, has appropriate quality-control management, and can assure in-country assembly and manufacturing of solar photovoltaic modules. Choosing right timing to start this second stage of technology-transfer is though more controversial. If a local and decentralized market infrastructure is not consolidated, the incoming PV manufacturer might assume a monopolistic position. In addition, if the PV technology is rapidly evolving, the risk of in-country manufacturing investments is that of obsolete and less efficient products. However, examples of PV “manufacturing-oriented” markets already exist in some developing countries (in particular, the Newly Industrializing Countries) like Brazil, China and Srilanka. A significant advantage of domestic PV manufacturing, besides the contribution to the level of employment and to the GPP, is the lowering of the foreign exchange components of PV systems costs. This cost components, indeed, even if lower than conventional rural energy sources is still a serious obstacle to wider PV commercialization (Hansen, 1998).

A way of merging the interests of Western Solar Industry with developing countries’ developmental needs could be to support a log term strategy for the international solar manufacturers. Companies could not only focus on PV module export but also modify their plans and manufacturer hardware export. If the expansion of rural PV market will continue in the next few decades as anticipated, there would already be a large market-potential for new solar companies which wanted to specialized in producing and exporting manufacturing capacity. SPIRE corporation in the United State is the only example of solar company in the export of PV manufacturing equipment, complete with technical training and technology-transfer and installed equipment at 82 PV production facilities in 26 countries (Darkazalli, 1992). In China, for instance, SPIRE exported 1 MW PV factory in the town of Qinghuangdao, which will supply the modules to a PV rural electrification program sponsored by the Gansu Province government in cooperation with the Solar Electric Light Fund (Williams, 1992).

## THE ROLE OF POLICY AND ENERGY-PLANNING IN SOLAR ENERGY DEVELOPMENT

The energy policy and regularity frame-work of developing countries have clearly an important role to play in the devlopment of solar photovoltaic technology as a tool for electrification. Public actions, therefore, could be taken at the national and regional level, (which support at the international level as well) and would entail the following policy areas:

a. national and regional energy planning;
b. economic policy incentives;
c. Education and training;
d. technology transfer and adoption;
e. research and development.

Solar photovoltaic rural electrification can not easily succeed if the energy-planning in developing countries does not shift from grid-extension and /or diesel generation approach to an approach that allows to compare the first two options with the harnessing of local renewable energy sources. In many developing countries, for political reasons, the central electricity grid is heavily subsidized thereby hampering the competitiveness of solar and other renewable energies. A first crucial step in energy planning is, therefore, the reform of energy pricing, so that renewables and fossil fuels options can be evaluated on equal economic grounds. A further step of the progressive energy policy (UNSEGED, 1992) would include efforts to incorporate in energy prices the estimated value of associated social, environmental and security impacts.

Another area needing public intervention is the legislation related to the public utilities: a new body of utility regulations might develop non-discriminatory pricing reforms and ease the access to rural electrification by private solar photovoltaic entrepreneurs. In the case of photovoltaic investment analysis, a low power risk-adjusted discount-rate should be established lower than the one used for fossil fuel fired power plants (for which future dependence on uncertain fuel prices should be acknowledged). As mentioned, these guidelines at national level could also be expanded to a regional dimension. They would support the common effort of a more integrated regional programmatic approach of renewable energy development. A recent example is the meeting organized among the central American energy ministries and representatives of international lending institutions (World Bank, Inter-American Development Bank and GFE) in Florida to plan a renewable energy strategy for entire Caribbean region. The participants agreed on developing a collaborative initiative, which will be named Central American Renewable and Energy efficiency for Sustainable Development Strategy (Keas, 1992).

Besides the energy-pricing issue, economic incentives and economic reforms can be created a) to support the international trade of solar photovoltaic systems components and b) to support the birth of a local solar energy industry and service infrastructure. Both approaches if carefully designed would be beneficial for a solar-based rural development.

An economic incentive of the first kind is the removal (or reduction) of import tariffs and taxes on solar photovoltaic modules. This would reduce the financial burden of photovoltaic systems purchase, especially with the scarcity of foreign currency and the foreign debt burden existing in many developing countries. In the Dominican Republic, a import tax relief on photovoltaic modules eliminated the high burden of the previous 70% import tax, thereby making the way to solar rural electrification much easier (Hansen and Martin, 1988). In 1986, Kenyan authorities also removed a 45% import duty on photovoltaic modules and the solar market responded with a remarkable increase in sales (Hankins, 1993). A more stringent policy, after removing the import duties on solar equipment, would also feature taxes on diesel and kerosene, fuel usually consumed by rural households, which are currently being sold at artificially low prices, thereby diverting the public resources from other socio-economic priority areas of intervention.

To foster a solar photovoltaic service infrastructure and local manufacturing capacity, the government can intervene in the market in a variety of ways including: a) support to joint-venture between foreign photovoltaic industry and local entrepreneurs; b) promote private business through tax credit and subsidies; c) create solar financing programs providing concessional loans to local entrepreneurs and rural electrification cooperatives; d) provide resources to establish subsidized financing to photovoltaic consumers: in Colombia , for instance , a system of individual small loans of $ 500 was set up with the mediation of commercial banks (Rannels, 1992). Further, support and action by government agencies is needed in the form of public educational campaigns about the sustainable solar energy option. Often, this activity can take place in partnership with NGOs and regional development organizations. An example of this public awareness support to photovoltaic technology comes from Kenya, where the government (and the action of UNEP) has set the media to spread the information.

As for research and development, the role of government in developing countries is to provide resources and programs to study the ways in which the country can foster self reliance, even as a mid or long-term goal. The question that needs to be asked is what are the technology-design changes that need to be addressed to take into account cultural, geographical and socioeconomic conditions of the specific rural areas served. An example on control box of the solar photovoltaic system can clarify this point. The solar photovoltaic experience gained in some experienced countries (like Sri Lanka and Zimbabwe) led the local photovoltaic companies to develop cheap charge-control devices as an alternative to the costly imported “low voltage Discount” control equipment (Williams, 1992) reducing the burden for foreign exchange.

## THE ROLE OF INTERNATIONAL INSTITUTIONS AND NGOs

International institutions within the UN system and environmental NGOs have an important role to play in shaping the international and organizational reforms needed for a transition to a “ soft energy path.” The promotion of solar electrification seems to be a sensible first step in this direction.

The international workshop on Mass Production of Photovoltaic Commercialization and Policy Options was held in Sao Paulo, Brazil, and focused on the identification of measures to foster PV rural electrification in developing nations. This Workshop brought together 141 participants from 22 countries, both industrialized and developing, and 7 agencies of the united nations (UNU, UNFSTD, UNDP, DIEC, UNIDO, DTCD). Besides for promising a set of recommendations on the policy, financing, R&D, training issues of PV technology transfer, the participants unanimously agreed that the PV crystalline silicon technology is “mature enough to meet the needs of inhabitants in remote areas of both industrialized and developing countries” (Eursolar,1992). They formulated the goal to be met in joint solar programme: the dissemination of 1 million PVs would be expected to reach 10% of worlds rural poor.

Working towards this goal, international institutions and NGOs together can press to leverage international financial aid from lending institutions and help the design of solar photovoltaic dissemination projects for rural development in the world. The challenge is to make evident to both donor agencies and local governments the benefits of solar energy related to the global perspective of the environment and development, as it was underlined at the earth summit. A strategy to open the way of international cooperation on the solar renewable energy technology-transfer is, therefore, based on an "issue-linkage" approach: efforts must focus on highlighting the benefits accruing to both parties, based on an agreed set of actions on renewable energy development by linking several different policy arenas. This is the context in which the following UNSEGED recommendation on renewable energy policy has to be placed, to be fully understood: *“The actions taken within nations must be seen in their international context in order to meet the global goal of protecting the environment, achieving continued economic development, and maintaining world peace”* (UNSEGED, 1991). Table-3 describes the benefits, in different areas of interest to both parties, occurring from the financing of solar photovoltaic technology transfer.

## CONCLUSION AND RECOMMENDATION

In the area of technology-transfer, local governments need to work closely with international lending agencies, on one hand, and local groups and NGOs, on the other hand, to ensure that financial resources are channeled to a process of technology-adaptation essential to a successful outcome.

In synthesis, the dissemination of solar photovoltaic technology, and its commercialization for rural electrification in the developing world, should take place, based on following recommendations:

1. Solar PV projects need to aim at closing the gap between large multilateral lenders and solar PV end-users by providing funding to in-country intermediate institutions for “retail” lending at the village level;
2. Cooperation between national and international institutions, including NGOs, private voluntary organizations and local communities, has to be strengthened in order to build partnerships in the identification, design, and appraisal and implementation stages of solar PV projects;

3. A special support is required for adaptation of technologies to local conditions.

Finally, local government needs to commit solar energy support at the regulatory and policy level. Especially when PV funding resources are not directly channeled from donor/lending agencies to local financial intermediaries, the local national governments need to follow a series of conditional policy-measures to receive and manage the international aid.

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