Center for RESOURCE SOLUTIONS

NON-GRID RENEWABLE ENERGY POLICIES: INTERNATIONAL CASE STUDIES

August 16, 2001

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Introduction

Governmental support is one of the main drivers of renewable energy dissemination throughout the world. Subsidies, import tariffs, quality enforcement programs, and governmental provision of financial intermediaries can all play a role in expanding the market for off-grid renewable energy services. This memorandum outlines actions a government can take to stimulate the growth of renewable energy markets and reviews case studies from three countries.

The three case studies represent a range of governmental support for the RE market. The Nepalese government has been proactively supporting the market with subsidies and the provision of financial intermediaries. The Chilean government represents a less intrusive model, providing utilities with some subsidies in a concessionary model for provision of rural energy services. In Kenya the government has had a hands-off approach and the market has flourished. However, there have been some market failures that could be addressed with minimal governmental intervention and market distortion.

Governmental Policies

Favorable policy of local and national governments is crucial to rural, off-grid renewable energy development. Without these policies renewable energy projects become expensive, difficult or simply too time consuming for technicians or entrepreneurs to complete. The following is a list of policies that support the sustainable growth of RE markets.

<u>National Level</u>

1. There needs to be a clear national policy for supporting RE development for rural energy needs. Governments need to recognize that off-grid rural electrification is often the least cost method of providing rural energy services. Though many governments subsidize grid expansion, equivalent assistance may not be offered for provision of renewable energy services. Subsidies equal to those granted for grid expansion should be available for financing off-grid projects.
2. Import tariffs and tax structures have a large impact on the cost of RE technologies. While it is important to support domestic industries, high import tariffs on hardware that is not well made domestically can hinder the growth of the RE market. Governments need to actively differentiate tariff structures to promote the development of high quality RE products.
3. Governmental support for credit lines through banks and lending institutions is critical for renewable energy markets. Governments can support RE development without major expenditures by guaranteeing RE loans.

4. Creation of a national certification and labeling program for RE hardware systems can protect consumers from low quality products. Even small quantities of low quality hardware can be detrimental to a growing market by reducing customer satisfaction and giving the entire industry a bad reputation. A domestic hardware testing center and a mandatory labeling program can be created without great expense to ensure that venders/installers and end-users are better informed about their decisions.
5. Though governmental support is often critical to jumpstart the RE market there is a growing consensus that market based dissemination is the most sustainable in the long run. Governmental support is generally required for training local technicians and installing pilot projects to generate local awareness. It is important that policymakers take the following into consideration:
   a. The importance of developing institutions that support the RE market, such as technician training and a hardware certification program.
   b. Implementing a technology neutral hardware subsidy. For instance a local government in Karnataka, Nepal has started subsidizing 40% of the hardware needed for home electrification, regardless of the energy source. This has lead to competition between RE technologies such as solar PV and hydro, which will ultimately benefit the market.
   c. "Smart Subsidies" with a clearly defined exit strategy that allows the government to withdraw when the market is self-sustaining.

<u>Local Level</u>

1. Provision of financial intermediaries is important for increasing access to RE services. National development banks can be used as intermediaries between national/multinational funding and end-users who require credit for purchasing RE systems. For example, financing in Nepal is supported through the Ag. Development bank of Nepal and local/regional institutions. Such a system could be useful in China through the Ministry of Agriculture, which has offices in 1800 of 2300 counties and is already used to distribute money.
2. Off-grid renewable energy investments are cheaper when communities and individuals can build and operate electricity generation facilities without going through regional governments and utilities. In Nepal systems under 1 MW do not need approval for off-grid development. "This has played a critical role in helping local micro-hydro entrepreneurs set a tariff which is acceptable to the community being serviced as well as being profitable to the entrepreneur running the micro-hydro plant.[i]"
3. Support ties between academia and rural energy providers is an important step in bringing together laboratory research and field experience. This brings cutting-edge technologies and ideas into an environment where the requirements of the technology are known and can be developed to best fit the local environment. This leads to two very important outcomes 1) the field to lab movement of information is crucial to appropriate hardware development, 2) active field research leads to more informed policy as those in academia often have close ties with (or are) policy makers.

Case Studies

<u>1) Nepal – Governmental Support Through Subsidies and the Provision Of Financial Intermediaries</u>

Background
The Nepalese utility is a national monopoly that is 1) dependent on foreign aid, 2) stifled by political interference and 3) an inefficient machine due to a the lack of competition. This has resulted in poor services, especially for rural peoples located far from the national grid. The national grid consists of 300MW of hydro and diesel power generation facilities. Much of this power has been very expensive to bring online and maintain, costing as much as US$4,000/kW installed[ii]. System losses are estimated at around 25% and the long-range marginal cost is reported to be US$0.11/kWh[iii]. Costs in rural areas are reported to be much higher and dependent on the area. Poor service and inefficient operation have inhibited the ability to collect enough tariffs to cover costs and expand the system. Electricity is barely available outside the urban areas and only 13% of the population is believed to have access to electricity. Due to population growth and the slow expansion of the system, there are more people each year without access to energy services. In the rural areas the percentage of people with access to electricity is approximately 5%[iv].

The government has attempted to adopt a "decentralized" electrification technique in remote districts using distributed power production facilities. However the monopolistic ownership and operations of the facilities by the national utility has continued. Thirty mini-hydro projects (5.6MW), 3 village scale solar PV projects (130kW) and 1 wind project (20kW) have been installed and until recently were all run by the utility. These projects have had the same problems as the larger generating facilities without the accompanying economies of scale and have thus required subsidies of US$160/kW just to cover operation and maintenance.

There has been a recent move within the government to support the development of decentralized technologies without the use of the national utility. The following examples provide insights on what these programs offer and how they have been constructed.

Examples of Progressive Technologies Supported by the Nepalese Government
<u>Biogas</u>
Since 1973 48,000 family sized biogas plants have been installed, half of them since 1995. Another 10,000 are expected to be in place by 2002. The gas is then used for cooking and lighting. The gas burns very cleanly with little smoke and causes none of the respiratory problems associated with burning biomass indoors.

The Biogas Support Program began in 1990, but subsidies were not granted in a consistent manner. In 1991 the program began running smoother and subsidies have been distributed efficiently since then. Biogas plants come in a range of sizes, from $4m^3$ to $20\ m^3$ with costs ranging from US$279 to $662. Individual families pay for the plants with a mix of personal equity investment, low interest loans from the Agricultural Development Bank and a well-known subsidy from the government. The size of the subsidy varies with the remoteness of the region to account for higher transportation costs. The costs are as follows: US$103 for flat areas, $147 for hilly districts and $176 for the remote hills. This subsidy is meant to be higher for smaller plants as a percent of total cost. The subsidies come from the Nepalese, German and Dutch governments. Credit is provided through the regional offices of the Agricultural Development Bank of Nepal. There are over 40 companies that manufacture the systems, which are standardized to make certification easier. The subsidy has been very effective at jump-starting the industry and leveraging high quality installations and competition between many suppliers. This resulted in the real price of biogas dropping 20% between 1993 and 1998[v].

Government subsidies have been justified for environmental (reduction of firewood consumption), social equity (less time spent by women in collecting firewood), and health reasons (reduced smoke in kitchen has positive impact for women and children).

Micro-hydropower

There are over 2000 micro-hydro units in Nepal, ranging from 0.5kW to 100kW. The plants are used for both electricity generation and mechanical milling of agricultural products. Rural entrepreneurs that own the mills collect fees from local villagers for the services they provide. It is estimated that 10% of the population makes use of these micro-hydro powered mills. The mechanical mills greatly reduce the amount of hard labor for women, allowing them to engage in other wage earning activities or pursue reading classes. The mechanical mills do not receive subsidies but do get loans from the Agricultural Development Bank.

In 1984 the government began allowing private investors to build and operate hydropower facilities for the sale of electricity. Plants up to 100kW could be built without permits and in 1992 this limit was raised to 1MW. There are now 11 manufacturing and installation companies building micro-hydro hardware in Nepal and over 500 plants have been installed with good results. The industry produces approximately 2 MW of turbines annually[vi]. The larger plants (>20kW) are often supported by local NGO's and owned cooperatively by user groups. The costs associated with these plants range from US$1,200/kW to $3,000/kW[vii].

The Nepalese government has been subsidizing these installations since 1984, but until 1993 subsidies were not granted in a consistent manner. In 1993 the subsidization process became more formal, with subsidies and loans coming through the local branches of the Nepalese Agricultural Development Bank. Electrical generation facilities are now subsidized based on the type of ownership, with communally owned plants receiving an 80% subsidy and privately owned plants receiving a 20% subsidy. Subsidy allotments are granted at a flat rate independent of the location of the installation. This has resulted in a concentration of installations surrounding manufacturing plants because transportation costs to remote areas is prohibitive.

Solar PV

Over the last 4 years around 3000 solar home systems have been installed in Nepal. There are three main companies that supply PV equipment and provide installation services through dealers and agents. The companies provide guarantees for the panels, batteries and lights. Most systems are 36W and cost approximately US$490. The government provides a flat subsidy of US$221 (45% of the system cost). Farmers supply a down payment of US$79 and take a loan from the Agricultural Development Bank for the remainder. The subsidy was consumed within 3 months and by the end of the year there were 8000 people waiting to receive the subsidy.

Lessons Learned

1) Government Subsidies

For subsidies to be successful at developing the commercial aspect of the rural energy sector they must be long-term and must facilitate high quality systems in a competitive commercial market. The high growth in the biogas market can be traced to the Biogas Support Program maintaining a constant subsidy policy since 1992. There are over forty companies certified to build biogas plants by the Biogas Support Program, and the competition prevents the subsidy from going to increase commercial profits. Instead, as companies get better at manufacturing and installing biogas systems the low costs are passed on to end-users. System quality is maintained by the fact that future subsidies are based on the success of former installations. The subsidy is also based on a uniform plant design, facilitating enforcement of quality control.

The most important aspect of the micro-hydro policy has been the de-licensing of installations less than 1 MW. This has allowed project developers to proceed without permitting delays and fees. The subsidy may need to be adjusted to account for the remoteness of the installation. Similar to the biogas subsidy, remote installations should receive a higher subsidy to account for higher transportation costs.

The solar home system subsidy has not been as successful. The subsidy has been too high, causing it to be depleted 3 months into the program and leaving a large unserved population waiting to receive funding from the program. To increase the effectiveness of the program the government could reduce the allotted subsidies as well as increase the total amount set aside for the program. The subsidy has had a negative impact on the market, by causing a boom and bust industry that creates consumer discontent and greatly increases the cost of doing business.

2) Government Supplied Intermediaries
The government can facilitate successful markets, with little cost, by providing intermediaries for financing RE systems. The Agricultural Development Bank has been a link between international donors and the rural population. Providing this link reduces transactions costs and risk for large lending institutions and provides local assistance and capital to end-users.

3) Ownership
Private ownership is much simpler and tends to be more successful than community owned projects. Community owned projects can be extremely tricky to administer and are unlikely to succeed unless the community is homogeneous and there is an NGO that is prepared to work with the community over the long term.

2) Chile – Concessionary Approach With Governmental Provision Of Subsidies To Promote Rural Energy Services

Background
In 1994 the government of Chile initiated a program to bring the percentage of electrified rural households from 50% to 85% by the year 2000. This would provide new service to approximately 195,000 households[viii]. The program has been very successful at stimulating existing utilities to provide electricity services to low density rural populations and several projects have been implemented which utilize renewable energy technologies. Governmental subsidies have been channeled through the regional governments and to the local utilities to provide financing to reduce the initial capital investment required to provide rural energy services.

The utility industry in Chile is comprised of private utilities that generate and distribute electricity. Rural electric cooperatives are engaged in distributing electricity services as well, but the private utilities are better capitalized and tend to be better organized and operated. Concessions are not granted on a regional basis and there are locations where up to three utilities compete to provide services to the local population. Because of low load densities there may not be enough consumption to warrant multiple utilities in a rural area, whereas one utility could be profitable. This has lead to fierce competition in some regions as utilities attempt to achieve monopoly holds on newly electrified areas.

The Rural Electrification Program:

The Rural Electrification Program (PER) has been jumpstarted by the Chilean National Energy Commission (CNE). The CNE has provided only a small amount of funds, but has been a major factor in regional education and evaluation of the program as well as creating political support for rural electrification. PER decisions are made at the regional level. Program funding comes from the Chilean government and a loan from the Inter-American Development Bank that is then funneled through the National Fund for Rural Development. Recently the success of the rural electrification program has garnered further funding from the Chilean government. The National Fund then provides funding to each region based on the projected need of that region and the demonstrated ability of the regional government to use the funds effectively.

Local governments solicit proposals from the electric utilities and cooperatives for providing service to rural communities through the rural electrification program. The proposals that are able to serve rural customers with the smallest subsidy per customer are then ranked from highest to lowest and the funding is distributed to the most cost effective projects until it is exhausted. This process foments competition between the electricity distributors to provide services to the rural populations. Funding is dispersed when projects are initiated. No family can be authorized for more than one subsidy.

In the beginning of the rural electrification program there was no emphasis on alternatives to the standard grid extension programs that the utilities had been performing. However, due to economic considerations it became obvious that off-grid technologies would prove to be more cost effective for remote, low-density areas. In 1995 CNE began to utilize the rural electrification program to encourage alternative technology options in areas with the lowest rural electrification coverage.

Project evaluation

Modeling Economic Feasibility:

Projects must be deemed economically feasible from a social benefit perspective. The Gross Social Benefit (GSB) of the project is calculated by estimating the current cost (P_0) and consumption (Q_0) of energy services and comparing that to the forecasted cost (P_1) and consumption (Q_1) after the utility has provided electricity. An example of the equation is as follows[ix]:

Where; $$e = \frac{\ln(Q_0 / Q_1)}{\ln(P_0 / P_1)}$$

And; $$a = \frac{Q_0}{P_0 \wedge e}$$

If e=-1 then; GSB = $$P_0 * Q_0 + [a * (\ln(Q_1) - \ln(Q_0))]$$

$$P_0 * Q_0 + e * \left[\frac{\left(Q_1 \wedge \left(\frac{1+e}{e}\right) - Q_0 \wedge \left(\frac{1+e}{e}\right) \right)}{(1+e) * a \wedge (1/e)} \right]$$

Otherwise; GSB =

Where: Q_0 = Energy consumption before electrification in kWh equivalent
Q_1 = Energy consumption after electrification in kWh equivalent
P_0 = Price of energy before electrification in local currency
P_1 = Price of energy after electrification in local currency
ln = the natural log

To estimate the Gross Social Benefit of an entire project, families are grouped into socio-economic status to estimate consumption level and the GSB is calculated for each group. The GSB is then summed for all groups. The economic Net Present Value is then calculated over 30 years (the estimated lifetime of the project) and compared to the project cost. If the 30 year Net Present Value is greater than the cost of the project then it is deemed to be socially desirable.

Modeling Financial Feasibility:

If the project has a positive Internal Rate of Return it will not qualify for a subsidy as a private utility should perform the project without government assistance. The financial analysis is a traditional analysis of the project's financial net present value over the 30-year project lifetime. The analysis covers all costs including; labor, materials, operation, management, and replacement parts. To be a profitable venture, the net annual cash flow from fee collections must cover all costs and yield a return on investment. For the rural electrification program there will be a shortfall in revenues. The approved projects receive a subsidy which covers the shortfall in annual revenue plus the amount required to give the executing utility a "reasonable" rate of return on the investment. The subsidy is therefore meant to make these projects worthwhile to utilities without distorting the market.

Example: Renewable Energy Project

The private utility Emelectic has signed a 20 year contract with two municipalities to provide solar power to around 120 households. The Rural Electrification Program subsidy paid for over 90% of the capital cost of the installation, while the remainder was paid for by end-users and the utility. The end-users will pay a fixed tariff of ~ US$8/month for a 160Wp system that provides 220VAC/50Hz electricity. The tariff is meant to cover maintenance and replacement parts but will not recover the capital investment. Since the project has only been in place for a few years, the question remains about the ability of the tariff to cover large part replacements, such as batteries over the 30-year project lifetime.

Service

Service to date has been very good over the first two years of operation. The average amount of days without service has been 6 days and 1day (per year) for the different municipalities. A small number of controllers have had to be replaced, but consumer satisfaction has remained very high. The systems are located at around 35 degrees south latitude, and receive low insolation in the winter. However, the 160 Wp provides up to 500 Wh of power per day for much of the year, which has been a satisfactory level to date.

Model Accuracy

The post installation demand was estimated to be 8 kWh/month (Q_1), which was a low estimate based on winter usage. This estimate yielded a Gross Social Benefit of US$ 331 per family and a positive Net Present Value of US$ 670 at 12% over 20 years. However there are two interesting things to note after two years of service. The first is that people are not using the systems as much as forecasted. Families are only consuming about 115Whrs per day (3.45 kWh/month), which would result in a lower Gross Social Benefit and Net Present Value than estimated. The second point of interest is that the solar systems have not been used to offset other expenditures for energy services. Families are spending the same amount of money for batteries and kerosene as they were before the systems were installed, in addition to paying for their new electricity service. Therefore, the final price that families are paying for energy services (P_1) is much higher than estimated. This largely arises from the fact that there is interference from the inverter, prohibiting the use of radios and inverters together.

These two points lead to an interesting situation. If the reduced final consumption (Q_1) and increased final price (P_1) had been accounted for in the model the project would not have proceeded because it would have appeared that the end-users would not be receiving enough energy services to justify the expense. However, end-users have continued to express satisfaction with their service, indicating that there is a higher willingness to pay that originally estimated in the model. Therefore, the model may need adjustment to account for the fact that consumers are willing to pay more for better energy service. Originally the model was set up to provide an equivalent service for an equivalent price, this does not appear to be the case.

Lessons Learned

Shortfalls of the Evaluation Methodology with Respect to Renewable Energy Technologies
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1) Model Definitions: The model defines an electrified household as one receiving 220VAC, 50Hz electricity with 24 hour availability. Utility executives, engineers and electricians are familiar with 220VAC and prefer to work with that type of electricity. However, this level of electricity requires hardware that may not be necessary for rural applications and is more likely to require maintenance than simple DC only systems. This may be one reason that the off grid systems in Chile are so expensive.

There is also no preference given to renewable energy technologies for their positive environmental benefits when compared to grid extension and fossil fuel generated electricity. The model does not differentiate between clean and dirty electricity within the household. There is no greater benefit for “clean” PV generated lighting over “dirty” kerosene light – even though consumers have been happy to pay higher prices for cleaner light sources. The model does not provide a way to differentiate between energy sources, because energy consumption (Q) is the only measurement of energy

2) Load Growth: Load growth is a long-term problem for the utilities attempting to implement renewable energy projects in Chile. Renewable energy installations are more restrictive to load growth than grid extension projects because of the set limitations of a particular renewable energy installation. Renewable energy systems are designed for a given load and maximum level of service and any expansion requires new hardware to be purchased and installed. Because the

PER/FNDR subsidy is only allowed once for each household in Chile, implementing utilities will be responsible for all capital costs of future expansions. This may cause utilities to design systems that are too large for current energy needs, enabling the household to “grow into” the system. The higher costs of these systems may prohibit households from participating and could jeopardize the long-term viability of the systems.

3) Energy Efficiency: The program can discourage energy efficiency. In the economic analysis, a project receives a higher score when the electricity consumed after project completion is higher. Therefore, the use of incandescent lighting is superior to energy efficient fluorescent lighting as it will increase final consumption (Q_1), resulting in a higher Gross Social Benefit and a higher likelihood of receiving a subsidy. This becomes especially important in the case of distributed energy technologies, when lower consumption and flatter load profiles can dramatically reduce the installed cost.

At this time in stand alone renewable energy systems, some appliances, such as efficient lamps, are now included in the initial installation. Though utility staff and electricians did not initially like this proactive approach it is now commonplace in renewable energy installations. Users are charged for the increased costs of efficient appliances over the first few months of their energy bill, allowing them to spread the cost over a longer period of time. However, the model still penalizes the use of energy efficient appliances and therefore disadvantages RE installations.

3) Kenya –Development of Solar Industry Without Governmental Assistance: options for creating a stronger market

Background

Kenya has developed one of the largest markets for solar home systems in the world despite a lack of governmental subsidies or assistance. The only assistance the government has granted was the removal of import tariffs for all types of solar panels[1]. Approximately 150,000 systems have been installed, with another 20,000 new systems purchased annually[x]. Because of the lack of governmental intervention there have been no system standardization or certification procedures. This situation has lead to an information market failure in which vendors and end-users must make all purchasing decisions with little knowledge of the quality of the hardware or the qualifications of the technician installing the hardware. Many Kenyans who have made investments equivalent to a 1-year salary have purchased PV systems that were: 1) of questionable quality and/or 2) never installed properly and therefore quickly ceased to function. Though the government has not been proactive to date, solar home systems provide the lowest cost route to electrifying rural populations. If the Kenyan government were to invest in certification and quality standards of PV systems the market could benefit as a whole, resulting in more rapid dissemination of solar home systems throughout the country.

Reasons for Certification/Quality Standards

The need for certification and standards is especially prevalent with off-grid renewable energy systems for a variety of reasons.

[1] The Kenyan government removed all import tariffs on PV modules in 1986, but reintroduced them in 1992. The 1992 tax was lower on amorphous silicon modules than on chrystalline modules. In 1996 de facto taxes were reduced to 5% for both types of panels only to be removed again entirely in June of 2000.

1. Solar panel performance is difficult to measure in the field. Owners may not realize that their solar system is not operating at expected levels because the battery will continue to power the loads with sub-optimal charging from the solar panel.
2. Battery failure is common. Once the battery fails the user still may not understand that the problem rests with the module because they expect battery failure and may go purchase a new battery. This will "fix" the problem until the new battery fails.
3. Vendors/Installers may not have the ability to accurately measure solar panel output. PV panels are warrantied at a certain level, generally within 10% of their rated output. Most vendors and technicians do not have the ability to measure PV output within a 10% margin of error, rendering it all but impossible to find out if a panel needs to be replaced without sending it back to the manufacturer at significant cost and inconvenience to the end-user.
4. End-users have little information about their solar systems. Survey data indicate that almost all solar home system owners do not know what brand of module they own let alone knowledge about manufacturers warranties[xi].
5. Vendors/Installers may not disseminate or honor manufacturers warranties. Honoring warranties can be expensive and time consuming for businesses with little incentive to cater to people who have already purchased a system.
6. Saturation of solar home systems is very light, making information transfer about bad brands/vendors/installers slow and imperfect. Because of the light saturation there are plenty of potential customers with no knowledge of the brands and/or businesses to avoid.

<u>Ramifications of Low Quality Product Infiltration</u>

The infiltration of low quality products into the market can have a negative effect on the rate of solar home system dissemination. Because of the imperfect transfer of knowledge regarding which products are failing, the entire solar home system market receives a stigma when in reality it is only a few products which should be avoided. This can severely impact the rate of SHS purchases at the local level as well as reducing governmental support for a technology that is viewed as "non-functional".

Corrective Actions

1) <u>Warranties</u>

Manufacturers can attempt to solve the quality issue by strengthening warranties and facilitating the return of faulty modules. This would allow the industry to take care of the issue, without bringing the government or third party actors into the situation. In Kenya the use of warranties for the replacement of faulty modules has been insignificant. In a study by Duke *et al.* (2000), it was discovered that all the panels from one manufacturer were operating at less than 75% of rated power, and while 90% of them were still covered by warranty, only 10% of them had been returned to the manufacturer. This shows that warranties have not proven to be an effective measure of assuring panel quality in the Kenyan market.

There are several steps that manufacturers can take to increase the use of warranties in the SHS market. The following is a list of possible solutions[xii]:

1. Issue clear instructions to vendors that they expect warranties to be honored, cooperating fully in processing returns, and covering the cost of shipping modules to and from rural supply shops (ideally including a handling fee to cover time and incidental expenses);

2. Provide vendors with instructions and simple meters for basic module output tests sufficiently accurate to detect severe under-performance;
3. Include a short version of the owner's warranty rights on the permanent module label;
4. Increase the length of their warranty;
5. Offer customers a super-warranty (*e.g.* providing two replacement panels to any customer who returns a substandard module);
6. Disclose the number of returns processed under warranty.

These steps will increase the cost of operation for the manufacturer, but the increased efficacy of the warranties will result in a stronger solar market.

2) <u>National Performance Testing and Information Dissemination</u>
A non-governmental, non-industry related third party could develop a testing facility to test module performance and disseminate the information to manufacturers, vendors, and end-users. Jacobson *et al.* reports that an outdoor testing facility can be developed for less than US$10,000 and sustained for approximately $20,000 per year[xiii]. This model assumes that panels would be donated by the manufacturers for testing and returned after the testing is complete. An indoor testing laboratory is also an option, but would greatly increase the cost of the program. The program could be funded by a 1% surcharge on solar home system sales within the country, or by an outside donor such as the GEF.

Such a program should have a recognizable label that is easy to understand by all potential users. National certification can be better than participating in an international certification program for two reasons. 1) International programs, such as PVGAP, can test many factors beyond just module performance and are therefore expensive for the manufacturer to participate in, 2) Most international programs offer a pass-no pass certification that is easy to understand but reduces consumer information and can be taken advantage of by manufacturers who produce their own "seal of approval". (**There will be another document outlining international certification programs forthcoming**). Were a manufacturer to falsify a national certification seal they would be susceptible to legal challenges, whereas it is difficult to litigate against a manufacturer that creates a seal of approval that looks similar to one from an international certification program.

This type of program could have positive effects on the industry at many levels. New information and the threat of lower market penetration could force manufacturers of low quality panels to increase module performance. Knowledge of module quality could help vendors and installers, intent on keeping the market growing, to shift away from bad manufacturers. Finally, information on panel quality can help end-users make better purchasing decisions. However, there is no guarantee that end-users will trust or understand what the certification means, reducing the value of such a program to module buyers.

3) <u>Domestic Minimum Quality Standards</u>
Minimum quality standards require a more aggressive stance by national governments for prohibiting imports and sales of low quality panels. Minimum standards address the problem that a certification and labeling program does not directly protect consumers from buying sub-standard solar panels. Standards do protect the end-users, but not without possible drawbacks. 1) Corruption within the system could result in market manipulation, such as domestic

manufacturers increasing import barriers, 2) Standards may add time and cost to the importation process. 3) If the domestic standardization requirements are similar to international standards, a manufacturer may choose not to pay the testing costs of a particular country. 4) If the standard is too stringent and difficult to test for, small manufacturers or newer companies may not be able to pay for testing procedures. Items three and four would result in fewer market players and could significantly reduce competition within any particular country.

The following is an outline of a hypothetical program for PV modules postulated by Duke *et al.* 2001. This model uses both international and domestic testing programs to minimize the impact on the market while maximizing consumer benefits.

Hypothetical Domestic Standards Program[xiv]

1. PV panel brands that are IEC, PowerMark, or PVGAP certified internationally receive a "Grade A" label; IEC, PowerMark, or PVGAP certification exempts them from any domestic testing.
2. PV panel brands that are not internationally certified can apply to be tested domestically by an appropriate agency. Modules that pass this domestic test receive a “Grade B” approved label.
    a. The domestic testing regime should be simple and inexpensive (*e.g.* the approach outlined in the “Performance Testing and Disclosure” section and described in Jacobson, *et al.*, 2000).
    b. The modules to be tested under the domestic program should be selected at random from vendors in the domestic market. A sample size of approximately 10 modules should give reasonable levels of accuracy. The applicant company should cover the cost of the testing.
    c. No module in the sample should perform at below 90% of its rated power level. If a module does perform at below 90% of rated, the manufacturer/importer has two options:
        i. de-rate the modules to the average output from the sample of 10 and sell them at this lower power rating, or
        ii. secure IEC or PVGAP certification through an international testing program
3. PV panels that do not have either a “Grade A” or a “Grade B” label cannot be sold domestically.
4. Applicant companies should renew the label status of their panels every 3 years.
5. To ensure the integrity of the process:
    a. Manufacturers whose panels perform poorly should be able to "contest" the domestic test by paying to have a random sample of their modules' power output tested by an internationally certified and neutral testing lab such as NREL in the USA;
    b. Manufacturers can also pay to "contest" the results of tests on competing brands (*i.e.* if Brand X passes the test, but the manufacturer or importer of Brand Y thinks that the modules perform below the level of the test results, then they can contest the outcome).

The benefits of this regime are: 1) companies that have already paid for and received certification from an international program can bypass the domestic program, 2) small companies that sell good products but cannot afford international testing programs are allowed to sell in the country with little additional expense, 3) low quality panels will not be sold in the country, 4) manufacturers can appeal to another institution, at their own expense, if they are unsatisfied with the results.

4) Balance of System/Installation Quality Management
Balance of system (BOS) components and installation have as much to do with system success as photovoltaic modules. Non-module costs already represent more than 50% of system costs[xv]. This percentage is likely to go up, as PV module costs are expected to drop faster than more mature BOS technologies, such as batteries. Installation quality also has a dramatic effect on system performance. Technicians that do not properly install system components or design underpowered systems, doom the customer to unsatisfactory performance and a short system life. Any country that creates a certification and labeling program or mandates minimum standards for PV modules should also be proactive on creating policies for BOS components and technicians.

Unfortunately many of the problems that make certification, standardization and information dissemination difficult with PV modules are also present with BOS and installation quality management (see - Reasons for Certification/Quality Standards). It is very difficult for an end-user to discern between a faulty installation, a bad module, loose connections, incorrect wire sizes, a bad battery, an underpowered system, or any combination of the above. Therefore, encouraging manufacturers to strengthen warranties or participate in a certification program can increase value to the end-user. It should be noted that the large international certification programs, like PVGAP, are often too expensive for local or domestic manufacturers and installers to participate in. Since it is these businesses that dominate the SHS market, requiring that all system components be internationally certified could drive up system costs, closing the market for most end-users. Thus it is important to start out with warranty programs and possibly move up to domestic certification or standardization programs that do not greatly increase the cost of SHS.

Conclusion
Governments can play a wide variety of roles in supporting rural, non-grid renewable energy markets. A consistent policy with long-term goals can be just as valuable as the provision of financial subsidies for the growing RE markets. It is imperative that there is an environment of support for renewable energy technologies with the understanding that they represent a viable option for the provision of rural energy services. The following governmental policies and actions are key to developing a sustainable market for off-grid renewable energy technologies:
1) Provide financial intermediaries to bridge the gap between multinational and domestic lending institutions and rural-end users.
2) Develop a well publicized subsidy program that is efficiently and consistently distributed.
3) Reduce or eliminate permitting requirements for off-grid renewable energy installations.
4) Policies should have a planned phase-out period dependant on a set number of criteria being met by the targeted industry. As the RE industry grows and prices fall, subsidies should be reduced to encourage a truly competitive market.
5) Import duties should not be designed to isolate the RE industry. High import duties will discourage international competition and create a domestic industry that will not compete with international manufacturers.

6) Policies must take into account the high cost of reaching remote communities. Financial subsidies should be adjusted so that those living in remote regions are not penalized for their location.
7) Do not make subsidies so high that the allotted funds are rapidly exhausted. This causes consumer frustration and distrust as well as being extremely detrimental to the growing industry.
8) Create subsidy programs that are service specific, instead of hardware specific. This will engender competition between technologies so that no one technology obtains a monopoly hold on the market.
9) When calculating the value of energy services, non-monetary aspects must be taken into account. For example, PV generated lighting is much healthier than kerosene lanterns in the indoor environment and is therefore of a higher value – even though the amount of "light", or kWh, may be the same.
10) Rural electrification does not need to mimic the electricity grid. Though AC wiring and appliances may be cheaper and more common, 12VDC systems are much simpler to install and maintain in the field.
11) Policies should always promote energy efficient designs. This will reduce system costs and increase user satisfaction throughout the life of the installation.
12) Governments can increase the quality of hardware being sold within the country by requiring that manufacturers adhere to international or domestic standards.

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