CERTIFICATION OF OFF-GRID RENEWABLE ENERGY SYSTEMS

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Introduction

The rate of dissemination of off-grid renewable energy technologies is greatly dependant on the satisfaction of end-users and therefore the quality of past installations. Many systems currently installed are not functioning at the promised levels. One of the main causes of sub-optimal system performance is the use of poorly made components and a lack of consumer education regarding the limitations of potential system output. Certification and accreditation of off-grid renewable energy system components is an important step in improving the quality of installations. It should be noted that the creation of a certification program is not an end in itself. The goal is to provide end-users with reliable high quality systems that will provide the proper amount of energy services.

Background

Over the last five years efforts have been made to develop international standards for manufacturing of off-grid renewable energy hardware. Small wind and solar home systems have received the most attention, with the International Electrotechnical Commission (IEC) developing standards for both technologies. There are two important issues with international standardization and certification programs: 1) High quality hardware does not guarantee that a system will function at optimum levels. Proper system design and installation requiring well-trained technicians as well as educated end-users that know the limitations of their systems are just as important as well built hardware. 2) Many components used in off-grid systems are manufactured by local businesses that cannot participate in international certification programs. These small businesses are integral to the development of sustainable RE industries. They supply low cost parts and develop technicians with knowledge of the hardware. The first issue will be addressed in the next document detailing technician-training programs. The second issue will be addressed in the following document.

Solar PV

International Standards for Stand Alone Photovoltaic Systems

IEC

The main body working on standards for PV systems is the International Electrotechnical Commission (IEC), which is based in Geneva, Switzerland. Technical Committee 82 was formed in 1981 and is working on standards for “Solar Photovoltaic Energy Systems”. The purpose is to prepare international performance and safety standards for PV cells, modules and systems. Working Groups 3 and 6 are focusing on stand-alone systems. Working Group 3 is working on system aspects while Working Group 6 is working on components. The development of standards through the IEC has been a long process due

to the many members involved. PV GAP has been created to produce standards that can be used as the IEC standards are formalized.

PV GAP

The Global Approval Program for Photovoltaics (PV GAP) was created in 1997 after a series of meetings within the PV community. Concerns were voiced that photovoltaics were developing a poor reputation because of poor quality products combined with improper installation and service. PV GAP was formed to promote high standards for production, installation and servicing of PV systems.

PV GAP is a non-profit, industry led, organization located in Switzerland that focuses on certifying the quality of PV systems. PV GAP publishes guidelines as well as enforcing standards that promote high quality systems. PV GAP works with large scale governmental and NGO PV programs to ensure that all products are PV GAP approved. PV GAP will use the standards developed by the IEC, but is producing its own interim standards until the IEC standards become available. Manufacturers, distributors and installers that are approved under PV GAP are licensed to use a "PV Quality Mark" for components and a "PV Quality Seal" for PV systems. PV GAP and the IEC have chosen National Supervising Inspectors (NSI's) in different countries who in turn accredit laboratories. Accredited laboratories can then test PV panels and components to obtain PV GAP Seal and/or Mark, respectively.

PV GAP has also started to work on the problem of implementing standards in developing countries. Together with the UNDP, PV GAP has selected 5 countries (China, Argentina, India, Indonesia and South Africa) to begin working on the national implementation process. In May of 1999 two documents were reviewed: "Quality Systems and Procedures Manual" for small PV manufacturing companies in developing countries and a "Quality Operations and Procedures Manual" for testing laboratories in developing countries.

PV GAP has already published the PV GAP Reference Manual that contains a list of Recommended Standards and a list of PV-applicable IEC standards. The manual also has the approval process for receiving the PV GAP Seal/Mark, and information about the approved testing laboratories. Information is available at http://www.pvgap.org/html/manuals.html.

International vs. National Certification Programs

The standards developed by the IEC and PV GAP can be used in donor based programs, but are difficult to implement in the small diffuse markets that make up a large proportion of the solar home systems market. International donor programs can stipulate what brands of hardware are used as well as limit the retailers and installers participating in the program to those that have passed certain quality tests. This is more difficult to do in rural markets that do not depend on donors. These markets often consist of small retailers who may have little information on product quality and may not be qualified to properly design and install solar home systems (see: Kenya case study in C.R.S. memorandum 'Governmental Assistance').

When instituted properly, donor-based programs that require certification of hardware and installers can have a positive influence on the non donor-based market. If the program focuses on institutional development of key governmental policies, financing mechanisms and technician training, the RE market can grow in a sustainable way that will outlive the programmatic funding. As programmatic funding runs out the personnel will shift over to thrive in a free market system using the skills, connections and knowledge gained during the life of the program.

Domestic hardware manufacturers may be unable to obtain certification by international programs due to the cost and quality requirements of the programs. These manufacturers are extremely important in the development of a thriving domestic RE market. They supply low cost products and create a knowledge base that is crucial in the development of the industry. Therefore donor-based programs should have stipulations to support the certification and participation of domestic players. The China Renewable Energy Development Project has accounted for this need by subsidizing the certification of locally made hardware.

The many aspects that need to be incorporated into a certification program are illustrated in the following figure. This figure was developed for the Solar Home System program in South Africa. Note that only two of the five categories, testing and manufacturing, are related to hardware, while the other three categories are related to technician and end-user training. Certification programs must include installation by trained technicians as well as educated end-users who know the limitations of their systems and understand the steps that can be taken if system performance begins to degrade. However, all five components must be successfully integrated to create a sustainable photovoltaic program and industry. Technician training and certification will be addressed in the next memorandum.

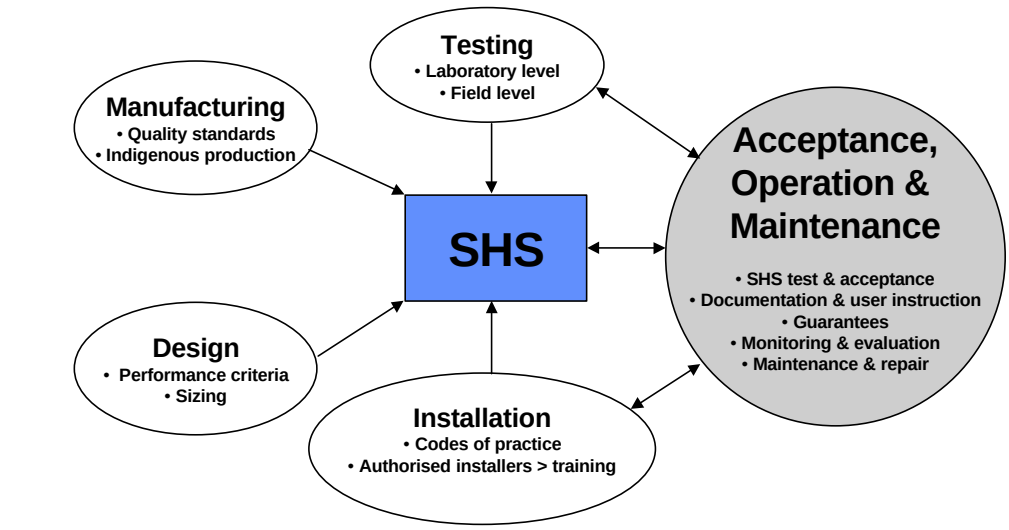

Figure 1: SHS Standards

Case Studies

Background on Quality Standards Aspects of the China Renewable Energy Development Project

The Renewable Energy Development Project is attempting to facilitate the widespread use of solar technologies by supporting development of many facets of the industry. The program will provide subsidies of $1.50/Wp to companies that agree to a set of requirements for system quality and reliability. The program is intended to drive down system costs by bringing economies of scale into the Chinese solar market, as well as increasing the quality of systems manufactured and installed in China.

The product quality aspects of the project include the provision of warranties and 'after sales service' to customers as well as the exclusive use of certified equipment. Systems equipment must be certified by an internationally recognized testing institute (with ISO 25 certification) or from a testing institution within China that has been accepted by the Project Management Office (PMO). The PMO supported testing and certification of systems during eight months in 1999, and assisted Chinese based companies by subsidizing testing costs if the hardware was found to meet the standards. This action was undertaken to develop the Chinese PV market by making sure that local companies were not excluded from participating. If hardware was not acceptable, companies were given financial and technical assistance to raise the quality of the hardware. The PMO is

supposed to make the list of certified suppliers available on the website, but has not done so yet.

The Renewable Energy Development Project has published a technical document for solar home systems and components. The document called the "Information Package for PV Solar Home Systems Specifications and Component Testing Procedures" is to be used by program participants. It is a part of the institutional strengthening aspect of the program.

Nepalese Solar Electrification Program
His Majesty's Government of Nepal has established a program to motivate investment in renewable energy during the early stages of the industry. Subsidies are meant to increase competition and viability of the renewable energy industry and to make technologies more affordable to Nepalese people. Subsidies of up to 8,000 Nepalese Rupees (US$105) are available for Solar Home Systems.

A Solar Energy Coordination Committee has been formed to organize subsidy deliveries, promote solar industries and safeguard end-user interests. The Committee advises on criteria regarding the eligibility of solar energy companies. The committee also advises on how to properly develop the solar energy industry of Nepal. The Solar Energy Support Program (SSP) and Solar Energy Test Stations (SETS) have been established under this committee to promote and disseminate information about solar energy as well as test and certify quality standards of SHS equipment. A PV market was in existence prior to the development of the subsidy program. Therefore, to aid in the development of the industry the SSP will work within the existing commercial PV market structure without preventing new actors from entering the scene. His Majesty's Government of Nepal has committed 8,262,000 Nepalese Rupees (US$104,500) for the establishment of the Solar Energy Test Station. The SETS is currently testing PV panels, balance of system components and integrated PV systems. The SETS is publishing test results and has creating a list of approved equipment and suppliers.

The main objective of the Solar Energy Support Program is to provide technical assistance to SHS manufacturers, retailers, installers and end-users. Activities include strengthening distribution networks for solar energy systems as well as qualifying companies that are manufacturing, distributing and inspecting the systems.

Solar Home System subsidies will be provided directly to the manufacturer. The Solar Energy Support Program will receive the subsidy application and make a recommendation as too whether or not it should be funded based on specified criteria. To receive a subsidy the project must meet the following criteria[1]:
1) The system must be installed within a prescribed area
2) The SHS must be installed by an SSP authorized installer
3) There must be at least 10 installations within the same locale
4) The dealers/manufacturers/suppliers must be certified by SSP to ensure proper after sales service
5) The SHS is a type/design approved by the SSP

[1] 2000, Renewable Energy Subsidy Delivery Mechanism. His Majesty's Government of Nepal Ministry of Science and Technology, Alternative Energy Promotion Center. Katmandu, Nepal. November, 2000

6) The proposed installation must not be in the area of the national grid or micro-hydro installation

The Solar Energy Support Program has developed a standard for Solar Home Systems subsidized by the Nepalese solar program. All projects must comply with this standard in order to be considered for the subsidy. The standard includes the following categories with a summary of the technical requirements[2].

Definition:	A "solar home system" is a DC photovoltaic system that provides light and some entertainment functions in a domestic environment.
Configuration:	The systems must contain a minimum of these parts. 1) A PV module greater than 10Wp, with a stipulation that the daily Amp-hours received by the panel may not be less than 1.1 times the expected daily load (while all calculations use 4.5 hours for the number of peak sun hours in Nepal) 2) A battery that can serve the expected load and serve the household for three days without power from the PV panel in case of cloudy weather of panel malfunction. 3) Lights must be compact fluorescents, tubular fluorescents or LED clusters 4) Balance of systems parts and a User Operations and Maintenance Manual
PV module:	Crystalline silicon PV modules must be approved by a third party according to IEC standard 61215. Thin-film modules must be approved by a third party according to IEC standard 61646. Or they can be approved by equivalent national or international standards
Battery:	The battery will be a flooded battery of a specific type with various quality control measures stipulating the thickness of the plates, the amount and density of the electrolyte, and a slow discharge rate.
Lights:	The lights will all be efficient enough to emit 35 lumens/Watt, be long-lived, safe and produce no interference that would disturb radio frequencies.
Charge Regulator:	The charge regulator must be one of three types, have a low power draw, protect from deep discharges, and cannot produce radio frequency disturbances.
Support Structure:	The support structure must be made of stainless steel, aluminum or galvanized iron and must withstand wind speeds up to 120km/hr and last for 15 years in an outdoor environment. The structure must be tilted to maximize solar gain.
Cables:	The cables must be "NS344-2052 PVC certified" as well as sized according to a formula that minimizes voltage drops and inefficient heat loss.

[2] 2000, Technical Standard for Solar Home Systems (SHS), Solar Energy Support Programme (SSP). Katmandu, Nepal December 2000

Switches:	Switches should be certified as “IS 1087 Switches, tumbler for AC/DC single pole 5 Ampere”
Sockets:	Only DC sockets should be used and it should not be possible to reverse the polarity.
Fuses:	Must be rated for DC service and should be sized 25%-50% larger that maximum estimate current.
Installation:	The system must be installed by a certified technician who passed the Solar Electric Technician L-1 skill test.
User Manual:	A manual with pictures and easy to understand Nepali narration should be provided that covers: PV basics, description of SHS components, operation and maintenance procedures, Do’s and Don’ts, contacts for manufacturers/installers.
Identification:	A permanent nameplate must be attached to the system that shows: name of manufacturer, model number, serial number of system, and serial number of installation technician.
Type Approval:	SHS components must be approved by a third party testing laboratory according to the above listed standards. The laboratory should be IECQ qualified. Components manufactured in Nepal must be approved by 1) the Institute of Engineering or 2) Nepal Bureau of Standards and Metrology.
Quality Assurance:	All manufacturers will also need to have a quality assurance program in place. There are several acceptable quality assurance programs: PV-GAP, IEC, ISO 9000, and the Nepal Interim PV Quality Assurance Program.

The Nepalese subsidy program addresses all five categories shown in Figure 1.

1) Testing - SHS testing is carried out at the Solar Energy Testing Station
2) Manufacturing – Quality is verified by either international or domestic third party testing agencies. Indigenous capacity is not stifled, but assisted by the SSP.
3) Design – The standard requires that systems are of a certain size compared to the load, and that components are of sufficient size and type.
4) Installation – Only certified installers are allowed to install systems through the subsidy program.
5) Acceptance, Operations and Maintenance – After sales service is required in the program and all installations must have hardware and installer information on a permanent nameplate. Easily understood manuals written in Nepali are also required to increase end-user education.

Conclusion

Certification programs will strongly effect the development of renewable energy industries. Well-installed systems with satisfied users will do more for promoting renewable energy than any advertising or educational campaign. Certification programs are most effectively utilized in international and national renewable energy programs, that require some type of application to receive funding. They are not as successful at the free market level, because there is no body to enforce the use of certified equipment and installers. However, certification programs can help the formation of a sustainable free market industry when instituted properly. Certification programs can mandate that distributors increase technician training, use high quality components and provide after-

sales service contracts. A national or international renewable energy program will be deemed a success when these practices become standard procedure for the distributor/installer even when the system is not subsidized.

International certifying bodies such as the IEC and PVGAP will help the industry by increasing the quality of hardware sold by multinational players. However, many small manufacturers will not be able to afford the testing fees. These local players are essential to the development of a sustainable renewable energy market and should be assisted by any government attempting to grow its renewable energy industry.

The Nepalese Solar Electrification Program provides a good example of how to increase the quality of solar home systems while including local manufacturers and installers. The program uses a simple set of criteria that mandates the use of certified hardware and installers while allowing local industries to participate. The standard allows flexibility in design as long as certain qualities are met, thus installers can modify the installation depending on the site while ensuring a high quality installation.