QUALITY ASSURANCE OF SOLAR HOME SYSTEMS IN NEPAL

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ABSTRACT: In Nepal 89% of the rural population is without access to electricity, and it is very tedious and expensive to extend the grid in the remote mountain areas. Micro hydro and solar electricity has therefore become an increasingly popular solution and has been supported by Danida, the Danish developing agency. In order to keep low quality products and installations out of the subsidised PV market, it was decided on an early stage to implement a quality assurance system with the following elements: 1) A basic training and certification of installers. 2) Introduction of minimum standards for BOS components and modules. 3) Establishment of a national solar energy test station (SETS) with the capability to check the performance of the system components. 4) Random inspection of the installations by a group of trained consultants. The approach for establishment of SETS has been to transfer the experience from Solar Energy Centre Denmark in a close dialogue with the local employees.

Keywords: Developing Countries, Qualification and Testing, Solar Home System

1 INTRODUCTION

The sun is blessing Nepal with abundant amounts of energy, of which a tiny fraction is already made useful to its citizens through the provision of hot water and electricity. However, for an accelerated dissemination of systems for solar energy conversion, improved economy and user satisfaction is mandatory.

Solar energy is practically the only possible source of electricity in the remote areas of Nepal within a foreseeable future due to the very high costs of conventional electrification in the mountains.

Nepal has a well-established network of suppliers of solar PV systems, which has been sold on commercial basis since the early 90ties. However the quality has not always fulfilled the users expectations.

Since 1999 Danida's Energy Sector Assistance Programme (ESAP) has supported the dissemination of solar electricity in co-operation with Nepal's Alternative Energy Promotion Centre (AEPC) with the main purpose of poverty alleviation in the least developed regions of Nepal. It has until now resulted in about 15,000 solar home systems out of 25,000 planned for phase I.

In order to ensure a high quality of the subsidised PV systems, certain minimum standards have been agreed with the local manufacturers, and a local testing laboratory has been established to check the solar home system components available on the market.

2 STRATEGY FOR PROMOTION OF PV

The promotion of solar home systems has taken place through promotion activities, campaigns, and through financial support of up to 50% of system costs in the remote and very remote areas. One important message of the campaigns has been that the customers should be conscious about quality, which is not regular practice in rural Nepal.

2.1 Solar Energy Support Programme (SSP)

The SSP is the framework for co-ordination between Danida and the local counterparts. SSP is the forum where the major discussions regarding the support are taken with the solar PV industry. In brief, the procedure has been:

1) Qualification of local companies eligible for participation in SSP
2) Acceptance of interim technical standard (NIPQA)
3) Agreement with industry on test fees
4) Establishment of test facility
5) Adjustment of technical standards

It has been of particular importance to have consensus with the local industry, because a local commercial market already existed and should not be destroyed by a massive subsidy program, for example by only using components from big international suppliers.

2.2 Cash flow

Without money, no development. In this case 90% support is given from Danida, 10% from government of Nepal. The subsidies are administered by the Interim Rural Energy Fund (IREF). For every system sold, the installation company will claim a subsidy depending on the location of the system, the highest subsidy will be in the very remote areas. The subsidy ranges from 30-50% of the total cost. The subsidy percentage will be gradually reduced through the programme period.

2.3 Quality aspects

The number of manufacturers has been growing steadily, and at present 14 companies are qualified for support. With the increasing sales many new and inexperienced companies are expected to enter the scene, and this will of course be a challenge to handle for SSP. The mechanism for exclusion of "hit-and-run" companies

and inferior products is composed of:

- Qualification based on prior experience
- Training of installers
- Approval of components
- Field inspections
- Comprehensive database
- Feed-back for corrective actions

Companies that cannot fulfil the technical standards or are not honest in their applications will be expelled from the shortlist of approved PV system suppliers.

2.4 Environmental aspects

The main objective for introduction of solar home systems (SHS) has not just been emission reduction from the kerosene or oil lamps normally used by the rural population with obvious negative health effects. Instead focus has been on improved lifestyle, reading and production opportunity for the poorest part of the population.

However the possible negative environmental aspects from disposal of lead-acid batteries have been addressed through integration with a general program for collection and recycling of all kind of lead-acid batteries in Nepal.

Considering the comprehensive approach and the good results verified in the field, the Nepal program is being seen as a model PV dissemination program in the world.

Figure 1. A proud PV system owner in a remote village

3 MARKET SITUATION

Solar PV System sales have been steadily increasing since beginning of the support program, so there are now around 30,000 PV systems in total in Nepal, including telecommunication and pumping systems. [5] At current only a few qualified companies are manufacturing balance-of-system (BOS) components locally, in particular lamps and charge regulators.

Most other products are imported from other countries of South and East Asia as finally or partly assembled. One company has a module lamination facility but it has not been used due to unsteady power supply, leading to many scrap modules.

The quality of the products is ranging from poor to perfect, so there is obviously a need to assist with product development. The variable quality is partly due to difficulties to find quality electronic components locally and the lack of knowledge on hot to test them.

4 SOLAR ENERGY TEST STATION (SETS)

With assistance from the Danida, a Solar Energy Test Station (SETS) has recently been established in Nepal, with the aim to perform quality assurance of solar energy systems.

Scope of work for SETS is:

- To perform measurements and quality control of solar energy components and systems eligible for financial support under the Solar energy Support Program (SSP)
- To assist Nepalese manufacturers of solar energy systems and components with product development
- To assist the Solar energy Support Program with technical information, standards development, international trends in solar energy, etc.
- To conduct research and development (R&D) as well as training.

The job of establishing SETS has been contracted by Danida to Solar Energy Centre Denmark (SECD), and involves planning, equipment purchase, installation, training of staff and a long term twinning arrangement.

4.1 Stakeholders

SETS is a collaborative project among Royal Nepal Academy of Science and Technology (RONAST), Alternative Energy Promotion Centre (AEPC), Solar Electric Manufacturers Association of Nepal (SEMAN), Nepal Bureau of Standards and Metrology (NBSM) and Danida´s Energy Sector Assistance Programme (ESAP). It is located in the Instrumentation Centre Building of RONAST on Khumaltar. SETS is an independent institution, governed by a managing board con sisting of the above institutions.

The mix of board members ensures that donor, government and private sector interests are well balanced. Furthermore, the location in a national R&D institution should facilitate the linkage to the academic and scientific society of Nepal.

4.2 Implementation of a Solar Energy Test Station

The project approach followed by SECD for the implementation can be summarised as:

- Stepwise purchase and installation of measurement equipment
- Partial use of local equipment suppliers
- Learning by doing
- Quality assurance (QA) system integrated from beginning
- Long term twinning arrangement
- Low running costs

This project approach has ensured a high degree of local involvement in the project, but has not always been easy to follow. For example some quality instruments had to be purchased from international suppliers.

SETS has now been in regular operation since summer 2001 and is capable of testing all common solar home system components.

4.3 Feed back of experience

One of the essential purposes of SETS is to increase the quality level of the industry by giving useful feedback of test results, being it from the laboratory or the field. It is planned that SETS should inspect 1% of the installed

systems annually, in order to record as much practical experience as possible.

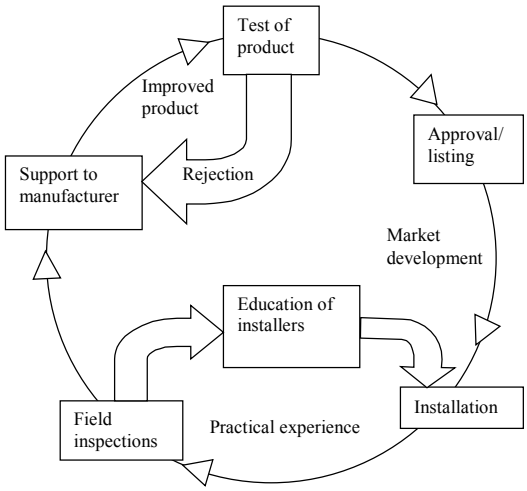

Figure 2: "The good circle"

SETS is conducting interaction programs with manufacturers in order to share the experiences form tests and ideas in the field of BOS components development.

As the test results are confidential, and direct feed back based on the reports is therefore not possible, the interaction program and result analysis will be helpful to each manufacturer to have a general overview of quality of the market. Besides interaction SETS also conduct the training program for the technicians from the manufacturers in topic of quality product development and testing.

4.4 Sustainability

It would have been easy to establish and run SETS for the entire project period with donor aid. However, the benefit for Nepal would then be very limited in the long run. Therefore it is the intention that SETS will become partly or fully paid by its clients in the future. Already now, the manufacturers pay a certain test fee to SETS for every system they sell, sufficient to cover the running costs. In return, if the products are approved, they can be sold with subsidy. The test report may also be used as documentation in their marketing efforts. If products are not approved, SETS will advice on how to overcome the problem.

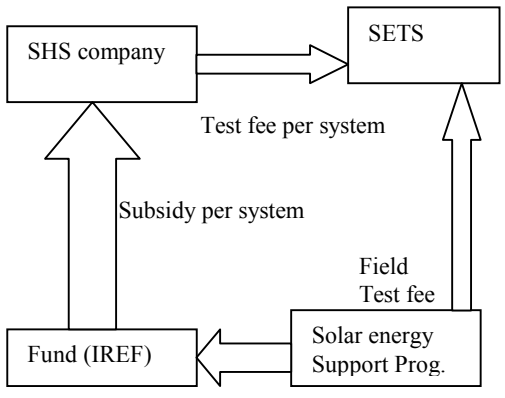

Figure 3. Cash flow diagram

4.5 Laboratory facility

SETS has established a fully equipped modern laboratory for measurement of all electric parameters of solar PV systems, but of course other electrical devices can be examined too. The physical parameters that can be measured are:

General electrical precision measurements of
- Voltage/ AC/ DC/ DC component
- Current AC/ DC/ DC component
- Frequency
- Resistance
- Active power
- Reactive power
- Apparent power
- Power factor
- Crest factor
- Total harmonic distortion
- Watt hours
- Ampere hours

Solar irradiance measurements
- Reference thermocouple pyranometer
- Silicon cell pyranometer

Lux measurements
Fluorescent lamp measurements
- Light distribution
- Lumen/watt efficiency
- Ignition time
- Inrush current/voltage
- Life cycle test

Battery measurements
- Ah capacity
- Cycle efficiency
- Life cycle test
- Acid density

PV Module measurements
- IV curve at STC, also in field

All essential instruments have been delivered with a calibration certificate.

4.6 Mode of operation

Nepal Interim Photovoltaic Quality Assurance (NIPQA) is the standard[1] followed by SETS. SETS has prepared test procedures based upon NIPQA, which covers the qualitative requirements of balance of system components. Prior to test SETS perform the sampling (random) from the manufacturer's store. After sampling process manufacturer's will provide their claim to their product for rating, consumptions, output etc. SETS perform the test following the test procedure. After completion the test SETS submit the draft report to respective manufacturer for the claim or disagreement giving one week period. If any claim or disagreement received from the side of manufacturers, laboratory will clarify them.

After one week period SETS will submit the final test report to the company and SSP with necessary comment if applicable. Based upon the result in the report SSP will take necessary action to the manufacturer's product (postpone or continue). If any product gets passed the NIPQA criteria they have to renew it in every two month.

So far SETS has been tested BOS components (lamp ballasts, charge regulators, modules, switches and sockets and deep cycle batteries) form each manufacturer.

Besides these continuous tests SETS also provides assistance to each manufacturers (SEMAN) in upgrading the phase of the product with innovative ideas and test facilities.

Table 1. Typical problems encountered with Nepalese SHS components

	Typical problems encountered
Modules	*Underrating* *Poor mechanical support*
Charge regulators	*Poor workmanship* *Incorrect voltage settings*
Lamps	*Unsymmetrical AC voltage, blackening of tubes*
Batteries	*No protection of terminals*

4.7 Staff and organisation

The organisation of SETS can be explained by the diagram of figure 4.

The overall management is the responsibility of a co-ordinator from the host institution (RONAST), who is assisted by a technical committee.

It can be seen that SETS has close relations to NBSM, the national standardisation body of Nepal.

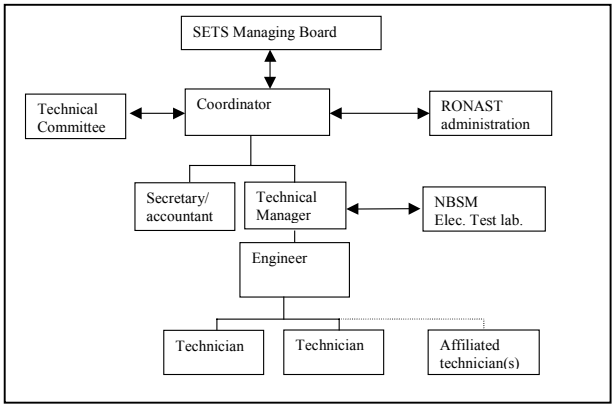

Figure 4. Management structure

4.8 Accreditation

Right from the beginning a laboratory quality assurance system has been part of the project. This should ensure that the local staff follows well defined working procedures, and should facilitate later accreditation of SETS. The laboratory QA system has been based on the guidelines issued by PV-GAP[6] and the ISO 17025 QA system of Solar Energy Center Denmark. Step one is to apply for a national accreditation, later on an international accreditation as per PV-GAP criteria might be obtained. Accreditation will be a blueprint of SETS, so other programs in the region can use SETS without question on the quality.

One important issue of running a well functioning laboratory in a third world country is to keep running costs low without sacrificing performance and reliability. Especially calibration of instruments can become a costly affair if it can not be carried out nationally. Therefore a concept of inter-laboratory comparison and in-house calibration has been adopted by NEPLAS, the Nepalese authority on accreditation.

It should be mentioned that running of an accredited testing laboratory may be in conflict with the involvement in product development assistance. However, there is no capacity for the moment to split the two activities but that will hopefully change in future.

Figure 5. Locally made lamp cycle switchboard at SETS

5 SUMMARY

A complete testing laboratory for PV systems has been established in Kathmandu, and is currently able to conduct tests on modules, charge regulators, batteries and lamps. It is the hope of the authors that SETS will be used by forthcoming PV projects in Nepal or near region in order to check the quality of the components and to gain from the extensive experience, which is already achieved by the staff.

SETS is probably one of the very few PV testing laboratories in developing countries which is in principle operating on commercial basis, and which has implemented a quality assurance system. This could be a model to follow for other PV support programs around the world.

6 REFERENCES

[1] Nepal Interim PV Quality Assurance (NIPQA), IT-Power India, December 2000

[2] Quality Program for Photovoltaics. World bank / ASTAE, 2001

[3] NEPLAS requirements for accreditation of laboratories in Nepal, NBSM 2002.

[4] Danida Energy Sector Assistance Programme (ESAP). Component description.

[5] Personnal communication, Prof. Shrestha, CES, Tribhuvan University, Nepal

[6] www.pvgap.org website of "Global Approval Programme for Photovoltaics"

[7] www.aepcnepal.org website of Alternative Energy Promotion Centre, Nepal