APPLICATION OF SOLAR PHOTOVOLTAIC TECHNOLOGY IN NEPAL: AN ASSESSMENT

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ABSTRACT

Photovoltaic (PV) technology is well suited to supply electricity to the vast rural population living in remote hilly regions of Nepal. Centre for Renewable Energy (CRE), a NGO in Nepal with a long association in PV technology, participated in a regional research and dissemination programme and carried out adaptive research and development, demonstration, training, and dissemination. A study analysed the current status of PV use and identified the research and development needs and measures for PV market development. Locally manufactured charge controllers, DC lights and DC-DC converters were tested and the charge controller was modified to improve the performance. A low-cost solar lantern was also designed and a prototype made. Dissemination activities consisted of publication of instruction manuals, awareness creation through newspaper advertisements and radio programs, and organizing of seminars and workshops. Details of these activities are described in this paper.

KEY WORDS

Adaptive Research; Charge Controller; Solar Lantern; Dissemination.

INTRODUCTION

Nepal is a mountainous land-locked country, with fragile and steep topography, located on the southern slope of the mid-Himalayas. The population of Nepal is estimated to be 22 million and more than 90% of them live in the rural areas. Nepal is one of the five least energy-consuming countries in the world. More than 87% of Nepal's total energy demand is currently being met by traditional energy sources such as fuel wood, agricultural residues and animal waste. Though Nepal has about 2.27% of the world hydropower potential, less than 2% of its total energy demand is being met by electricity. Nearly 85% of the Nepali citizens do not have access to grid electricity.

Very difficult terrain and scattered settlement makes centralized grid supply to all the population in Nepal very difficult. Photovoltaic technology is deemed to be one of the most appropriate means to provide electrical energy for various applications in remote areas of Nepal. The Government of Nepal has launched special subsidy programs to promote the PV technology for meeting the demands of rural households. The
application of PV technology in the field of communications, civil aviation, water pumping for drinking water and irrigation and household electrification is increasing day by day.

The Centre for Renewable Energy (CRE) participated in a project, the Renewable Energy Technologies in Asia: A Regional Research and Dissemination Programme (RETs in Asia), funded by the Swedish International Development Cooperation Agency (Sida) and coordinated by the Asian Institute of Technology (AIT). CRE carried out activities related to PV technology with the objectives of adaptive research and development of PV accessories, demonstration of PV systems, training of personnel involved in PV, and dissemination. A comprehensive study was conducted in order to find out the current status of PV technology in the country and to identify the research and development needs. It also attempted to identify some of the problems confronting the dissemination of the technology.

STATUS OF PV IN NEPAL

The information for the study was gathered using a structured survey, field visits, interviews, and discussions with various actors in the PV field, and reviewing published data. Nepal started using PV technology at a regular basis in telecommunications sector from early 1980s. Solar Electric Light Fund (SELF) of USA initiated stand-alone PV solar home system (SHS) in Nepal in late 1993. The current status of use is given in Table 1.

Table 1: PV Applications in Nepal (CRE, 1998a)

<table>
<thead>
<tr>
<th>Organization</th>
<th>Peak Power (kWp)</th>
<th>Number of Installations</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nepal Telecom</td>
<td>745</td>
<td>3000+</td>
<td>Rural Telecommunication</td>
</tr>
<tr>
<td>Nepal Electricity</td>
<td>130</td>
<td>3</td>
<td>Rural Electrification</td>
</tr>
<tr>
<td>Civil Aviation</td>
<td>20</td>
<td>45</td>
<td>Remote Airports</td>
</tr>
<tr>
<td>Security (Police &amp; Army)</td>
<td>30</td>
<td>8</td>
<td>Telecommunication</td>
</tr>
<tr>
<td>Water Supply</td>
<td>56</td>
<td>8</td>
<td>Water Supply</td>
</tr>
<tr>
<td>Private Consumer</td>
<td>100</td>
<td>2000+</td>
<td>Household Electrification</td>
</tr>
</tbody>
</table>

His Majesty's Government (HMG) of Nepal started subsidizing solar PV for household applications from 1996/1997. The subsidy amount exceeded Rupees Twenty Million (1US$= 68 Rs. approx.). The popularity of SHS in Nepal has gained momentum and the number of pending applications for subsidy, which is around 8,000, supports this fact. PV based water pumping systems are getting very popular in Nepal for irrigating cash crops and for drinking water projects. While government or semi-government owned PV installations do not seem to have serious operating problems, the SHS installations suffered from poor performance largely because of the problems related to DC lights. There were three manufacturers of PV products in Nepal in 1998. The non-government organizations actively involved in promotion of solar PV in Nepal were Centre for Renewable Energy (CRE) and Nepal Solar Energy Society (NSES- a local chapter of International Solar Energy Society). The only formal educational institution offering elective courses on PV in Nepal was the Institute of Engineering of the Tribhuvan University. The Center for Energy Studies (CES) at the Institute of Engineering, Tribhuvan University, offers various training programs to disseminate PV in Nepal.

The study also focussed on the marketing aspects and the analysis of information lead to the following recommendations: continue subsidy on solar PV for some years to come, continue creating awareness on applications of PV among policy makers, development workers, administrators, planners, university teachers, school teachers, entrepreneurs etc., integrate PV SHS with income generating activities as far as possible, design innovative funding mechanism, promote women's participation in SHS installation programs, ensure that manufacturer's data are reliable and accurate, ensure quality control of the accessories
of SHS, and train system designers and installers in proper selection and installation of PV based power systems (CRE, 1998d).

ADAPTIVE RESEARCH

The methodology adopted for the adaptive research consisted of field testing of existing PV accessories, laboratory testing of the accessories to verify their performance parameters, identification of major problems associated with the accessories, modification of the existing designs if necessary, sample production of modified/improved accessories, and field testing of modified/improved accessories (CRE, 1998b).

Solar charge controllers, DC lights and DC-DC converters are locally manufactured and were considered for adaptive research and development. Before conducting laboratory tests, a set of test procedures were finalized in consultation with the manufacturers. The SHS systems manufactured by two leading manufacturers were put into the field test for more than six months. The observation showed no major malfunction of the systems. The charge controllers (CC) manufactured by three solar PV system manufacturers of Nepal were tested in the laboratory. The results of the test indicated that one CC uses mechanical relay for load disconnect and over charge protection, while the other two samples use semiconductor switches for both purposes. One of the tested CC was of PWM type and showed good performance. The drawbacks noticed were inadequate heat sinks for switching devices and inadequate regulation of reference voltage. This CC was modified by incorporating an adequate heat sink and inserting a stable voltage regulator for reference as well as supply purpose. A prototype incorporating the modifications was produced and put in the field test. The field test results indicated excellent performance of the modified CC. DC lamps manufactured in Nepal showed good performance in laboratory tests. A 9 Watt PL lamp showed superior performance in terms of lux/watt value and the life-cycle test. The only drawback observed in that set was the high level of radio frequency interference (RFI). It was therefore recommended that the manufacturer incorporate RFI choke to reduce the interference to acceptable level. The laboratory test of the DC-DC converters manufactured by two different manufacturers indicated that the maximum conversion efficiency was 44.6%. But considering the fact that the power associated with the use of these converters (i.e. the power consumed by the appliances run from these converters) are low and that the design of the converters are cost effective, no modifications were suggested.

A low cost universal solar lantern (a solar lantern that can be charged both from a 12 V or a 6V solar system or from 12 V storage battery used in SHS) was designed and prototype fabricated.

TECHNOLOGY TRANSFER AND TRAINING

The technical know how on manufacturing of modified solar charge controller produced by CRE was transferred to six engineers and technicians from Lao PDR and Bangladesh. The three-day training program was jointly organized by Solar Electricity Company and CRE, and provided theoretical background, assembly experience and testing procedures on the charge controllers. The participants of the training were able to assemble and test the controller at the end of the training program. This training program was quite successful and can be taken as an example of effective South-South cooperation in technology transfer. CRE also developed Skills Testing Standards for solar electric technicians in collaboration with a government agency (Council for Technical Education and Vocational Training) and these have already been approved for implementation. CRE has conducted different types of training programs. Twenty-four users of SHSs from Southern Nepal were given one day training on the general use and care of the systems. During May to July, 1998, five training programmes were conducted for installers of SHSs and 72 technicians from 27 districts participated. Ten entrepreneurs involved in SHSs were given a one-day training on business-related matters.
DEMONSTRATION AND DISSEMINATION

Two SHSs were installed in the districts of Siraha and Chitwan for demonstration purposes. Each system consisted of a 36 Wp PV panel, a 70 Ah automotive battery, a 10 A improved charge controller, and four 10 W lamps. A local NGO in Siraha and a Users’ Committee in Chitwan are operating and maintaining the systems. These systems have been monitored and show good performance.

The dissemination activities consisted of publication of manuals and booklets in Nepali language, awareness creation through mass media (newspapers and radio), and participation in various workshops, seminars, and exhibitions. The booklets published in Nepalese language are: *An Introduction to Solar PV Home System* – forty-one selected questions and answers related to SHS meant for creating awareness among the potential users of SHS, *User's Manual for SPVHS, Manual for Installers of SPVHS, and Manual for Entrepreneurs of SPVHS*. All these booklets and manuals were used in the respective training programs.

As a part of the dissemination program, CRE organized an Interaction Program on PV Technology and its Prospects for Nepal. This program was attended by professionals and representatives from various institutions involved in energy. Similarly the members of CRE participated in various workshops and exhibitions related to renewable energy technologies. The impact of the dissemination programs conducted by CRE was high. A vivid example of this is that the HMG of Nepal increased the amount of subsidy by 300% compared to the last fiscal year.

CONCLUSION

The study on the status of PV technology in Nepal has provided useful information with regard to the various applications and spread of the technology, technology deficiencies, research and development needs, and the PV market operations. These led to the development of an improved charge controller and recommendations for PV market development. The transfer of technology for manufacturing of improved charge controller provides a good example for regional co-operation. Training programs and the dissemination activities are necessary for the development of PV technology in Nepal and RETs in Asia Programme has significantly contributed to this task. The recent increase of subsidies for PV systems show that the activities of CRE and others have made an effective influence on the government policy.

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