UNSW PV PROJECTS IN NEPAL

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ABSTRACT

Most remote Nepali health posts and school buildings rely on poor quality kerosene and diyalo (fat wood) as a source of light. This paper reports on a recent field trip carried out by UNSW staff and students in conjunction with Renewable Energy for Clean Environment and Development (RECED) in two remote villages in Nepal during February, 2008. The original photovoltaic (PV) system at Sankhe health post, which was installed in February, 2004, was inspected and found to be, on the whole, still providing lighting, especially for emergency operations. Sankhe health post was previously using expensive and toxic kerosene light for emergency treatment at night. Kerosene light provides very poor visibility and is inadequate for surgery, particularly childbirth. The photovoltaic lighting systems provide clean, safe, and free light, improving health services for more then fifty thousand people of this local community. Similarly, many remote Nepali schools are also not able to access grid electricity. Classes are often held before and after normal school hours (10 am – 4 pm). Students are often studying in very dim classrooms. A new PV system was installed at the local high school in Borlang-7, which provides power for class room lighting and two computers. The benefit of laptop computers was demonstrated in the field. Both systems are currently being monitored by local project participants and results are reported in this paper.

INTRODUCTION

Students and staff from the School of Photovoltaic and Renewable Energy Engineering at the University of New South Wales have over the past 4 years been involved in two PV projects in Nepal. The first project involved installing a PV powered lighting system on a small health post at Sankhe Bazaar in February 2004, just south of Pokhara. An initial paper describing the proposed project was presented in 2001 after the project was postponed due to events of September 11, 2001 and later due to internal conflicts in Nepal (Sproul *et al*. 2001). The second project was carried out in February 2008 and involved installing two small PV lighting systems and another large PV system for powering two computers at the Shree Jageshwor Secondary School in Borlang-7, a village near Gorkha. In February 2008 the UNSW team also revisited Sankhe Bazaar health post to inspect and test the system that was installed 4 years previously.

SANKHE HEALTH POST 2004

Sankhe health post serves a large number of villages in the surrounding district. Typically a single doctor with a local assistant manages to provide health care for approximately 50,000 people who live in the district. Until February 2004 the health post had no lighting apart from kerosene lamps, often with fuel provided by the patients. The PV system was installed by UNSW students and staff in conjunction with the Himalayan Light Foundation and the PV system was supplied by Lotus Energy.

Figure 1 shows some of the work being carried out on site. Six PV panels (36 W, Siemens, SP36) were installed with each panel having its own individual charge controller (Lotus Energy) and flooded lead acid battery (Trojan 24TMX, deep cycle, 85 Ah) (Figs. 2 and 3). The systems were configured in this way as this was the typical PV system configuration that was widely available in Nepal at the time. Twenty three 11 W fluorescent lights were installed in the various rooms in the health post, running off 4 batteries. One system was also installed for the caretaker's home located nearby. Most importantly a single system was dedicated to power lighting for emergency operations. At the time the most appropriate lighting available for this task was two 35 W (DC) halogen spotlights (Fig. 4). These were used, despite their low efficacy, however the system was designed to be used only for emergency operations and so the battery supplying the emergency lamps would have sufficient time to recharge in between operations.

Fig. 1: Wiring being run from the PV panels on the roof of the health post Sankhe, Feb. 2004. The small panel visible in the upper right of the picture is used to supply power to the caretaker's home (not shown).

Shown in Fig. 2 are three 36 W Siemens PV panels mounted on the concrete roof of the health post. Each panel is connected separately to individual charge controllers and batteries. The concrete roof had a slope of about 15 degrees and faced approximately SW. The two arrays mounted on this part of the roof (the 3 panel array shown in Fig. 2 and a 2 panel array mounted on the NW side of the roof) both were oriented due South. The slope of the roof to the SW means that the array normal is essentially pointing towards the 1 o'clock position of the sun, rather than directly at the midday sun.

All of the batteries were mounted as shown in Fig. 3. The original design was to simply place the charge controllers on the floor and screw them to the wall. As many children would potentially have access to the batteries it was thought that it would be best if the batteries were mounted off the ground. Revisiting Sankhe in Feb. 2008 it was realised that the batteries were probably installed at a height that was too high for many of the local people to easily maintain and check the batteries. The original 2004 team from UNSW and local members of the project team are shown in Fig. 5.

Fig. 2: PV array installed on Sankhe health post (SE side of roof).

Fig. 3: Two of the battery charge controllers installed at Sankhe health post (NW room).

Fig. 4: Dr Poudel with his new operating lights.

SANKHE HEALTH POST , 2008

In February 2004 a second team of UNSW students and staff revisited Sankhe health post to inspect the PV systems. Since 2004 there had been personnel changes at the health post, which unfortunately meant that Dr Poudel, the original doctor who hosted our first visit was no longer posted to Shanke, but worked in another district health post about 30 km away. The PV panels, except for the single pole mounted panel, were in excellent condition. The pole mounting had at some stage been blown down in a storm. The panel and wiring had amazingly survived as the panel dangled off the side of the two story building. In February 2004, the panel was resting on the roof, held down by large stones and was still connected to the caretaker's residence.

Fig. 5: The UNSW team from 2004 ((L-R) Scott Partlin, Alistair Sproul, Karen Sharpe, Luke Johnson, Paul Rodden, Jesse Clarke, Esther Lee, Lawrence Yu, Margaret Wong. Anita Ho-Baillie, Jason Tan and Ly Mai and Suprabhat Basnet (HLF), Sukaram Harajan (Lotus Energy) Samir Newa (HLF).

The wiring and lights in the health post were still in excellent condition. However some of the batteries were in very low states of charge and two out of the six were not operational. The two batteries located on the NW side of the health post were registering voltages less than 11 V, when not being charged and were either low on electrolyte or had no electrolyte at all. For one of these systems it was found that a light had been left switched on in a locked storeroom on the ground floor of the heath post. The three batteries located on the SW side of the health post were still operational (see Fig. 6). This was good news in that the batteries supplied power to the emergency lighting. Unfortunately the performance of this system was somewhat compromised by the use of some of the power for powering a television located in the health post. This was a load that was never intended but with a change in personnel and a family in residence it was probably unsurprising that an additional load was placed onto the system. An unintended consequence of this additional load was that the performance of the emergency lighting system was at times compromised. Also note as shown in Fig. 6 that the new family in residence were making use of the battery stands to house personal items such as toothbrushes etc.

The caretaker's system was operational when we visited despite the fact that the controller had failed. This had been bypassed but with no protection for the battery the battery was operating at a low state of charge. Lotus Energy systems offer a 10 year maintenance contract, so under this plan replacement batteries and charge controllers will be supplied. There was also a radio connected to the PV system which was added soon after the system was installed in 2004. The charge controller malfunctioned in 2007, at which time it was removed by a technician for repair. The technician connected the battery directly to the PV panel. When we visited, the system had limited availability, but the doctor's assistant's family had learnt to self-regulate the battery use without the battery charge controller. They simply stopped using the system when the lights dimmed or if there had been a cloudy day.

Fig. 6: Batteries located in the SW room of Sankhe health post (Feb. 2008)

BORLANG-7 HIGH SCHOOL 2008

The major project undertaken in February 2008 involved installing PV systems in a high school at Borlang-7, a small village about 3 hours bus ride out of Gorkha. This was carried out by a team from UNSW in conjunction with local personnel from RECED. The high school has about 500 students. Like many Nepalese high schools well away from the major cities, only about half the funding required to run the school is provided by the government, the remainder of the budget has to be found locally. As such installing lights and power capable of providing computers for the school was again seen to be a good project with wide benefits for the local community.

The PV system for powering the computers consisted of four PV panels in parallel (87 W, Kyocera, KC85T). These were roof mounted facing due south at tilt angle of 30° (Fig. 7). Due to the latitude of most of Nepal being ~28° N, a tilt angle of 30° is commonly used. The monsoonal influence on the solar irradiation would actually push optimal tilt angles lower but this is not standard practice and so was not implemented at Borlang-7. The batteries for the computer system consisted of four Trojan, deep cycle 100 Ah batteries in parallel and were charged via a Steca PR3030 charge controller, capable of handling 30 A (Fig. 8).

Two smaller PV panels (Kyocera, 40 W) were installed with their own charge controller (Sundaya) and flooded lead acid battery (Volta 95 Ah), which are connected to twelve 11 W fluorescent lights in 4 classrooms, the staff room, the battery room and the Principal’s office. Shown in Figure 7 is the completed installation of the charge controllers and batteries in the battery room. On the left hand side of the picture, the 600 W inverter can also be seen. This provided AC power for the computers.

Fig. 7: Installation of the main array which was used to power the computers.

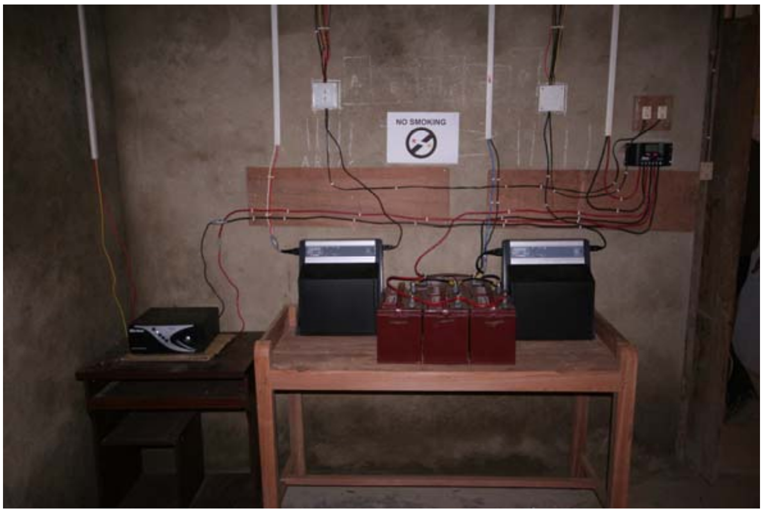

Fig. 8: Battery room showing the completed installation. The inverter can be seen on the far left, which is connected to the 4 batteries in the centre of the picture which power the PC and laptop. The charge controller for this system is mounted on the wall. The two black boxes contain the charge controllers and batteries for the two lighting systems (#1 & #2).

The remaining figures show wiring being installed in one of the classrooms (Fig. 9), and the same classroom late in the afternoon with lights on (Fig. 10), installation by the local carpenter of the mounting bracket for one of the two pole mounted PV panels (Fig. 11), and testing of the computer (Fig. 12). The original location of the main array was to have been directly over the room which was set aside to house the batteries and next to the room for the computers. However upon inspection this location was found to be adversely affected by shading of a large tree (Fig. 7). After much negotiation it was decide to relocate the PV panels to an adjacent roof well to the west of the tree. This meant that the PV panels were unshaded typically between 9 am until 3 pm throughout the year. Appropriate cable of 16 mm diameter copper was eventually located, however it was commented that such thick cable was unusual for PV systems in Nepal.

Fig. 9: UNSW team wiring up lights in one of the classrooms.

Fig. 10: The same classroom as above with the lights operational.

The initial computers were standard desktop PCs with CRT screens. A laptop belonging to UNSW was trialled and shown to use about 25% of the energy of the standard PC and screen. Initially we were unsure about the acceptability of laptops and the additional expense. However given the superior efficiency of a laptop, a single laptop was purchased and sent back to Borlang-7 and is currently in use as well as one of the original PCs. If the laptop is found to be acceptable then a second laptop will be installed and the original PC removed.

After completion of the project there was a wonderful farewell organised by the community for the UNSW/RECED team. There were a number of cultural displays which was part of the local community's expression of appreciation (Figs. 13 and 14). There were also a number of other cultural displays which often occurred late into the night, and the dancing and singing were incredibly spontaneous and joyous. Special songs were composed to thank us for what we had done. The UNSW team from 2008 and RECED personnel are shown in Fig. 15, taking in some of the scenic beauty of Nepal after the completion of the project.

Fig. 11: Installation of one of the pole mounted PV panels.

Fig. 12: UNSW student David Mason testing out the PV powered computer.

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Fig. 13: Farewell ceremony for UNSW team, Feb. 2008, Shree Jageshwor Secondary School.

Fig. 14: Enthusiastic students farewelling the UNSW team

MONITORING RESULTS

Since the completion of the project in Borlang-7 in February 2008, the systems have been monitored carefully by staff and students at the school. Shown in Fig. 14 is a graph of the battery voltage for the three systems installed (April – September 2008). The two lighting systems are showing battery voltages typically in the range of 12.3 V to 13 V. For batteries that are neither being charged nor discharged voltages between ~12.1 to 12.7 V give an indication of the state of charge of the battery. It is difficult to say from this data whether the batteries are in good condition or not. Any battery voltages higher than 12.7 V indicate that the readings were taken whilst the system was receiving charge. For the PC battery system the voltages are consistently between 12.4 and 12.7 V. Again it is difficult to asses whether these voltages give an accurate indication of the state of charge for the system. Further correspondence with the staff who are gathering the data will hopefully clarify the issues but it is heartening to see that the systems are being monitored on a regular basis.

Fig. 15: UNSW team, 2008 (left to right), Lisa Dobinson, Dean Redman, Long Seng To, David Mason, Alistair Sproul, Suprabhat Basnet (RECED), Johnson Lee, Tim Larsen and Ramesh K.C. (RECED) (not present: Claire Disney, Gilbert Jin).

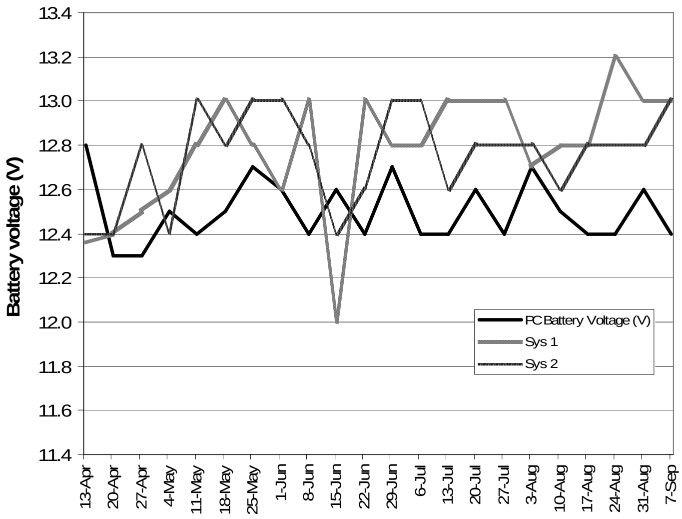

Fig. 16: Battery voltages recorded over the period from April 13 – September 7th, 2008.

CONCLUSIONS

The PV lighting systems in Sankhe health post were revisited in February 2008 and found to be in a fairly good condition. With the changes in personnel at the health post the usage and maintenance of the systems had changed as well. However anecdotal evidence acquired from discussions with other Nepali users of PV systems is that typically batteries in PV systems in their experience never last longer than 2 years.

Discussions with some PV suppliers in Nepal also viewed this as a normal state of affairs. So we consider that the system is performing relatively well as the majority of batteries at the health post are still operational after 4 years. For the new system installed at Borlang-7 we are encouraged at the continuance of monitoring of the batteries by the local staff and students. One of the authors (Long Seng To) will be returning to Nepal in Feb 2009 and will have the opportunity to visit Borlang-7, check the systems and also to supply a second laptop computer.

ACKNOWLEDGMENTS

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For both projects the UNSW teams were warmly welcomed and farewelled by the villages of Shanke and Borlang-7. Not many of us have ever experienced anything quite like that before in our lives! On behalf of all the UNSW team members we would like to thank the communities of both Sankhe and Borlang-7 for their wonderful hospitality, for their cultural programs of singing and dancing and for the wonderful meals that you provided for us. Special thanks to Dr Vanu Poudel and everyone involved with the Sankhe project. Also special thanks to Mr. Mukti Dhakal (Principal, Shree Jageshwor Secondary School) and everyone involved with the project at Borlang-7. For all of us who were involved in the projects we will always have many wonderful memories of the people we met and worked with.

REFERENCES

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BRIEF BIOGRAPHY OF PRESENTER

Alistair Sproul has been involved in the photovoltaic field since 1985. He is currently an Associate Professor at the School of Photovoltaic and Renewable Energy Engineering at the UNSW. He holds a BSc (Hons I) from Sydney University (1984) and a PhD from the University of New South Wales (1992). He has worked in the area of photovoltaic research and R&D in a range of positions with various companies (BP Solar, Pacific Solar) and research institutions (UNSW, Fraunhofer Institute for Solar Energy Systems). Since 2001 he has been strongly involved in developing and delivering the undergraduate program within the School of Photovoltaic and Renewable Energy Engineering at UNSW.