Renewable Energy Development International
Presents

Sun Horse

PV Community Development in Nepal

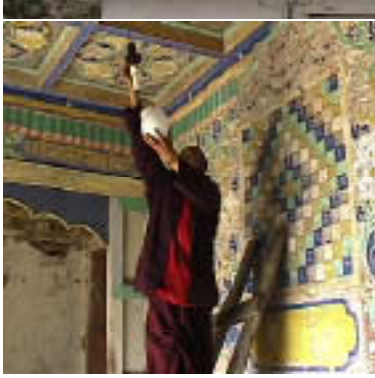
by Dennis Ramsey

Chiwong Monastery was built in 1923, and is the primary religious institution for a large Buddhist community in the shadow of Mt. Everest. In October 1999, Renewable Energy Development International (*REDI*) installed a PV lighting system of 108 lights throughout the large compound. With a crew of 15 masons, electricians, and laborers, we finished the work in the three weeks leading up to the full moon.

The nunber 108 is the most auspicious number possible to Buddhists, because the texts indicate that Lord Buddha has 108 avatars or incarnations at work in the material world. It was pure happenstance that the final number of lights required for the complex equaled 108! Interestingly, the array size is one horsepower, and prayer flags here are known as *wind horses*. Thus the title "Sun Horse."

We began the long design process for this project by looking at the monastery's basic situation regarding the need for light, and their community's ability to provide support.

Sherpas are the ethnic group who inhabit the high altitude regions near the highest mountain on Earth. The social structure of the Sherpas has changed dramatically since about 1955, when Nepal's tourism



and mountaineering industries began. This has brought wealth to the community, but unfortunately the beneficiaries usually move to Kathmandu where they have access to facilities such as telephone, fax, internet, electricity, and decent schools for their children. Their social and financial contributions to their home communities have been nullified, and this leaves the poor and the old behind to tend the remnants of Sherpa culture.

REDI is an environmental non-profit I founded in 1993, and has already installed PV lighting systems in three other important monasteries in the region (HP45 & 54), and hydronic heat for the regional dental clinic (HP75). Our program strategy is to focus on improving baseline public institutions, through the use of renewable energy.

The primary reason for installing solar electric light in Chiwong monastery is to transform public health realities in this bastion of religious learning. Next to intestinal parasitic diseases, the second most dramatic class of illness is caused by burning kerosene for lighting in closed rooms. The incidence of respiratory aliments, ulcers, and eye strain is quite high.

Research among the monks and nuns here reveals that they collectively burn about 90 liters of kero per month, at a cost of about $1000 per year. Over the projected life of the solar electrical system, they can avoid the adverse health and environmental impacts of burning 36,000 liters of kerosene, and will have saved $30,000. This is one-third more than the cost of system installation!

The social impact of this change in living standards at the area's primary religious institution will make it a more attractive destination for young people seeking education and social betterment. The monks themselves often speak of the modern facilities of Kathmandu, particularly electricity, and of how much harder life is in the mountains.

A small amount of electricity can make a huge difference in living standards. We've seen already in the 18 months since this system was installed, that people are inhabiting more of their own space. They can read anytime and anywhere, the cooks can better see the food they prepare, no one stumbles on the way to the outhouse at night, and the ceremonies are smoother and more precise because they can see their texts clearly. One of the nuns informed me that it is also keeping outsiders honest. If someone comes in the night who shouldn't be there, they can now be seen.

The dogs bark much less at mysterious visitors.

It is the improvement in the ability to see and to read, and the removal of burning hydrocarbons, which do the most to improve the personal environment. Everything is impacted: education levels,food quality, public health, social intercourse, community pride, and ultimately, out-migration. In addition, the cash which was previously spent on kerosene is available for other needs.

SYSTEM PLANNING

Planning for this installation was rather involved, because there were several specific issues to address. My over-riding concerns were to create a system that answered its users needs for simplicity, invisibility, low maintainence, a low level of user comprehension, and adequate electricity supply.

My survey of the monastery complex indicated they needed about 100 lights in a mixture of public spaces and 24 private residences, spread across 4 acres of hillside. Because the general public, who are not users of electricity, find the bulbs and switches so fascinating, we had to devise a method of avoiding "curiosity damage."

Tamper-proof outdoor fixtures were chosen for all public locations where lights were within reach. For public areas where the fixtures were high and quite visible, we selected tasteful and refined globes. All switches for the public lights, as well as all breakers for separate wire runs, are in locked boxes so that only specified monks have access.

There was great concern that the system be safe, particularly from fire. It would be tragic if in this attempt to bolster cultural survival, we inadvertently destroyed this repository of history and community. We chose to build a stand-alone powerhouse which allowed us to avoid mounting any equipment on or in the monastery buildings. We also provided two industrial fire extinguishers, one in the powerhouse and one in the main building.

I wanted this system to be as unobtrusive as possible. Often while trekking through these regions, one sees a gorgeous community marred by a badly installed satellite dish. And electrical wiring carelessly strung and dangerously low, is the norm everewhere there is a small local grid. My resolution

was to "hide" the solar array, bury all the transmission wiring in conduit, and then string all indoor lines above the ceiling, so that nothing would be visible. I felt it was important to respect the original ambience.

In only two cases did we need to run a line as an overhead, because trenching through the jungle was impossible. Those two overheads were disguised as Tibetan prayer flags, which are a common feature here. No one notices that these two lines of flags are actually electrical cable until we mention it.

NON-TECHNICAL USERS

Another very important issue to address was that the users are unsophisticated about electrical power. They don't distinguish between voltages, neither AC nor DC. It's a common occurance in this region for someone to try to plug an incompatible device such as a 12vDC motor into a 220vAC recepticle. If the plug doesn't fit, it will be cut off and the stripped wires jammed into the receptacle.

The solution was to install a closed system - no recepticles for plugging-in appliances or TV's, etc. But then the question is what to do about free-lance splicing into the distribution wiring? or the possibility that a smart individual will go to the bazaar and buy an adaptor for the bulb socket? Solving this was a little more involved.

In every private space, a locked j-box with a 0.5 amp breaker was installed at the point the wiring left the conduit and entered the home. In a 220volt system, this gives each individual about 110watts of supply. This is more than adequate to operate their three 15watt CF bulbs, and allows for ballast spikes. But if for any reason the load goes above this small amount, the breaker trips and the monastery's Lama must be called to reset it, and investigate. Honesty is highly valued here, but there must be a mechinism to protect against the occasional "bad boy," as well as the innocent and unaware. Small individual breakers insure an equitable distribution of power to all users.

We chose modern compact florescent bulbs for the installation because they provide good luminance and spectrum at 25% power consumption of standard bulbs. They






dramatically lowered our overall system size and costs. But a further concern was that it would be quite easy for an individual to go to the bazaar and buy a standard Indian incandescent bulb for use in their fixtures. Even a small 60watt bulb from the bazaar would pull four times the specified 15watt CF bulb load, and if quite a few of these bulbs were used the load would be unacceptable.

A simple solution was to use standard US type screw-base, pull-chain fixtures for several reasons. First, the integral switch allows us to skip the extra wire runs for wall switches. Second, the much-feared local incandescent bulbs are Indian-style bayonet base, and won't fit in screw-base. The issue of screw-base bulb supply to the monastery over time, in this Indian-dominated market, would be a problem if not for the fact that the Chinese domestic market uses US standard screw-base, at 220volts, and they make a large variety of modern CF bulbs. We were able to order these bulbs from the Chinese traders at the boarder crossing with Tibet, at one dollar each. Quality control is poor, as you might imagine, but 65% of them work as they should.

The lights are a mix of CF bulbs ranging from 9 to 15 watts, and there are 108 of them. What we found is that the users really like the 15s, and since they have enough power, that's what they use. All the lights are never on at once, and the average nightly peak load in festival season is about 40 amps at 24VDC, which is about 960 watts of lighting, or about 65 bulbs on at once. Their non-festival nightly load averages about 375 watts (25 lights) of lighting for 3 to 4 hours.

The community here uses quite alot of small batteries for flashlights and radios. When these are exhausted they are thrown on the ground. Along the margins of many commuities there are batteries in the crops. To help stop this low-level pollution we installed two Saitec smart chargers in the kitchen pantry, and provided 100 each of D and AA NiCad cells. One of the most purchased items here after kerosene and food, is batteries for flashlights and radios. This money can also now be saved.

LET THE GAMES BEGIN

The staging of the installation took place alongside the three weeks of preparations at the monastery for their annual masked dance festival. The Mani Rimdu is performed each fall in all of the major monasteries in this region. It is a mideaval morality play about the struggle of Buddhism over the earlier Bon religion of Tibet. Their replaying of these events each year reasserts their bond with the ancestors. And because the Sherpas arrived here from Tibet over 400 years ago, their's is an earlier and more orthodox form of the religion. The dance expresses what was recent Tibetan history at the time of their migration to the southern slopes of Mt. Everest. Our own choreography began by discussing with the monks and nuns where the lights were to be placed, assembling the workers, deciding where the trenches would be dug, and building the powerhouse.

Local boys were quite willing and capable of digging trench all day long, and were generally cheerfull to have around. A joint Nepali/Swiss hydroelectric utility some kilometers away allowed me to hire 7 of their electricians to lay the wire and set the fixtures. They were very experienced, and needed only basic instruction in how I wanted it done. I brought along a set of tools for each electrician who worked on this job because they can't get and can't afford proper tools, and when the job was done they got to keep their set. Tools were: wire stripper, multi-tip screw driver, razor knife, heavy insulated electricians pliers, two rolls of Scotch T-40 electrical tape, and a pocketfull of wirecaps.

POWERHOUSE & CONTROL CENTER

I contracted a group of Tamang tribal masons from a lower village to build a 9 x9 foot (2.7 X 2.7m) stone powerhouse with a south-facing corrugated roof at 5 degrees slope above latitude. They were able to put that little house up in 5 days because we had the stone delivered in the weeks before. We chose a site on an unused portion of the extreme north end of the compound. The exposure to available sunlight is excellent, and the array is almost unnoticeable. One day last November I clocked the sun at 13 cloudless hours, for a total input of 230 amphours at 24VDC, or about 6KWH.

The altitude is 11,000 feet (3,350 m), cool and breezy, so the array output is above nominal.

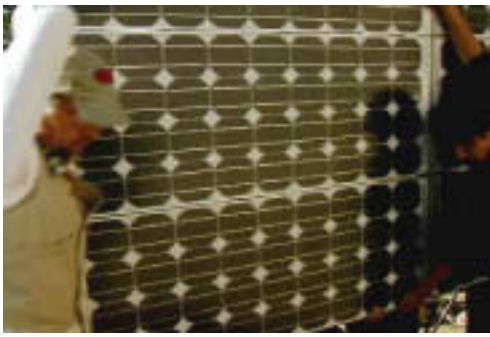
Rather than buy and import a pre-assembled power control center, we built ours on the spot from components. I chose a Trace C-40 controller with digital metering and battery temperature sensor, combined with a Trace 2424e (24vdc input/240vac output) inverter. Since there is no intention to ever run anything but lighting from this system, this modified sinewave inverter does the job at reasonable cost. Both components are oversized for the load and input so that the monastery has the ability to easily expand their system at a later date. Although I don't feel that Trace products are the best choice, I chose them because the local dealer in Kathmandu handles nothing else of comparable size, guarantees the products for two years, and provides good service after warranty.

In the nearby township, I had a carpenter build 2 air-tight boxes: one for control center, and one for batteries. We drilled and vented them both for air flow. The control center was assembled and mounted to the powerhouse wall, and the stubbed-out transmission lines joined into steel conduit through the flagstone floor. All was done to US Code standards.

Mounting the array of 10 Siemens SP75s was nearly a disaster, but we had to have at least one scary moment, after all. After assembling and wiring the array against the powerhouse wall, 8 people of various dialects had to delicately move it 20 feet along a ledge, turn it 90 degrees without shattering the corner at the ground, and then heft it onto a 7 foot roof. This was oddly difficult for our little crew, and we realized later that some of the guys were shouting mistaken cues at the tribal masons. Trying to speak a language they didn't know in a difficult moment, they mixed-up the words for right and left. The whole array nearly went over the side.

BATTERY INSTALLATION

The finishing touch, on the nineteenth day of the project, was battery installation. The battery bank consists of twelve, 120 amp-hour, 12 VDC tubular plate deep cycle batteries. The batteries are wired in series/parallel for a nominal system voltage of 24 VDC. Limiting daily cycling of the batteries to a 50 percent state of charge (SOC) gives us about 360 AH of effec-



tive energy storage at 24 VDC.

These batteries weigh about 75 pounds each, with acid, and they were carried on the backs of single porters for four days to arrive at Chiwong. Each porter was given a packet of baking soda and strict instructions to keep his load upright.

All of our equipment came by truck from Kathmandu to Jiri, then we hired 50 porters to carry the entire lot for four days to deliver it to the monestary. This is 200 man-days of wages injected into the local economy. The alternative was to have the equipment helicoptered-in in 45 minutes from Kathmandu, and the cost would have been almost exactly the same. However, the money would have gone into the pockets of the private transport company.

EQUIPMENT & COSTS:

1) 10 Siemens SP75 modules	5,940
2) Trace DR2424E inverter	1,450
3) Trace C40 controller	250
4) 12 Volta 120Ah batteries	1,950
5) Lights and fixtures	1,350
6) Electrical equipment (j-boxes, locks, wire, conduit, breakers, lightening arrestors GFID, tools, etc.)	2,630
7) Fire extinguishers	130
8) Labor	1,500
9) Transport & Porterage	1,300
10) Contingencies	1,500
TOTAL BUDGET	$20,630

FINAL CURTAIN

When a monk takes vows and enters monastic life, one of those vows is celibacy, and another is to not till the soil, or engage in "earthly" persuits such as commerce or labor. Their realm is the spiritual. But one thing they were able to do to help with the project was to carry batteries to the hill-top powerhouse from storage. They were both very anxious for the lights to come on, as well as wanting to participate.

They took time off from their preparations for the dance, and very sweetly formed a grand procession and hefted all 12

batteries for us, since they could see we were wearing down. And it was fitting and auspicious that they should all have a direct hand in the final act before the lights went up.

We wrapped each battery in plastic so their robes wouldn't be burned. This gave them some immediate contact with the realities of the system, since they are the ones who were later trained do battery maintainence. The assembled procession then watched us intently for an hour while we wired the batteries and finished-up.

SUPPORT PRESENT & FUTURE

Long-term maintainence of a remote stand-alone system such as this can be problematic. Even though we took precautions to limit the use of the system to avoid potential user bad-practices, future battery replacement as well as potential electronics melt-downs needed consideration.

We met with the Chiwong Preservation Committee, which is a board of ten local stake-holders who oversee the monastery. Many of them are relatively wealthy. They were already very pleased that REDI was initiating the project, so we appealed to them on the maintainence issue. They agreed that it wouldn't do to let the lights go off from laziness or poverty. They agreed to establish a maintainence fund bank account of $2,000 in member donations, which will accrue interest until the time it is needed. At that time the interest only will be used. By projecting 10 years into the future and considering buying a new battery bank, the interest on the original principal is adequate. All other maintainence costs will be provided by the fund, and three signatories are required to access it.

The participants who funded and supported this project were many. The Jean-Pierre Michaud Fund of Geneva, Switzerland provided 95% of financial support, the other 5% coming from the Eugene/Kathmandu Sister City Committee, of Eugene, Oregon.

Mr. Phuri Lama of the Saleri/Chialsa Electricity Company (SCECO) was extremely generous in allowing REDI to hire his electricians. Mr. R.P. Lama of the Hotel du Sherpa in Phaplu helped enormously with communications and contract arrangements for local work. Mr. Tenzin Tsering Lama,

Chairman of the Chiwong Preservation Committee, arranged for the establishing of the maintainence fund for the on-going sustainability of the system. Mr. Kul Narayan Shrestha of SCECO was an extremely talented foreman and leader of the electrician crew. And my assistant, Ongel Lama, learned enough to later wire three local homes with solar lighting systems all by himself.

LIKE FLOWERS BLOOMING

The community's vision of electrifying Chiwong has finally been realized. The remoteness of this important public institution had doomed it to slowly fade into history while the world around it hurtles through the time barrier.

Chiwong and other monastic centers like it throughout the world are true sanctuaries. Chiwong's Buddhist religious culture has long lived out of contact with the western time machine. We now find it utterly refreshing to meet so many here who are so honest, so charming, and so deserving of support. Dramatically improving their personal and collective environments through simple electric lighting, has fostered renewed community interest in the institution's primary functions.

The residents can now see inside their homes after dark. The collective space can be lit during gatherings long into the night. And monks, teachers, and students are able to clearly see and read their texts. These simple realities all augment and strengthen the community's basic values.

But just as important, the monastery will no longer need to buy and porter kerosene, or buy and maintain lamps. Eyestrain, ulcers, and respiratory problems resulting from burning kerosene are all gone with an extinct technology, not to mention the slow ruin of the murals and ancient texts from soot.

Who would have thought that the creative application of modern silicon technology could catalyze social cohesion and cultural survival in a remote, traditional community? This is technics-based community development at its best. As Sonam, the head nun, said to me, "when the light came, it was like the rhododendron flowers blooming in the jungle..."

REDI is a 501c3 non-profit, and is entirely supported by public donations from readers like you.

Visit our new website: www.redi-org.com for the three previous Home Power articles on our various projects, as well as to see the 10 minute video documentary, SunHorse.

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