Solar Energy Work on the Miskito Coast

By Richard Komp

I had wanted to visit the east Coasto Atlantico of Nicaragua ever since I started working with the Grupo Fenix over ten years ago. Finally, with the help of Cody Clare, I got to go this last February. Cody is a very creative young man who has been working with the Miskito Indians for several years now. By the way, the Miskito Coast is named after the Indian tribe, not the insect and the name "Mosquito Coast" of the movie with Harrison Ford is a misspelling (although there plenty of those insects there).

I first met Cody when he was working as an apprentice with Marco Antonio, the landmine victim who runs the small cottage photovoltaic (PV) module assembly workshop in Sabana Grande in Northern Nicaragua (You can read about these tiny 3rd World PV assembly plants in the paper "Photovoltaics as a Cottage Industry" available online at www.mainesolar.org) Later, a couple of summers ago, Cody came to work for a while with my apprentice, Dan Uptegraft and me here in Jonesport. We all worked on making various small PV modules and devices like solar cell phone and PDF chargers and we also worked together to give weekend solar workshops around the state of Maine. Cody would disappear for a while and go back to Nicaragua to visit the Miskito Coast, where he has developed a number of close friendships.

After talking with his friends and seeing the large number of very poor people living with no electric power and no chance of ever getting the electric grid into the remote areas of the rainforest (what we used to call jungle), he decided to start one of the cottage PV assembly workshops there in 3rd World Porto Cabazas, the main town right on the coast. Cody would spend six months or so working in New Hampshire, where his family lives, then take the money he had saved up and buy PV cells and the other materials to keep the cottage factory going. Since Skyheat Associates, my nonprofit was supplying him with the PV cells, I had been following the progress of this work and (of course) sold him the PV cells at Skyheat's cost, rather than the higher price I normally ask from 1st World people.

This year, Cody finally talked me into coming to Puerto Cabazas to help give a workshop on how to build PV modules using the new Evergreen Solar ribbon grown PV cells. These cells are efficient polycrystalline silicon cells made in a new way that uses up less than 1/3rd of the silicone that the conventional process uses, but they are very thin and fragile and loaded with crystalline strain form the quick freezing when they are pulled from the molten silicon bath. Marco Antonio has developed a unique way of encapsulating these cells to produce first class modules and Cody had learned the method (he is even a co-author on a scientific paper outlining the method, given last September at the international IEEE conference in Dresden, Germany). However, recently both Marco Antonio and Marilu, the person in charge of PV module assembly at Suni Solar (Grupo Fenix's profit making company), have developed new techniques to handle the extremely fragile Evergreen Solar cells and Cody asked me to come and teach these new methods.

Not having enough time to take the notorious yellow school bus that goes from Managua to Puerto Cabazas, I flew in a small plane. (The bus takes from two to three days in the dry season, depending on how often it breaks down. In the rainy season, it doesn't go at all.) The trip was wonderful and the welcome by the people I worked with was extremely warm; I felt like one of the family. They had a lunch waiting for me of deer meat gumbo cooked in coconut milk and rice. We spent the first day going around the small town and checking out the workshop site, which, during the day is the headquarters of the disabled diver's organization. At night the head of the society takes back his little garage to park his car, which barely fits, so the desks have to be pushed to the far corner. The divers dive for lobsters and far too often they go too deep and come up to fast and the ones who survive are disabled by the "bends". This organization is sort of a self-help group, since there is no real social safety net for these people.

We started the workshop with everybody making small solar battery chargers. These only take 4 small PV cells and are a good way to start the lessons. The cases are made in Maine for my by the Penobscot Indians out of recycled plastic so I felt it was appropriate for the Miskito Indians to use them. We next started soldering together the bigger Evergreen Solar cells, which came with the ribbons already attached to their fronts.

Photo 1 shows one of the Miskito Indians learning how to solder together the Evergreen Solar cells. 36 of these will be strung together to make a 60 watt PV module.

While these disabled divers have nerve damage which makes walking hard (or sometimes impossible) it didn't seem to affect their hand-eye coordination so they quickly picked up the techniques of soldering and cutting these fragile cells. A lot of the cells in the boxes ended up cracked or broken after the jouncing by the two day journey on the bus from Managua, so we sorted the cells and cut them in half, where possible, or into smaller sizes to make 30 watt and 15 watt modules, as well as the solar battery chargers.

When the cells were soldered together into three strings of 12 cells each, they were tested to make sure all the cells were working properly together. Then the strings were laid on a large sheet of ordinary paper, with a flattened piece of garbage bag underneath to make sure we didn't glue everything to the tabletop and a special two part silicone resin was mixed and poured onto the strings of cells. This silicone was developed especially for encapsulating PV cells for the space program and works extremely well. It never yellows or disintegrates, but costs over $260 per gallon. One of Marco Antonio's clever ideas was using the paper which soaks up the liquid silicone and allows the use of only half as much as we were using in the past. When the silicone is cured, the completely impregnated paper acts as fiber reinforcement for a strong, completely sealed module without the automated laminating machines usually employed on the large PV module production lines.

Photo 2 shows the group putting measured teaspoons of the expensive silicone on the PV cells. It will flow behind the cells and completely encapsulate them by capillary action.

This new method uses about 400 ml of silicone per 60 watt module, which allows one gallon to encapsulate about 10 modules. This keeps the cost of the encapsulant down to below $30 per module. Altogether with the cost of the PV cells, glass, aluminum frames and the other materials needed the cost of materials as about $120 dollars for a module that sells for $375 in Nicaragua. The idea is to have a product that can be made and sold with a good profit margin so the disabled divers get paid well for their value added work.

Once the module was coated with the silicone, a piece of ordinary window glass was laid on top of the wetted set of cells and the air bubbles were carefully massaged away to the edges of the array. (This is one of the new techniques I learned from Marilu.) We then covered the glass with sheets of cardboard and old car batteries to squeeze the module together. This technique replaces the half million dollar automated laminating machine used by the large manufacturers of these modules (companies like Shell Oil and British Petroleum, and the Japanese). The entire arrangement then sat overnight to cure properly while Cody, his girlfriend and I went back to feast on wild boar that one of the local people had shot in the neighboring rainforest. The food on the Miskito Coast is very good but would be a problem for a vegetarian, since wild meat or fish is a large part of the diet, when possible. Cody's girlfriend is working to get them to always include green vegetables or a salad.

Using old car batteries as weights to laminate the 60 watt PV module.

Photo 3. Testing the finished 60 watt PV modules the next day. Cody, on the left, is waiting for the sun to come out from behind a cloud to get a good reading.

The finished 60 watt modules worked perfectly and looked really professional once a nice aluminum frame (made from pieces aluminum window frame extrusions) was installed. We also had classes on cutting the cracked PV cells and made a 30 watt module from the bigger pieces. I had to leave before noon on the last day to catch the plane back to Managua but before I left, we had a raffle to give four of the workers the solar battery chargers we had made. They have decided to make these chargers as one of their products, since they will sell for only $12 each, which is an affordable price for their friends and neighbors and will make them a steady income using up the smaller broken pieces.

There is a pent-up demand on the Miskito Coast for PV modules of any size; before I left, they had sold the module we had just made and had customers arguing about who would get the next one. Porto Cabazas has utility electricity but it is very expensive and undependable so that all the businessmen want to have solar backup with storage batteries for the times when the electricity is down. The Miskito villages in the area have no utilities at all and most people are way too poor to afford a PV system with a 60 watt module, so some sort of microloan will have to be worked out so they can pay for a smaller 30 watt system to run a few lights and a radio (a TV set takes 30 watts all by itself so only the affluent can afford to run one). The Grupo Fenix is starting to do more work in this part of Nicaragua and I got detailed information from the local sailors on local wind conditions. With the trade winds always blowing, this is a natural place to replace the diesel generators of the power company with wind turbines.

Porto Cabazas is such a small place that everybody seems to know everything that goes on. While I was at the airport waiting for the small plane to show up to take me back to Managua, the brother of one of the divers came up and asked me if I was willing to talk to somebody who wanted to know how she could get a PV system for her remote casa (home in Spanish). I t turns out that her mother already had a PV system, but it wasn't working properly. I told her how to get hold of Cody, who could take care of both problems. I strongly suspect from the description of the system and the problem that her mother's PV module had been stolen from one of the community PV systems that have been installed on the Miskito Coast by the Moravian missionaries over the years. Several years ago, one of the Moravian missionaries visited the Grupo Fenix in Managua wanting how to solve this problem. He said that the PV modules disappeared even before he left the village; and I told him there was no technical solution that would work, since the villagers have unlimited time to figure out how to remove the system. The solution, I said was to let them use the system to watch television. That way they would have an incentive to guard it carefully. I'm afraid that he wasn't happy with my advice. He didn't want to "let the noble savage be corrupted by degenerate modern values".

2008 Update on the PV work on the Miskito Coast

In February of 2008, I went back to the Puerto Cabazas to once again work with Cody Clare and the disable lobster divers, and to see what kind of progress they had made in the 11 months since my first visit. Cody had been on the Miskito Coast for about three weeks before I arrived on the 3rd of February and had found a house to live in. The house had been a cybercafé, then was abandoned after the café owners ran up a very large electric bill and then tried to connect the house wires directly to the electric grid, bypassing the meter. The poor quality and undependable electric service in Puerto Cabazas is also very expensive. The lady who owned the house is letting Cody live there for free while he is fixing up the place and he worked like a beaver for 8 days before I came, not only making the house livable but cleaning and fixing the yard and planting bushes and creating a garden.

We had a nice pleasant flight from Managua flying fairly low over the extensive rainforest so I go to see the extensive damage done by Hurricane Felix last August. I was met at the airport by Cody and we went straight to his new home, which he is planning to buy if he can get good price from the landlady. We spent the day going around town, visiting the dock and talking with boat people about the possibility of going on a trip to an outlying island or costal village later on in the week. The house no longer has any electricity and cannot be hooked back up to the grid until the monster electric bill is paid so we discussed Cody's plan to make it an off-the-grid solar home right in the middle of town.

The next day, we started the photovoltaic (PV) module assembly workshop at 9 am, although none of the lobster divers really showed up until quarter to ten, and then people sort of drifted in until about noon. Talking with the lobster divers, I realized that very little had been done since I left last year. They had made and sold a couple of

60 watt PV modules and had made a number of small solar battery chargers of their own design, but after Cody left in May to go back to the US to work and raise more money, everything stopped. Cody had taken the soldering irons with him, but nobody seemed perturbed by that.

Starting these little cottage PV workshops is a bit like starting a fire with wet wood, just when you think the blaze is going well and you go do something else, you come back to smoldering sticks with no flames. However, after we started soldering the strings of PV cells together and people saw the progress, everybody started getting enthusiastic. Having a nice space to work in with a long, strong workbench Cody had built along the whole wall of the former cybercafé also helped the situation, since people now realize that is going to be a permanent operation. There are a couple of new people involved, who are not disable lobster divers, and together with about a core group of three of the divers from last year, I think there is a nucleus for restarting the enterprise. However, they have not picked a name to call their little company.

We finished soldering and testing the strings of cells and encapsulating the module by early afternoon. I didn't have to give much instruction since Cody can now do that so I spend the time taking photos and puzzling over the very wonky house wiring. In the afternoon, we worked on tracing the house wires and making the necessary changes to switch over to 100% 12 volt solar wiring. I thought I had it all worked out, but when we were ready to connect the battery to the modified wiring, the overhead lights wouldn't work (although we had continuity earlier in the day.

The next day, I had some new ideas on the wiring problem and while the group cut assembled the aluminum module frame and finished wiring up the strings of PV cells, continued to search for loose wires and bad grounds. The finished module worked perfectly and looked very professional. I also got the wiring all straightened out and hooked up the battery so we now had lights in the house. We spent the afternoon teaching a workshop on light emitting diodes (LEDs) and how to assemble them to make small 6 and 12 volt reading lights.

Installing the 60 watt PV module we had just finished building, onto the roof of Cody's new home.

The third day of the workshop was spent installing the new 60 watt PV module on the roof of the house and hooking it up through a charge controller to a set of two 12 volt batteries in parallel. This work took most of the day, but when we finished, the batteries were being recharged to replace the electricity we had used up running the soldering iron and power tools. We modified a portable electric drill to run directly from the 12 volt system, replacing its old, unusable battery pack with a line cord. During the installation, lots of neighbors and people walking along the street came in and asked lots of questions. Everybody was intrigued by the idea of having disconnected the power lines and replaced them with free power from the sun. The idea of borrowing electricity from the battery and replacing it with power from the very module we built also appealed to their sense of irony. That evening, we got invited to dinner with a group of German volunteers on the other side of town, so I got to practice my German, which I had not spoken in some years. However after enough Flor de Caña rum and Coke, it came back.

We had planned for Cody and I to take a trip up the coast, but this turned out to be difficult to arrange. We either had to rely on paying a small fee to ride with somebody who was already planning to go where we wished to visit and wait a day or two for the right boat (with a similar problem coming back) or pay a large fee to hire somebody to take us directly there. I didn't have the hundreds of dollars asked for the latter, or the extra week to spare to do the former, so I decided to come back to Managua early the next morning. The weather had turned very rainy, with real deluges and low areas were getting flooded, so spending 12 to 16 hours in a small open boat out in the Caribbean was also not looking all that inviting. I am going to continue working with the Miskito Coast people to see that the energy generated by the new workshop continues to excite people and that the new PV cottage industry takes off.