



NUST
Pakistan's National University of
Sciences and Technology

Pakistan – FATA Area Solar Pumping Project Implementation Stage

Training locations

Islamabad, and
Villages in FATA

Agencies in FATA

Khyber Agency
Kurram Agency
Bajour Agency
Mohmand Agency

Project dates

Training – May 2006
Implementation :
November /
December 2006

Areas Covered

6 Villages
2,116 People

Capacity of installed

PV Systems
4,800 Watts

Equipment for each Pumping System

1 – Solar Array
1 – Solar Pump
1 – Pump Controller
Piping from Pump to
Tank
Required Controls
and Wiring

In late 2005, Solar Energy International and the National University of Sciences and Technology were jointly awarded a USAID project to provide solar pumping systems for drinking water supplies in 6 villages of the FATA area in the Northwest Frontier Province of Pakistan. (NWFP).

To initiate this project, SEI conducted a training in Photovoltaic Systems and Solar Pumping Systems in April and May of 2006.

NUST then proceeded to finalize the locations of the candidate villages, and to design and procure the equipment required for the systems.



Class in May 2006

This equipment arrived in Pakistan in October of 2006, and in early November SEI returned to Pakistan to work side by side with NUST on the first two village installations, thus continuing the hands-on portion of the training, on site. This implementation training took place between November 6th and November 20th, 2006.

Work Preliminary to Implementation

After NUST received the primary equipment at their location in Islamabad, they proceeded immediately to test the equipment and then to order all of the required auxiliary equipment. (cables, pipe, fittings, racks, connectors, etc.)

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Every panel was tested with its Open Circuit Voltage and Short Circuit Currents being measured and compared to the ratings (adjusted for available sunlight at the time.) The panels were also arranged in strings of five panels, as they would be in the final installation, to test the string voltages and currents.

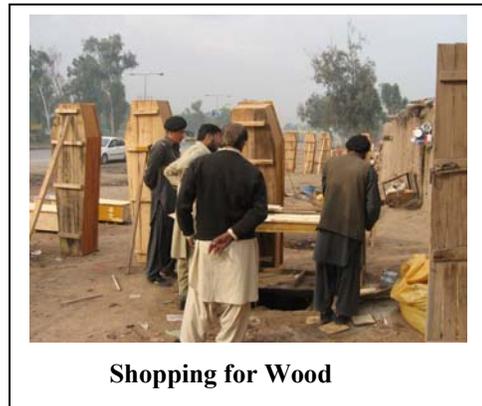
Each pump was connected to the 1,000 watt array (two strings of 5 – 100 Wp panels) to check that the pump functioned, and that the rotation was correct. Output piping was installed at a height that was able to simulate the TDH at some of the lower elevation sites.

No problems were identified with either the panels or the pumps.

The next step, prior to leaving for the villages, was to list and then procure all of the materials required to complete the installation. This includes conduit, wire, connections, piping, fittings, and a large assortment of various hardware and mounting equipment. After SEI and NUST compared notes on the required material items, the crew proceeded to go around to the various markets and procure all of the items, hire a big truck, and deliver the equipment to our partner NGO, CMDO, in Peshawar – the capital of the NWFP.



Unloading Truck in Peshawar



Shopping for Wood

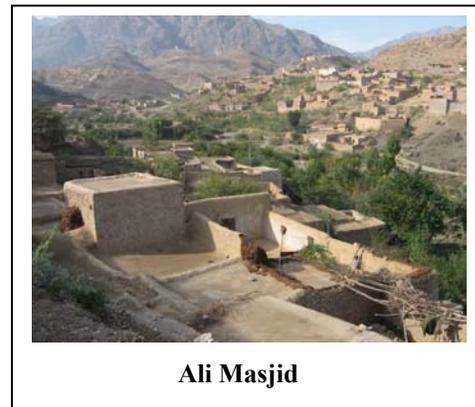
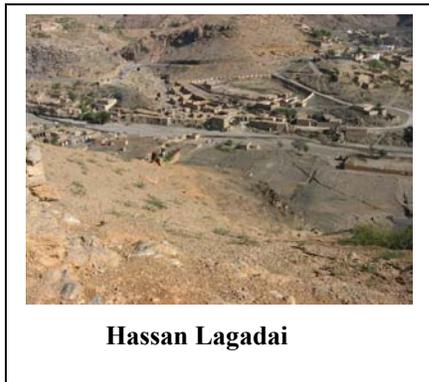
Scope of Project

There are six village systems included in this project for implementation in 2006. The table below lists the pertinent information for five of these six villages. The sixth village, not listed, is Mirdu Tang.

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| Village Name | Population | TDH | Gallons per Day | Pipe Length (Metres) |
|---|------------|-------|-----------------|----------------------|
| Hassan Lagadai, Tehsil Jamrud, Khyber Agency | 285 | 108 m | 1875 | 300 |
| Toda Cheena, Tehsil Lower Kurram, Kurram Agency | 500 | 61 m | 3553 | 370 |
| Khurhchai, Tehsil Mamund, Bajaur Agency | 630 | 50 m | 4145 | 55 |
| Shabana, Tehsil Ghalanay, Mohmand Agency | 271 | 98 m | 2139 | 219 |
| Ali Masjid, Tehsil Jamrud, Khyber Agency | 430 | 60 m | 3395 | 450 |
| Midu Tang | 320 | 110m | 3600 | 400 |

The joint SEI / NUST implementation stage would take place in two of these villages. NUST and CMDO chose the two villages located in Khyber Agency. This was a consideration made because of their proximity to Peshawar (within 1.5 hours of travel), to facilitate logistics. We had anticipated including Khurchai in the Bajaur Agency, as it is also fairly close to Peshawar, but the recent bombing of the Madrassah there (about 3 km from the village) influenced the decision to focus on the Khyber Agency villages first.



With two of the villages having Total Dynamic Head calculations of approximately 100 meters (over 300 feet), and total delivery pipe lengths of over 1000 feet, these projects would indeed prove to be challenging solar pumping installations. The rugged terrain between the pumping locations and the tank locations, one of the reasons for doing the project in the first place, was impressive.

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Implementation Work

On Monday, November 13, we had completed the testing, and the purchasing of all of the equipment and the truck with the supplies was sent on its way to Peshawar. We got our crew together in two vehicles and headed likewise for Peshawar, arriving there in the afternoon.

We had loaded all of the equipment that we had for all of the villages into 1 big truck. So, we had the truck stop first at CMDO's office, and off-load all of the supplies in a warehouse area that CMDO has set aside for this project. Then, we chose the equipment that would be needed for the two villages in the Khyber Agency, and loaded them back on the truck, which then left that evening for the villages to offload the equipment there. (The villages were close enough, that one staging area was used for both of the two sites..)

On Tuesday morning, we left for the sites to start the actual work. Due to the security in the area, and the fact that I am a foreigner, we were required by tribal regulations to stop every morning at the Khyber Rifle guard post in Peshawar and pick up a guard who had to stay with us at all times. This required a good bit of preliminary planning on the part of CMDO, which they were thankfully able to take care of quite efficiently. The rules were that we always had to be back out of the tribal area by sundown. (No one really said what time sun-down was, so sometimes sun-down was fairly dark....)



So, on Tuesday, we were able to assure that all of the equipment was at the two sites, and start the installation of the racks that would hold the solar panels. Also on Tuesday, we double checked all of the previous data that had been gathered regarding the depth of the water in the well, and the height of the tank relative to the water depth. That evening, we double and triple checked the calculations and the pump selection, and cable selections to be sure that we were making a proper installation. This checking was used as a training as well.

It took us all day Wednesday to get the excavation work and concrete mixing and pouring done to fix the racks for the 20 panels. This was quite a bit of work, and we expected that this might take two days, so we were fortunate to get it all done on Wednesday. Now we could start the installation of the panels on Thursday.

During Thursday, Friday, and Saturday, we proceeded with the installation in the following order.

- The villagers took the coils of 1.25" PE pipe and rolled it out from the well locations to the tank locations, and proceeded to dig the ditch for the piping (as well as the cabling to the float switch at the tank.)
- The installation crew, comprised of villagers, CMDO, NUST, SEI, and other folks who wanted to chip in, continued with the installation of the solar panels.

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- After the solar panels were bolted into the racks, the interconnection wiring could proceed, along with the wiring between the panels and the controller locations.
- Walls had to be built at each of the pump locations to hold the pump controller board and junction boxes. This work was done by the villagers.



It was Saturday when we were ready to make the down-hole assemblies for the piping and the wiring in the wells. This included assembling all of the 1.25" piping along with the safety cable, the power cable, and low water probe cable into

one group, making the submersible wiring connections, and lowering the assembly into the hole, fixing it at the top by the drop pipe, and fastening the safety cable as well.



We decided to include a manifold assembly at each location which consisted of two valves, and a "T" fitting. This would allow us to (a) test the pump at the well location without having to climb up the hill or look for waving hands to see if water is coming out, and (b) would provide an auxiliary water point for people who might need water at the well location. This assembly also provides a maintenance factor to be able to turn off the valve directing water up the hill, so if the pump has to be removed, we don't have to remove all of the water in the pipe first.

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On Saturday, when we installed the pump, there was very little sun. We didn't expect anything to pump, so we decided to leave the pump controller on, and the valve open at the first site, when we drove over to the second site. As we were climbing into the truck to move over to the second site, we heard a bunch of shouting, and pointing at the ground where we had installed the T. Even with the limited sun (barely enough to cast a shadow) the pump system was pumping water up the 70 feet of drop pipe to the ground level. This was of course quite encouraging, as the force with which the water was pumping with almost no sun, was a good sign of what it

could do with proper sun.

For the rest of Saturday, we completed the pump installation at the second village. I had to make it all the way back to Islamabad for my flight out to the States, so Saeed and I left the sites at about 2:30 p.m. The others stayed and completed the installations at both sites except for the joining of all of the pipe sections going up the hills to the tank locations. The others remained in Peshawar Saturday night, and returned on Sunday to complete this work.

After taking one week to catch up in the office with other responsibilities, the team is preparing to head back out to FATA to complete the next two installations in the first week of December.

This was a terrific hands-on training, and culmination of the program that started back in April with the classroom training program. By the end of the year, we expect that another couple of thousand residents of FATA will now have access to clean drinking water, at the location of their villages, which was only a dream a few months ago.



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