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# The Indo-U.S. Cooperative Photovoltaic Project

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# THE INDO-U.S. COOPERATIVE PHOTOVOLTAIC PROJECT

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## ABSTRACT

A cooperative program was established in 1993 by the governments of India and the United States. The 50-50 cost share project funded $500,000 of PV systems for home lighting, water pumping, battery charging, and vaccine refrigeration systems in the Sundarbans region of West Bengal, India. The project was designed as a sustainable rural economic development initiative with the Ramakrishna Mission, a well-respected humanitarian non-government organization (NGO) in this remote area of India. Special attention was paid to building an infrastructure for financing, installing, and maintaining the PV systems. A before-and-after impact study on the beneficiaries is being done. Lessons learned to date are presented along with details of the installed systems.

## INTRODUCTION

The Sustainable Rural Economic Development Ramakrishna Mission PV Initiative was conceived as a small-scale demonstration project that would show the economic viability of PV systems in the Sundarbans region of West Bengal [1, 2]. This region comprises hundreds of villages in the area criss-crossed by branches of the Hoogly River. There is no electricity grid in the area. Thousands of families living in the region depend on kerosene lighting systems and have no access to communications, television, or health facilities that require electricity.

The viability of the project was predicated on the systems being economical without substantial subsidy, and eventually without any subsidy at all. The operation and maintenance of the systems were the responsibility of the chosen NGO, the Ramakrishna Mission. The role of the mission personnel was to identify beneficiaries of the PV systems, define a financing arrangement that would be acceptable and sustainable to the villagers of the region, and serve as a banker to collect revenues from the end users. The potential for expanding the project beyond the limited demonstration was also a prime consideration. The cooperative nature of the project was expected to lead to improved relationships between our two countries and lead to further trade expansion. The project was also designed so as not to distort market forces, i.e., true costs. Further, without excessive subsidies and with end-user money required for participation, it was expected the systems would have the best of care. A more important consideration is that the benefits of electricity would be made available to those who in the past had little or no access. Improvements in educational opportunities, health care, productivity, and entrepreneurship were standards for success of the project. Finally, the project was designed to be self-sustaining. An infrastructure should remain that would support further applications, including financing, education, training, repair, and maintenance. Successful PV deployment under these most difficult circumstances would pave the way to acceptance of the technologies as a way to fulfill the tremendous need for energy in the developing world.

## APPLICATIONS

The following applications and participating villages were initially identified and agreed to. In the village of Gosaba (with 1000 families), the training center will be provided 10 lights for 4 hours of operation each night, two 30-watt wall sockets, a battery charging station for 10 (100 amp-hour) batteries and 20 solar lanterns, and three stand-alone streetlights with 11-watt compact fluorescent (CFL) lamps. The village of Katakhali, with 100 families, will be provided 90 domestic home lighting units with one 11-watt CFL and one 30-watt socket per home. The youth club will have two 11-watt CFLs and one 30-watt wall socket. Ten systems will be distributed to other villagers in the area. The village of Pakhirala will have its weaving center provided with three 11-watt CFLs, a community street light and eight 11-watt CFLs with two 30-watt wall sockets. These additions to the weaving center will extend the productivity hours by

Figure 1. Typical rooftop installations for solar PV lighting systems in the village of Katakhali.

about four per night. about four per night. The health clinic in Satyanaryanpur will get a vaccine refrigerator and eight 11-watt CFLs with two 30-watt electrical sockets. A second battery charging station for 10, 100 amp-hour car batteries, will be placed at the Chota Mollakhali youth center. The village of Kumirmari will have 100 home lighting systems with a 9-watt CFL and a 30-watt electrical socket. One home lighting system and one battery charging station have been shown in the village of Chhotomollakhali for community purposes.

A 2-week training program was available for 16 participants who were chosen by the mission for their background in basic electrical applications (including radio and television repair). The mission has a very good reputation for providing high-quality training in a variety of areas. Remote Power International prepared a detailed training manual that was left for the mission to continue training sessions after the trainers funded by NREL leave the area. During the two weeks, the last week was used to do hands-on installations in the island communities. Applied Power Corporation, the project's systems integrator, has prepared detailed schematics for all of the systems provided Table 1 shows a summary of the equipment to be provided.

## PROJECT RESPONSIBILITIES

The agreement between the U.S. Department of Energy and India's Ministry of Non-Conventional Energy Sources (MNES) calls for 50-50 cost sharing: the United States provides the PV modules, charge controllers, a water pump, and the training; India provides the batteries, CFLs,

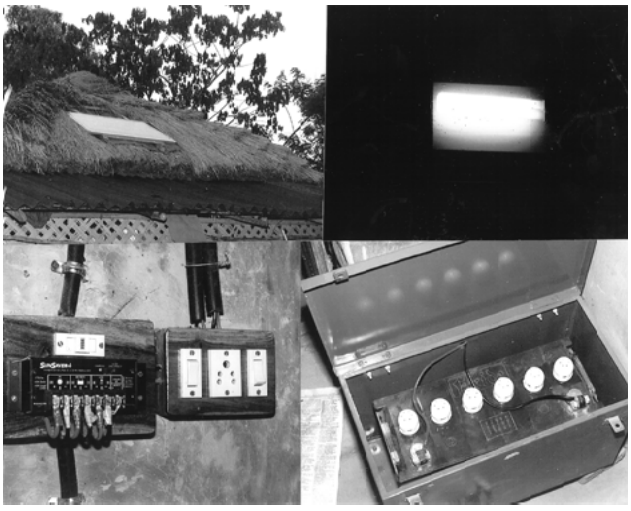

Figure 2. Looking clockwise, mounted PV module on a thatched roof, 9-watt CFL, 75 amp-hour battery mounted in a protective battery box and a charge controller and electrical sockets.

lamp fixtures, a vaccine refrigerator, mounting structures, all balance-of-systems components, and solar lanterns, and pays all customs duties for the imported system components. The Ramakrishna Mission is responsible for identifying the recipients of the various systems and participants in the NREL-furnished training sessions, providing follow-up training, maintenance, and replacement, and collecting revenues from the end users. NREL will also work with the mission to identify potential private-sector partners with whom proposals will be submitted to the Indian Renewable Energy Development Agency (IREDA) to move the project beyond the limited size possible from this initiative. The West Bengal Renewable Energy Development Agency is sharing part of the cost of the project and is providing technical guidance to the Ramakrishna Mission.

Table 1. Summary of systems and equipment to be provided

| System Type | Quantity of Systems Requested | Number of Solarex VLX-53 Modules per System (ea.) | (tot.) | Charge Controller, One per System |
|---|---|---|---|---|
| Home Lighting | 300 | 1 | 300 | SunSaver-6LVD |
| Training Center | 1 | 5 | 5 | ProStar-30 Marine |
| Youth Club | 1 | 2 | 2 | ” |
| Weaving Center | 1 | 5 | 5 | ” |
| Clinic | 1 | 5 | 5 | ” |
| Portable Lighting | 1 | 2 | 2 | ” |
| Vaccine Refrigera-tion | 1 | 10 | 10 | ” |
| Spice Grinding | 1 | 14 | 14 | None |
| Water Pumping | 1 | 16 | 16 | SA-1500/ SP5A-7 Pump |
| Street Lighting | 15 | 1 | 15 | Trace C-12 |
| Solar Lantern Station | 1 | 1 | 1 | ProStar-30 Marine |
| Auto Battery Station | 2 | 88 | 176 | Two APT2-4X special |

## PROJECT FINANCING

In India, the domestic unit of two lights plus one wall socket along with the necessary PV panel, battery, and accessories cost approximately Rs. 14,000 (1 $ ` Rs. 35). Out of this amount Rs. 6,000 is available as a government subsidy. Hence, the amount to be borne by the user is Rs. 8,000 per unit. The end user will be asked to provide a down payment of Rs. 3,500 at the time of installation. The rest of the amount (Rs. 4,500) will be treated as a low-interest loan to be repaid in monthly installments of Rs. 40 per month over 10 years. In this way, Rs. 40 x 12 months x 10 years, or Rs. 4,800, will be realized—Rs. 4,500 against the loan and Rs. 300 as interest. In addition to this, an amount of Rs. 20 per month will be charged for each unit as maintenance charges for which the users will receive free service at their doorsteps. However, the costs for spares will be at the owners' expense. Thus, the users will pay a total of Rs. 60 per month for 10 years. They may also opt to pay Rs. 100 per month (80+20) for 5 years. For a few beneficiaries of special category who are not in a position to make the Rs. 3,500 down payment, provision will be made to pay Rs. 500 only during installation and the rest of the amount will be treated as a loan to be repaid in 5 to 10 years. After the loan is liquidated, ownership will be transferred to the users. The amount recovered from the end users in the form of the down payments and loan interest will form the "Revolving Fund Capital" for the project, which in turn will be used to replicate the program among new users and also to finance replacement of batteries The sustainability of the project and its further replication is thus ensured through this arrangement.

## LESSONS LEARNED

When involved in a project such as this, you learn to be patient and expect the unexpected. In the United States, participants were determined through a public procurement process that takes typically six to nine months to complete. After selection of Applied Power Corporation and Remote Power International as the system integrator and training provider, system components were shipped by boat to India. Upon arrival in Calcutta the shipment encountered a dock strike. After waiting patiently, the next obstacle to be overcome was payment of customs duties, the responsibility of MNES. Unfortunately, the amount budgeted was inadequate because the components came in two shipments and the order could not be aggregated to take advantage of lower rates. Eventually, all was taken care of, but then the rains came with the onset of the monsoon season and local holidays and festivals to be respected.

Hence, the second lesson learned, and the most important, is to select a credible partner on the ground in the area. The mission is a well-respected humanitarian NGO with excellent credentials in training, education, and working with the area's poor. Just as important, the mission was empowered to select the beneficiaries of the PV systems, become trained in installation and maintenance, and serve as the banker to make loans and collect revenues from the project. The trained mission personnel now have replicated themselves such that a full complement of trainers exist in the area who can carry on once the government-funded project is completed. The mission has established a solar store in the region with separate funding from MNES where locals can purchase home lighting systems, arrange for the subsidies on the spot, and receive their systems from inventory. This type of solar store has been proposed by MNES for expansion this year to six stores. NREL is working with the mission to identify a private sector partner to team together on a proposal to the IREDA to expand the project in the region. Tens of thousands of potential purchasers of PV systems have been identified in the Sundarbans region alone. MNES has committed to an additional 2000 systems this year. This region can potentially have among the largest rural electrification projects in the world.

## OUTCOME

In addition to the project being self-sustaining, it is important to identify both positive and negative impacts on the beneficiaries of the energy systems. To accomplish this, a before-and-after impact study in the region is being undertaken. Another expectation by the governments of India and the United States is that business opportunities will be expanded as potential end users become better informed of the economics and performance of PV systems. This also extends to the financial community who will be responsible for making the necessary loans for any significant future purchases. NREL is working with the Solar Energy Centre of MNES to develop test procedures for PV modules and systems. Such test standards will insure that the various company's products will be evaluated on a fair and equitable basis as well as providing higher probability that reliable product will be fielded that meets expected performance criteria.

A successful outcome of this project can have impact around the developing world. The experiences of the beneficiaries in the Sundarbans will be common to billions of people who currently do not have access to the many benefits of electricity.

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