

# Solar Energy in the Developing World

## Orissa, India

### Introduction

Beyond Solar is a non-profit organization whose mission is to improve the lives of those in the developing world through the use of renewable energy. Co-Founders Jeff Olshesky and Trevor Knauf applied the concept of micro credit to the renewable energy sector to prove that the rural poor could afford the cost of solar powered lighting systems. The avoided cost of kerosene, the most common source of energy, and the ability to extend productive working hours would provide income to pay for the lighting systems. Beyond Solar's objective was to complete a pilot project that demonstrates a sustainable and profitable model in hopes that private entities, such as microfinance institutions and technology manufacturers, will see opportunity in this market and focus their efforts on a large scale distribution.

To execute this project, Beyond Solar partnered with D. Light Design, a solar lantern manufacturer with an office in New Delhi and distribution capabilities throughout India, and South Orissa Voluntary Action (SOVA), a registered non-government organization (NGO) in the Indian state of Orissa. This document provides background information on the region and villages, deployment methodology, and conclusion in regards to scaling opportunities. It is intended for those interested in participating in the large scale deployment of distributed solar lighting in rural villages.

### Village Information

Orissa is located in eastern India along the coast of the Bay of Bengal. With a population of over 36 million people, Orissa's rural landscape consists of many tribal villages, distinct from traditional Indian culture in language, custom, and average income. The region's tribal communities are among the poorest in the nation.

Puki, Ganjei Pradar, and New Kerenga are three tribal villages in the Koraput district of southern Orissa. An average village household of three to four people earns approximately 625 rupees (Rs) per month, equivalent to approximately \$12.50. The primary source of income for villagers is manual labor in the form of breaking stones into construction-grade materials and the seasonal sale of agricultural products, primarily rice, in nearby markets. The sale of plates made out of leaves supplements family income when time for fabricating permits.

The three villages are without electricity and are located an average of five kilometers from the nearest market, the only location to purchase kerosene. Kerosene is the primary source of light after sunset and an average household consumes approximately eight to twelve liters of kerosene per month. Government subsidized kerosene is sold at 10 Rs per liter, but quantity is limited to five liters per month per household, and villagers can only purchase one liter per day. Villagers can purchase supplemental kerosene on the black market for approximately 15-30 Rs per liter. Average households spend 100 to 150 Rs per month on kerosene. A round-trip to the market requires a minimum of two hours and consumes valuable daylight hours when villagers could be doing on income-producing work.

Kerosene as a lighting source creates many health and safety hazards. Village homes do not have efficient ventilation and indoor combustion causes routine respiratory problems. In addition, careless children, stray dogs, or even wind can knock over kerosene lamps causing fire. Each of the three villages reported home destroying fires in the last two years, with two of the villages reporting severe injuries from burns.

### Solar lantern benefits

Beyond Solar purchased D. Light Design solar lanterns, which consist of a two watt solar panel, a connecting wire, and a lantern that contains a battery, charge controlling chip, and a LED light. The connecting wire is easily removed from the lantern and the handle design and light weight

allow for portable use. The lantern has four brightness settings, and on a fully charged battery, the light will last for 12, 20, 40, and 200 hours in decreasing order of brightness. The battery takes approximately 12 hours of direct sunlight to charge completely.

To collect data on the effectiveness of the solar lantern, Beyond Solar provided the three villages with solar lanterns for a trial period of seven nights. After the trial period, Beyond Solar interviewed the households that used the lanterns and found that they did not consume nor did they have to purchase any kerosene during the seven days. Users also gathered and processed rice during the time previously allotted for trips to the market to purchase kerosene. Additionally, with use of the solar lantern, villagers were able to perform domestic activities, such as food preparation and home maintenance, after sunset. This extended their work day and increased earning potential. Finally, the light of a lantern allowed each woman to assemble enough leaf plates per night to earn 10 Rs at the local market. Beyond Solar estimated total financial benefit per lantern at 300 Rs per month, depending on seasonal conditions.

The villagers also reported many qualitative benefits to the solar lanterns. They felt safer knowing that an errant movement would not knock over the lantern and cause fire. Children were able to study at night. They also prevented insects from getting into their food during meal preparation and consumption. Women valued not only the economic benefit of making the leaf plates, but the social value of working communally at night as well. The village leaders held community meetings and noted the lantern's potential during village festivals, when villages typically spend thousands of rupees on kerosene. Finally, users of the lanterns felt safer at night walking through the village with the lantern, as bears and other predatory animals are a constant threat.

### **Deployment**

After collecting data from the trial period, Beyond Solar distributed 162 lanterns to each of the villages. Villagers provided a down payment of Rs. 250 and have agreed to pay an installment of 25 Rs per week until the 1200 Rs price of the lantern is recovered. The Village Development Community (VDC), consisting of village leaders, is responsible for collecting payments and is also responsible for maintaining records of each individual's payment history. Once a month, a field representative from SOVA will meet with the VDC to discuss any issues with payments. The field representative will also transfer money collected by the VDC into a general account in the name of the village, which will be available to the village to finance future projects. Villagers who miss more than two consecutive payments will have their solar panel confiscated by the VDC until payments resume. SOVA prepared a registrar with the name of each individual participating in the program. Literate villagers signed their names to make the agreement official; those who could not write made fingerprints next to their name. Though the agreement was largely symbolic in nature, villagers took great pride in assuring SOVA and Beyond Solar that they were capable of repayment.

This benefits of this model are threefold: moving away from the donation style of simply giving products away for free will give the villagers a greater sense of ownership while maintaining dignity; establishing credit amongst the villagers will enable them to participate in similar village empowerment programs in the future; and by recovering costs, the private sector can replace philanthropies as the source of funding, making the projects sustainable and scalable.

### **Follow-up**

At time of writing, two months have passed since the distribution of lanterns to the villages. The SOVA field worker has reported that all villagers are current with their payments.

## **Obstacles**

Though the initial data collected during the pilot project in Orissa have been positive, many obstacles exist that could prevent future large scale deployment of solar powered lighting to non-electrified villages in rural India.

### *Financing*

Beyond Solar purchased lights at 1100 Rs and entered into agreements with villagers for a total repayment of 1200 Rs, over a span of approximately nine months. As a non-profit organization, Beyond Solar did not have to take into account cost of capital, payment default, shipping and logistics expense, or profit. A private enterprise would most likely require a profit greater than 100 Rs per lantern, which could increase the cost per unit up to 30%. Though the long term economic benefit of the lanterns is apparent, the increased weekly installment requirements may prove too much for the average villager to commit.

### *Village Culture*

Interest in the solar lanterns amongst the villagers was extremely high and the benefits were readily apparent. Even with an installment program, however, the villagers had a difficult time appreciating the value of the lantern when considering its total cost. The concept of investing in a product that will more than pay for itself over time was extremely complex and required a significant amount of explanation. In addition to the relative high cost of the lantern, villagers were also rightfully concerned about making payments during the slower times of their economic cycle, especially the monsoon season. Finally, the pilot project is still too early in its stage to predict accurately what default ratios will be.

## **Conclusion**

Solar powered lighting has a tremendous impact on the lives of rural people without electricity. In both quantitative economic terms as well as qualitative lifestyle conditions, the benefit derived from such a simple device is irrefutable. Users of the lighting systems increase productivity and income, while safety, education, health, and general quality of life all benefit. Yet wide scale deployment of solar powered lighting has yet to take place.

To facilitate the large scale deployment of solar powered lighting, private enterprise must be involved. For this to happen, the three parties expected to participate in this market must address the following issues:

1. *Technology Manufacturers:* Product costs must come down. Economies of scale in both production and logistics can effectively lower costs, but maximizing energy production and storage must be at the forefront in the minds of manufacturers. Suggestions include centralized charging stations that would maximize the use of solar panel production as well as the use of more efficient lithium-ion batteries (though limited availability of lithium-ion batteries may add an additional cost when factoring replacement).
2. *NGO's and Village Leaders:* Villagers must be educated on the advantages of solar powered lighting. All parties easily identify the initial benefits, but community development efforts should focus on the long term value. Many rural villagers, and by association, the NGO's that support them, do not have the long term vision to encourage investing in a product that will help to improve living conditions over its useful life.
3. *Microfinance Institutions(MFI):* MFI's will be the most likely funding source for such initiatives and should establish business units focused solely on deploying distributed renewable energy solutions on a large scale. Through further research and analysis, large scale implementation can become a realistic and profitable venture.

By overcoming the challenges of finance, culture, and technology, solar powered lighting systems can become a reality in much of the developing world. This will create a sustainable, environmentally friendly, and dignified way to improve the lives of millions of people and help in the efforts to alleviate poverty.