

The Tuki: Lighting Up Nepal

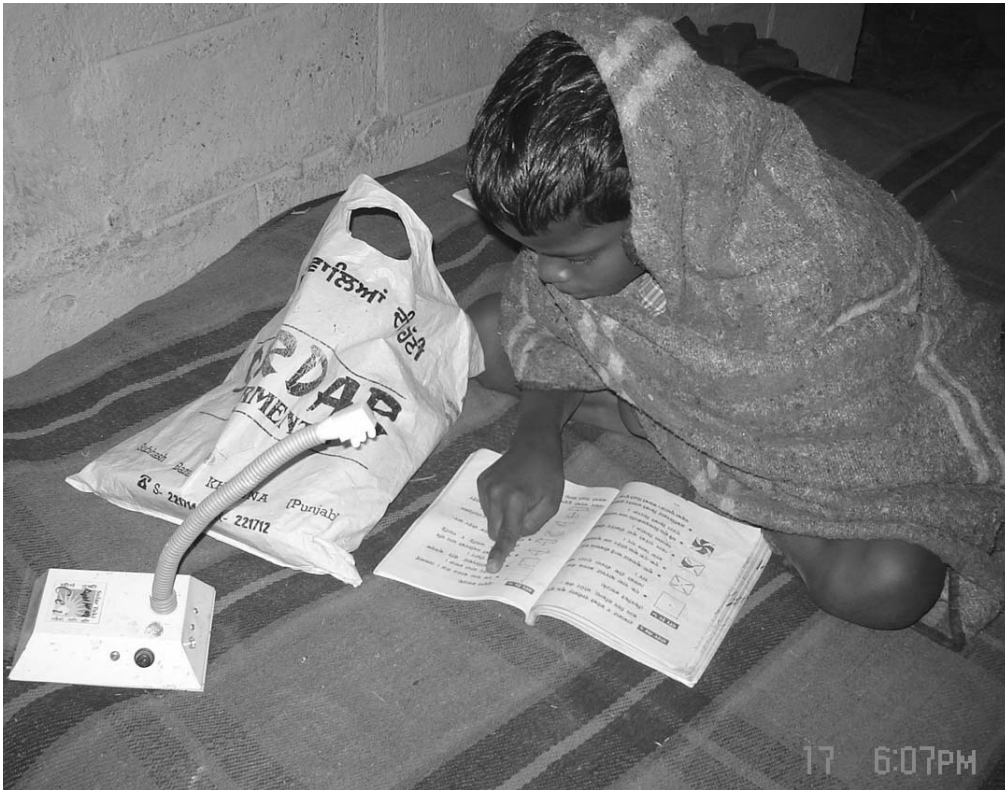
*Innovations Case Narrative:
Solar-Powered Tuki*

The effort to provide the world's poor with affordable, safe, and sustainable solutions to the problem of energy poverty has yielded myriad solutions. Current methods of providing light, heat, and energy for cooking pose major health and safety risks to users, often the same people who struggle every day with poverty and its resultant problems. Our work in conservation awareness and sustainable resource use in Nepal has led us, among other projects, to promoting the Solar Tuki, a white LED lamp powered by batteries that are recharged with a small solar panel. Each unit has additional functionality that extends to charging mobile phones and powering small radios. The Solar Tuki provides a clean, affordable, and safe alternative to the more prevalent, dangerous, and expensive kerosene *tukis* (lanterns). In addition, the light and power it provides acts as a platform for other development drivers related to education, communication, and income-generating activity that will, down the road, improve the quality of life for all those who adopt the Solar Tuki technology.

Anil Chitrakar trained as an engineer and energy planner, and for the past 25 years he has worked to bring technology to rural communities. Through his work, Chitrakar seeks to enable communities to manage local natural resources, and he has assisted in crafting national and international policies that affect natural resource management. He directs Environmental Camps for Conservation Awareness in Nepal, an organization he founded.

Babu Raj Shrestha has worked as an aeronautics engineer, having earned his degree in mechanical engineering. He currently serves as president of the Centre for Renewable Energy, a Nepali organization that promotes sustainable technology, such as solar driers, wind-driven pumps, and solar stoves, to help local communities make the best use of their resources.

Chitrakar and Shrestha and their respective organizations joined in a partnership to manufacture, distribute, and promote the Solar Tuki, a solar-powered white LED light, to replace kerosene-fueled lanterns as the dominant form of lighting tool used in Nepal's poorest communities.



A student at work using the Solar Tuki.

Users of the Solar Tuki, a simple device for which spare parts are easily available, can leave the lamp in the sun all day long, which will power it to work for up to 10 hours during the evening. In Nepal, an average of 300 sunny days a year provides a ready supply of power without incurring continuous costs for fuels like kerosene. We continue to train local entrepreneurs to manufacture, repair, and sell the device on their own, and have begun to expand both the supply chain and the marketing networks to further weave the Solar Tuki into the Nepali social fabric.

At present, we can report that 300,000 units are in use in over 150,000 households across Nepal. Six private enterprises play roles in manufacturing the device; an additional three companies help to produce the inputs needed to assemble the tuki. In addition, over 40 nongovernmental organizations operating savings and credit programs have helped us to create a cost-effective mechanism through which our target population can purchase the product. Creating a business model that operates self-sufficiently and still reaches the poorest groups has required inventive solutions, as well as a clear vision for future projects that will speed the tuki's adoption throughout Nepal and other areas that experience similar conditions. However, the breadth and depth of energy poverty throughout the region, in

addition to a bleak outlook for improvements to the conventional energy infrastructure, adds to the urgency of developing workable solutions.

NEPAL'S ENERGY LANDSCAPE

Nepal's terrain reaches across geographical extremes. Its special setting poses unique challenges to those committed to improving the quality of life and the economic opportunities available to its residents. Development professionals must understand these conditions if they intend to succeed at designing and distributing technological innovations that meet the needs of the people they seek to assist. With an average annual per-capita income of US\$300, the roughly 28 million Nepalis rank among the lowest in the world in terms of purchasing power, making their energy problems all the more severe.

The type of electrical power available and access to it varies from region to region. The country's elevation varies from around 100 meters above sea level to about 8,000 meters within a range of just 150 kilometers. This makes Nepal look like an ideal place to generate hydropower. Despite this potential, however, power plants in Nepal currently produce only 600 megawatts (MW) of power per day. (In the United States, 500 MW typically powers a city of 300,000, about the size of Seattle or Milwaukee.) Efforts to create small hydropower plants that are owned and managed by local communities have led to the construction of over 1,000 of these generators, each of which produces between 5 and 500 kilowatt hours (kWh). In addition, about 200,000 biogas or methane gas-powered plants operate in Nepal today, lighting about 9,000 homes. The simple technology of these generators uses methane gas, mostly from animal manure, to produce energy. An additional 96,000 homes use other sources to supply energy, such as animal fat, vegetable butter, and strips of resin-laden pine. Many homes simply use light from a fireplace that is also used for cooking and heating, or rely on tools powered by conventional dry-cell batteries.

Despite these numbers and the advances made in biogas and micro-hydropower plants, only 1.6 million Nepalese homes have access to an uninterrupted supply of electricity. Very few of the nearly 28 million Nepalis have access to electricity and the grid. In the midwestern region of Nepal, only 18 percent of the 65,000 homes have access to electricity. This year, the situation became much worse due to scant rainfall, an important source of water for reserve inputs at plants generating energy. Subsequently, even the few who have a connection to the grid had to bear with as many as 16 hours of daily power outages during the dry spell. This meant there was no power for homes and offices, which then had to invest in diesel generators. The Nepal Electricity Authority has lost millions in revenue due to these outages. Worse still, about 96,000 of the country's total 4.1 million households live in total darkness during the night without any source of energy to produce light; among them are some families who do not even have access to kerosene-powered lamps.

For 2.4 million households, 2.3 million of them in rural areas, kerosene lamps serve as the primary source of light. The government imports the country's entire supply of petroleum products, including kerosene, using its very limited foreign currency reserves. Frequent strikes and highway blockages constantly interrupt the stream of these materials into Nepal. Furthermore, day-to-day increases in international petroleum rates only exacerbate the difficulties of supplying kerosene. In fact, this problem is so severe that the G8 countries have introduced a plan to create an antishock fund to protect developing countries against the rapid rise in fossil-fuel prices. The government has raised the prices of petroleum commodities many times over the past few years, as many as three times in a five-month period. One such increase raised the price of gasoline and diesel by 10.71% and 17.14%, respectively. The price of liquefied petroleum gas went up by 13.33%, and the price of kerosene rose still higher, increasing by 28.57% and leaving subsidized kerosene up 25% per liter. Taxes bring the amount paid by consumers to even greater heights relative to national income, and these prices only continue to go up.

As a result of these high prices and the pressing need for fuel, Nepalis go to great lengths to obtain kerosene and other petroleum commodities. Along the Mahakali River, which forms Nepal's natural border with India, villagers walk an average of three days to the markets in India to buy kerosene. In India, consumers pay half as much as in Nepal, due to a better distribution infrastructure and subsidies from the Indian government. However, the limited supply of subsidized kerosene makes it difficult to acquire in large quantities. On any given day at the Dharchula suspension bridge that spans the Mahakali, one can see 150 to 200 Nepalis crossing over to get kerosene, bringing back a combined amount of 1,000 to 2,000 liters.

The use of kerosene-powered tukis presents major health and safety risks as well. Lamps cause fatal accidents and fires, as tragically illustrated by the recent destruction of an entire village in Bhojpur. Small-scale fires occur on an unfortunately frequent basis, and the fumes and smoke from the lamps damage people's eyes and lungs. Those who lack access to electricity face these risks every day, just to obtain weak light of inferior quality.

SOLUTIONS: MAKING A SUSTAINABLY POWERED LIGHT AVAILABLE TO THE POOREST MILLIONS

We have been working to provide technological solutions to rural Nepal for over two decades. During this time we separately introduced many solutions, including the methane gas plant, the small hydropower plant, solar cookers and driers, some wind technology for lifting water, and cooling and refrigeration for vegetables and fruits.

Eventually, like minds met, and we began to work on the Solar Tuki together. We also both became Ashoka Fellows (although at different times). For both of us, it has been a lifelong undertaking to make technological and other kinds of solutions available to people who live in impoverished conditions that simply need not

be that way. The first time Anil set up a solar light was in the mid-1980s, when it was too expensive to be practical. However, the light, battery, and panels have since become much better and more affordable. We did not wake up one fine day and decide to build and sell the tuki. Developing the radio, the mobile charger, and now a chlorinator has been a natural evolution involving not only our individual efforts but the combined efforts of our respective organizations: Babu's CRE (Centre for Renewable Energy) and Anil's ECCA (Environmental Camps for Conservation Awareness). ECCA is now about 20 years old; since its founding it has mobilized young people to be the first adopters of new ideas and solutions aimed at resource management. CRE has also been dedicated to transferring renewable and clean technologies to rural Nepal.

Through the partnership, Babu and CRE focus on the technology while Anil and ECCA focus on distribution. Together we entered the tuki in a local competition in Nepal. We won \$25,000, followed by another \$50,000 from the Global Environmental Facility of the UN. We then took the tuki to the World Bank's Development Marketplace, where we won an additional \$92,000. Then we got \$100,000 from the carbon fund of a U.K.-based company called ERM. The money helps us develop new products, such as the chlorinator mentioned above, which is powered by the same solar panel as the Solar Tuki.

Our primary goal is to create a self-sustaining system to produce the Solar Tuki that is paid for with revenues generated by sales. Meanwhile, we must sell the tuki at an affordable price point and create as many mechanisms as possible to make it easy to pay for. The Solar Tuki producers receive no subsidy, and the price—which pays for one three-watt solar panel, two tukis, and a cord to attach a radio—reflects the real cost of manufacture, overhead, and distribution. Moreover, we do not want to sell a Solar Tuki and then leave the buyer with a damaged or nonfunctional unit. Therefore, the price of the tuki also pays for a five-year warranty on the entire set. We train local individuals to provide repair and maintenance and keep spare tukis available for immediate replacement in case one is damaged. Although the initial cost of the set shocks those used to the cheap lights imported from China, they begin to prefer our tuki when they understand that the price includes a five-year warranty and after-sales service. These people cannot afford the luxury of throwing something away as soon as it stops working, but that is inevitable with cheap Chinese products.

As most of the targeted beneficiaries of our tuki live below the poverty line, most of them cannot afford the up-front cost. Therefore, we have implemented a microfinancing system that enables customers to purchase our tuki on an installment basis, paying the equivalent of US\$2.30 each month for two years. This approximately equals the amount they now pay for kerosene or dry-cell batteries. At the end of the two years, the users continue to get clean light and access to the radio at no cost, until they need to replace the rechargeable batteries, usually after an additional three years. We can reach even the most difficult markets using this program. For example, for the Mushahars of Nepal's eastern plains, probably the



We aim to make training hands-on and accessible.

poorest section of Nepali society, we have set up a revolving fund that charges for the tuki at only 4 percent interest.

One key way we disseminate the tuki is through training and orientation. ECCA has a training center in Kathmandu and CRE has one in eastern Nepal. Basically anyone who says he or she wants to launch an enterprise can sign up for a three-day training program on the basics of launching an energy enterprise. Training covers ways to deal with issues of natural resources management and explains the workings of saving and credit groups. We also train participants on the basics of building a Solar Tuki and encourage them to share many past experiences—both mistakes and successes. We keep it very informal.

A key challenge of getting the tuki to the most remote areas with high demand is proper distribution. The primary strategy allows local entrepreneurs to make over 36% of the total cost of the Solar Tuki by assembling and marketing it themselves. This network of local entrepreneurs throughout Nepal provides the best and probably most effective model we have developed. The huge market for our tuki requires this kind of decentralized assembly and transport in order to succeed. Moreover, with local assembly, 36% of the tuki's cost enters the local economy as wages. We support this network through centralized strategic advertising. We already have a model entrepreneur in Biratnagar in eastern Nepal who is producing 300 sets, and another is producing 200 in Kathmandu.

MOVING FORWARD: GROWING IN A CHALLENGING ENVIRONMENT

Ever since we started working with the Solar Tuki we have faced significant challenges; some of them have more to do with attitudes than with technology. Generally, we knew that there are people, in the charity world especially, who raise money by presenting a good victim. Their focus is not on the solutions but on presenting the problem in the most articulate manner in order to raise money. The biggest challenges for us have always come from these people, who ask questions like, How will the poor pay for this when they do not even have enough to eat? Is this a priority? But we are thick skinned and never ask for anyone's permission or money to do the things we believe are important; when some people caught on to what we are doing, they came to help. Another challenge arises when the government steps in and wants to distribute the tuki free of cost. That destroys the market for a long time and creates a dependency that is hard for people to escape. Also, donors tend to prefer to subsidize the consumer rather than the technology and the people who make it happen. These are all challenges we have faced and continue to face.

The savings and credit groups have provided the principal financing for the tuki's spread throughout Nepal, and the grants and prize money, like that awarded to us by the World Bank's Development Marketplace, have helped us build our capacity to develop and distribute our tuki and provided the finances we needed to start initial production. In addition, two years ago we lobbied the Nepali government to help pay for the tuki as part of a plan to go to scale. However, the funds the government allocated for 60,000 units went toward distributing the Solar Tuki free of charge, instead of through savings and credit groups or subsidies, as we had proposed. Although this helped spread the technology to remote parts of Nepal, it also created a new dependency and a huge distortion in the market. Many of the tukis found their way back into urban markets, as some recipients sold their devices, seeing that as an easy way to make money. We must remain cautious as we move forward and grow, avoiding this sort of philanthropy and remaining true to our business-driven model.

Our growth becomes all the more critical when one takes into account the increasingly difficult energy landscape in Nepal. The government made its last big investment in a major hydropower project, the 70-MW Marsyangdi plant, five years ago, and only the 30-MW Chamelia and 14-MW Kulekhani are planned for construction. Nepal continues to recover from a ten-year armed conflict, and for at least the next five years the government will have little capacity to build and deliver large-scale energy projects. Therefore, the Nepal Electricity Authority (NEA) has no funding to pay for anything larger than these plants, and the ongoing political uncertainty and threat of new conflicts makes it nearly impossible, even to field exploratory teams. The NEA predicts that the demand on the current grid will grow by 75 MW each year for the next 20 years, which will only increase the current power deficit of 400 MW. With conventional electrical power unavailable, tools like the Solar Tuki will become ever more important.

It will require some innovative changes on our part to produce and distribute the number of Solar Tukis necessary to fill the gaps left by a failing energy infrastructure. We do not doubt that there is a huge market for our tuki, but it is a challenge to find manufacturers who will help us meet this demand. In addressing this challenge, we plan to maximize the backward and forward economic links between creating jobs and eradicating poverty. We also believe that those previously excluded from the mainstream economy could do this job best. These target groups include local entrepreneurs, single-women's groups, and even kerosene-tuki burn victims, who know better than anybody the pain that the Solar Tuki helps its users avoid. Assembling tukis near the end users through groups like these will benefit everybody, and we continue to develop these programs. Environmental Resources Management, a U.K.-based company, has helped us build a central warehouse for parts so we can develop our decentralized manufacturing model.

In terms of marketing, we intend to grow by developing new partnerships, novel forms of purchase and payment, and additional appropriate products. For example, the diverse Nepali market has the unique feature of being almost cashless. People in the most remote areas of the country trade primarily through barter, and Nepal is one of the few remaining places on earth where most people grow or gather what they need. In a region so rich in natural resources, villagers can weave baskets and mats from local fibers, make paper from local shrubs, extract oil and herbs from the local forest, and engage in a variety of other activities. The production of these items gives us a variety of options, as finding a larger market for these products could enable people to pay for household appliances, the Solar Tuki among them, that would improve their quality of life. In the hill district of eastern Nepal, Madan Rai of the Khotang Development Committee (and also an Ashoka Fellow) has initiated a program to promote raising goats among the Brahmans and Chettris and pig raising among the Rai villagers. Dealers weigh the livestock, and when they meet the Solar Tuki's price point, we can make a trade. If this model begins to work, we can replicate it with other easily saleable commodities, such as fruit, coffee, and bamboo.

In terms of manufacturing, we tried to do it with two private companies, one each in Kathmandu and Biratnagar. Both failed. We then began to train local entrepreneurs. Today, more than 13 local manufacturers are involved in assembling and distributing the Solar Tuki, and we have the resources for a central warehouse to support many more.

We have always believed that we have to focus not on the cost of a technology but on how much people can pay. If it were not for the many groups setting up savings and credit programs in Nepal, we would not be able to sell the tuki. Initially we thought we could offer the design to local workshops—Maharjan Electric in Kathmandu and Krishna Grill in Biratnagar—to see if they wanted to manufacture the lights. It did not happen. Then we began to have conversations with the Karnali Savings Cooperative, which gave us many helpful insights. Pati Bhara Solar Industries became the first group to assemble the tuki and sell it according to the savings and credit model. Shree Savings Cooperative was the second. The Bhojpur



Charging up the Solar Tuki with a rooftop base station.

and Khotang districts in remote areas of eastern Nepal then followed.

To further reduce the per-household cost of the Solar Tuki and reach the poorest of the poor, we have developed and begun to promote a community-based charging model, as opposed to the present model, where each house owns one 2.5-watt solar panel and two lamp units. In this new model, the villagers set up a large solar panel (36 watt or 50 watt), together with a charger that has many (20-40) outlets, in a community building (e.g., school or ward office), and people who have Solar Tuki lamps will charge them there. This way, people will have to buy only the Solar Tuki lamp, which costs US\$11, eliminating the need for each consumer to buy the more expensive solar panel at US\$28. Poor people will have to invest less money, which will bring more of them within reach of the tuki. Villagers could extract extra value from the solar panel by using it to charge the local battery system and light the community building itself. In Nepal's remote western district of Myagdi, Ashoka Fellow Mahabir Pun runs a number of schools. The children have no access to electricity and therefore can only study by day. In order to change this situation and give the children access to solar light and radio, Mahabir has given each student one of our tukis. They use them at night and must bring them to school the next day to be recharged at a collective solar panel charging station. The users repeat this process each day. This model eliminates the cost of the solar panel and enables each family with a school-going child to pay for only one Solar Tuki, rather than for two tukis and a solar panel.

Finally, we have initiated a series of pilot programs to both extend our vendor reach and make the tuki available through partnerships with other organizations. We already have begun to leverage the existing network of kerosene dealers as a resource for distributing the Solar Tuki. If these successful salesmen can grasp its powerful potential benefits, they will play a vital role in distributing the tuki. Industries and businesses can make the Solar Tuki available to their workers and primary producers, and also create a financing mechanism that allows workers or vendors to use part of the price of the product purchased, or part of their wages, to pay for the Solar Tuki. We have begun to implement such a scheme in partnership with ITC Nepal/Surya Nepal for the Simra area of south Nepal.

Worldwide, 1.6 billion people go to bed after blowing out a kerosene lamp—this, at the beginning of the 21st century. We cannot accept this reality, given the fact that simple, clean, and affordable lights can easily replace the kerosene lamp. We must commit ourselves to change this state of affairs and apply the lessons we have gathered through promoting the Solar Tuki. The relatively low capital cost of the device allows for its mass dissemination, provided that certain support mechanisms are in place. Most important, we must mobilize every community and instill in their vision for development an awareness of environmental conservation and applying clean technology. A change in these attitudes, more than anything else, will lead to real development among the Nepalis.