The Rosenfeld Fund for Global Sustainable Development

Energy Efficient & Environmentally Conscious Solutions for the Poor

ULTRAVIOLET WATER PURIFICATION
A model of success that the Rosenfeld Fund is designed to replicate

Two methods of gathering drinking water –before and after Water Health International. WHI is an innovative application and commercialization of a technology that benefits the poor while protecting the environment – a tremendously successful model that the Rosenfeld Fund is designed to repeat.

The Problem: Over two billion people lack access to potable water. Of those, about one billion have the ability to boil their water. When they do, about half will use biomass for fuel. Even if sustainably harvested, this fuel wood, burned inefficiently, will emit greenhouse gases equivalent to 500 MtCO2 (500 million tons of CO2) per year, -- which is the CO2-equivalent to the tailpipe emissions of 100 million US cars. The other half billion will probably use kerosene, which burns 5-fold more efficiently, but still produces greenhouse gases equivalent to 20 million cars.

Real-world Solutions: UV Waterworks (UVW) traces its origins to a class that Dr. Rosenfeld taught at UC Berkeley from 1975-93, and was invented at Lawrence Berkeley National Lab (LBNL) by Dr. Ashok Gadgil, a colleague of Dr. Rosenfeld. After an initial investment at LBNL of $300,000 to develop and test UVW, this innovation has produced incredible real-world results. Licensed by LBNL, UVW has now been commercialized by WaterHealth International (WHI), and hundreds of units are installed in India, Sri Lanka, and the Philippines. Drawing only 60 watts of power for a germicidal lamp suspended over a trough of flowing water, a single UVW unit disinfects water at a rate of 20 tons/day, enough to supply a village of 2000 people. WHI is now selling WaterHealth Centers (called WHC-65) with three UVW units, storage tanks, and filters. Serving a village of 6000 people, each WHC-65 costs about $60,000 (and comes with an 8-year service contract, and education materials for health and hygiene). A large Indian bank (ICICI) is lending most of the necessary funds, leaving a small fraction to be paid by the village council. To repay the loan and cover operations, in 2007 the individual villagers paid just 2 US cents per 3 gallons of water (a day's supply for one person), which is perceived to be both affordable and cost-effective even to those earning a dollar a day. One million villagers are now using UVW, providing clean water to families, and avoiding 600 diarrheal child deaths per year. In September 2007, Dow Chemicals Co extended a $30 million loan guarantee. In response, ICICI is offering loans to 3000 more villages to purchase CWS, thereby ultimately serving almost twenty million more people.

Impact on the Environment: WHI has the potential to eliminate the emissions from boiling water for a billion villagers -- a CO2-equivalent to eliminating the emissions of over 100 million US cars. In other words, for every1000 users, three tons of firewood is not burned *each day*, and so about three tons of CO2 equivalent is not produced *each day*. The typical US car emits five tons of CO2 *each year*, thus 1000 villagers using UVW can offset 200 US cars, and India alone has a rural population equivalent to half a million such villages.[1]

Water Health International's remarkable success is an example of what the Rosenfeld Fund has been established to repeat: the development and deployment of technology to benefit the poor that is also energy efficient and can help delay global climate change.

[1] For more information about these carbon calculations, please see "Energy-Efficient Drinking Water Disinfection for Greenhouse Gas Mitigation," ACEEE Summer Study 1998 Paper, Ashok J. Gadgil, David M. Greene, Art Rosenfeld, Asilomar, August 23-28, 1998.

CURRENT ROSENFELD FUND PROJECTS

Two examples of current Rosenfeld-supported projects are "Cookstoves for Darfur Refugees" and "LED Lighting to Replace Kerosene Lamps." These projects, and others now under consideration, share two fundamental goals. First, the Rosenfeld Fund supports innovative technological solutions to help the poor with their energy needs. Second, these same Rosenfeld supported projects do so in a manner that is both energy efficient and environmentally conscious.

1) COOKSTOVES FOR DARFUR REFUGEES
World-class engineering applied to a desperate problem

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Otash Refugee Camp in Darfur:
Women return from search for fuel wood

Dr. Ashok Gadgil:
Re-engineered cookstove for Darfur

The Rosenfeld Fund supports several coordinated cookstove projects, of which the Darfur Stoves is described here.

The Problem: There are approximately 2.2 million refugees living in camps in Darfur, mostly women and girls because many of the men have been killed. Refugees rely on firewood to cook the meager rations they receive from the United Nations. However, because the area around the camps is now fully denuded, the average outing to collect firewood is now over 7 hours (up from 5 hours just a year ago). During that journey, women and girls risk being raped or killed by the Janjaweed. Their only other option is to trade a portion of their food rations for firewood, making increased hunger the only alternative to the dangerous journey.

The Solution: Dr. Ashok Gadgil focused on engineering a better cook stove to replace the highly inefficient traditional "three stone" technique. To begin, he selected four cookstove designs likely to work in Darfur, given the uniqueness of the region (the lack of fuel, the local food habits, and the extremely windy weather). Testing in Darfur refugee camps during the fall of 2005 revealed a design that saves half the fuel when compared to the current three-stone technique. Then working with UC Berkeley students during the spring of 2006, Dr. Gadgil improved the efficiency of that stove, so it now saves 70% of fuel. In Nov-Dec 2006, the first 50 stoves were built in Khartoum and successfully field tested. In April-June 2007, the team set up a small workshop in South Darfur to build the stoves, trained local refugees to make stoves, and produced the first 200 locally built stoves which were distributed in the refugee camps. Current

production from that workshop is a very modest 500 stoves per month. Gadgil's team is developing a supply chain so that flat-kits punched from sheet metal can be shipped to Darfur and assembled locally into stoves at a lower cost and much higher production rate.

Impact on the Environment: From a global warming perspective, the 500 kg of wood not burned annually by each improved cookstove avoid the annual emission of about 2 tons of CO2, which can be compared with the typical 5 ton tailpipe emission from your car. The 2.2 million Darfur refugees comprise about 300,000 households. Thus, providing efficient cookstoves to 300,000 households is equivalent to getting 120,000 US cars off the road.

Real-World Deployment: Each stove will cost $20 when assembled in Darfur, and will save $240 worth of fuel wood (about 500 kg) every year per household. This is both financially viable for people in the refugee camps, and also economically beneficial for the region where it can increase local employment and stop environmental degradation. Next steps include engineering the proper production facilities for the stoves in the region (including local testing for quality) and collaborating with local humanitarian groups to sell the stoves to the refugees via micro-lending and other financially viable distribution methods.

How You Can Help: **With additional funding, we can reach 300,000 households in Darfur, helping more than 2.2 million refugees. We then can work throughout sub-saharan African where these stoves could be deployed to reduce women's exposure to indoor cooking smoke and simultaneously reduce GHG emissions from domestic cooking**
We can improve quality assurance in the production process, obtain and incorporate user feedback into successive improvements in the stove design for higher user satisfaction. In addition, Gadgil's team is aware of, and would like to research how to make low-cost design improvements that will reduce carbon monoxide emissions from the stoves.

2) "LED" LIGHTING TO REPLACE KEROSENE LANTERNS
Lighting the world without harming the environment

Traditional kerosene versus LED solar: Today, LED technology is poised where compact fluorescent bulb technology was in the 1970s – a nascent but extremely promising energy savings technology. But consumer acceptance of compact fluorescent bulbs was delayed almost 30 years, in part because some products on the market were of low-quality and uneven performance, and standards were nonexistent. Taking the lessons learned in the development of compact fluorescent market, the Rosenfeld Fund hopes to accelerate the promise of LED, and in so doing, improve the lives of the poor while protecting the environment.

The Problem: About 1.6 billion people in the developing world lack access to electricity at their homes and workplaces. Most get their lighting from inefficient and unhealthful flame-based lighting sources, such as kerosene lamps. Many more burn wood to light their workplace and schools. Even those served by the electric grid often have light in only one room and frequently must revert to fuel during all-too-common power outages. Poor households collectively spend more than $40 billion each year on kerosene and other lighting fuels, resulting in nearly 200 million tons of CO_2 emissions annually. These families can spend up to 30% of their income on fuel for lighting. In addition to the economic burden, low-quality flame light is implicated in global problems of literacy, indoor air quality, and deforestation

The Solution: White light-emitting diode (WLED) light sources are 500 times more effective in generating light than kerosene lanterns. WLEDs of one watt or less, recharged from grid-connected kiosks (or paperback-book-sized solar panels), are beginning to come to market, and can attain, at a target price of $10-$25, a payback time (in avoided kerosene) of less than a year.

Real-World Deployment: With Phase-1 funding from The Rosenfeld Fund, Dr. Evan Mills, a long-time associate of Dr. Rosenfeld at Lawrence Berkeley National Lab assessed market acceptance by villagers in Kenya and India who had access to grid connected kiosks to charge rechargeable batteries, and evaluated the quality of commercially available LED lamps and flashlights. Results from the focus groups on market acceptance revealed strong demand for the products and a willingness to purchase at market prices (i.e., without subsidy). But results from the quality evaluations have identified only some reasonably good products and none optimized for price and performance. In fact, only a few perform as advertised. Some manufacturers are well-intended but lack the skills for properly designing and evaluating prototypes, and need market data on end-user baseline lighting conditions and consumer preferences.

Impact on the Environment: Improved lighting will help desperately poor people, but it will also help the whole world delay climate change. Because fuel-based lighting is so inefficient, the volume of fuel consumption approaches two million barrels of oil per day. Eliminating this

would be equivalent to getting 60 million cars off the road, or converting 200 million American SUVs to ordinary cars – a significant saving of energy and CO_2.

For those who wish to recognize Art and his wonderful years at the California Energy Commission, you are welcome to make a tax deductible donation to the "**Rosenfeld Fund**" at the Blum Center for Developing Economies at U.C. Berkeley. Please visit http://blumcenter.berkeley.edu/donate-blu-center and in the special instructions section, indicate that your gift is for the **Rosenfeld Fund**.

You may also contact Dr. Rosenfeld at rosenfeldfund@berkeley.edu or the Blum Center (blumcenter@berkeley.edu) for more information on how you can help.