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Stove Solutions: Improving Health, Safety, and the Environment in Darfur with Fuel-Efficient Cookstoves

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In Brief:

Nearly three billion people across the globe cook every day using open, three-stone fires, or rudimentary stoves that burn biomass such as wood, agricultural waste, animal dung, and charcoal. Cooking with these traditional cookstoves is inefficient and grossly polluting, harming health and the environment, and contributing to global warming. In many places worldwide, women must walk for hours to collect firewood, risking their safety and sacrificing energy and time that could be used to earn a living. While often overlooked as a major contributor to the global burden of disease, cooking over open fires indoors is the largest environmental health risk in developing countries, and exposes women (and the young children near them) to amounts of smoke equivalent to burning 1,000 cigarettes inside the home. In Darfur, Sudan, where about 2.7 million people have been displaced from their homes by conflict, the situation is particularly dire. Each day, Darfuri women face the difficult choice between risking sexual assault during treks to collect firewood or selling a portion of their family's meager food rations for cash to purchase wood. The Berkeley-Darfur Stove, developed by scientists at the Lawrence Berkeley National Laboratory (LBNL) and volunteers from UC Berkeley and Engineers Without Borders, is a metal stove that reduces the need for firewood by more than half, owing to its improved combustion and heat transfer efficiencies. LBNL has partnered with a nonprofit organization, Potential Energy, and a number of aid organizations to disseminate more than 22,000 Berkeley-Darfur Stoves to Darfuri women. Several hundred thousand more are needed.

Key Concepts:

- More than three billion people cook using biomass fuel over open fires or rudimentary stoves. This practice affects the health of women and children disproportionately, resulting in four million premature deaths annually.
- Black carbon soot like that produced from burning biomass is responsible for 18 percent of the planet's climate forcing.
- In the fall of 2005, hundreds of thousands of women living in Darfur's displacement camps walked up to seven hours per day, three to five days per week, to collect firewood for cooking. During these treks, many women were subjected to sexual assault.
- The Berkeley-Darfur Stove (BDS), developed by the Lawrence Berkeley National Laboratory, was created to address this problem. When compared in the laboratory with the traditional three-stone fire, the BDS uses 65 percent the amount of firewood, and emits only 61 percent the amount of carbon-monoxide and 48 percent of the disease-causing particles (PM2.5), resulting in a net climate cooling impact of the stove emissions compared to a baseline three-stone fire.
- Today more than 22,000 Berkeley-Darfur Stoves have been distributed, improving the lives of more than 120,000 people, and saving $32 million in firewood cost, over the five-year life of the stoves, to the stove users.

Approximately three billion persons around the world eat daily meals cooked with fuel consisting of wood, twigs, agricultural waste, animal dung, and charcoal. They cook in diverse ways with diverse foods in diverse pots across many cultures, often on three-stone fires. A three-stone fire refers to three stones placed on the ground, supporting a pot under which a fire is lighted. Cooking with these traditional cookstoves is mostly inefficient and grossly polluting. Exposure to smoke from traditional cookstoves and open fires causes four million premature deaths annually (eight per minute), and is the largest environmental threat to health in the world today, measured in disability-adjusted life years.1 Women and newborn infants kept close to them are at the greatest risk, as the women spend countless hours tending to these polluting stoves. Cook-fire smoke contributes to a range of chronic illnesses and acute health impacts such as early childhood acute lower-respiratory infections (including pneumonia), which lead to mortality, low birth-weight, and associated long-term adverse health impacts. For adults, the smoke can lead to risks and mortalities from lung cancer, emphysema, chronic obstructive pulmonary disease, cataracts, and bronchitis. According to public health researchers, “A fire in the kitchen, if you’re cooking a meal, produces about the same pollution per hour in a typical house as a thousand cigarettes burning.”2

Reliance on low-efficiency ways (e.g., three-stone fires) of using biomass for cooking and heating also forces women and children to spend many hours each week collecting wood. In humanitarian displacement settings such as Darfur, women face severe personal security risks when they collect fuel and some must trade their food aid rations for cash to purchase wood.

Lastly, residential biofuels’ contribution to the total sunlight absorbing black carbon (BC) emissions is substantial, comprising 63 percent of the total BC emissions from India, 30 percent from China, 67 percent from Africa, and 33 percent globally.3 Thus, airborne pollution from biomass cookstoves contributes significantly to indoor air pollution locally, and also to global warming. BC particles in the atmosphere absorb solar radiation and reduce the sunlight reaching the planet’s surface. This absorbance directly heats the atmosphere, and also produces solar dimming as observed from the planet’s surface. This dimming reduces surface evaporation and atmospheric moisture. This atmospheric BC effect has been shown to reduce precipitation in some areas.4 Overall, BC has emerged as an important contributor to global warming. Recent studies estimate it is responsible for 18 percent of the planet’s heating overload (technically called *climate forcing*), compared with 40 percent contribution from anthropogenic carbon dioxide.3 Studies have also shown that BC deposition on snow and ice increases their rate of melting.5 There is increasing concern that BC-induced melting may contribute to the depletion of fresh water reservoirs stored in mountain glaciers and snow packs. Due to the short atmospheric lifetime of BC particles (a few weeks compared to a lifetime of about a century for CO2), reducing emissions of BC can immediately mitigate global warming and lessen impacts on water resources.

Darfur, Sudan

Reliance on biomass for cooking has created a particularly acute situation in Darfur, where conflict has claimed the lives of at least 300,000 people and driven as many as 2.7 million more from their homes, making them refugees in their own country.6 These internally displaced persons (IDPs) have settled in displacement camps throughout the arid region, where they receive food aid and cooking oil from humanitarian aid organizations. However, IDP households are still responsible for gathering firewood as fuel for cooking. Because of the desert-like terrain and the large concentrated populations of the IDP camps, wood is scarce. The burden of collecting firewood falls almost entirely on Darfur’s women and girls. Females in the IDP camps must walk up to seven hours three to five times a week to find a single shrub. During these treks outside the camps, women are often assaulted. While the incidence of assault is not fully known, international aid organizations have estimated that 82 percent of all attacks against women and girls occur when the victims are outside the camps, often collecting firewood.7

In some parts of Darfur, areas around the camps have become so denuded that it is nearly impossible to find any biomass for cooking fuel within a day’s walk. In these areas, women purchase firewood from vendors who transport it to the camps and towns on trucks. Our 2010 survey of one camp in Darfur, Zamzam, showed that 80 percent of women there purchase, rather than collect, their firewood. A full 100 percent of firewood purchasers reported having to trade some of their food rations for fuel in the last food distribution. In this context, an appliance that reduces the need for firewood is of great value.

Our Solution

Late in 2004, Ashok Gadgil, senior scientist at the Lawrence Berkeley National Laboratory (LBNL), was asked by the Office of Foreign Disaster Assistance at the United States Agency for International Development to help find a solution to this grave problem facing Darfuri women and girls. On collecting data and studying the problem, he had developed a strong hunch by the summer of 2005 that fuel-efficient stoves would be a feasible approach to provide relief to Darfur’s displaced women and girls. After another few months to raise funds, arrange logistics, and train for the visit, Gadgil led a team of LBNL scientists on a fact-finding mission to Darfur in November of 2005. The team systematically collected information from displacement camps in North and South Darfur about food, cooking methods, fuel use, fuel gathering activities, the feasibility of manufacturing stoves locally, and relevant aspects of the culture with respect to cooking and stove usage.8 The three-stone fire was found to be the vastly predominant method of cooking, a finding that highlighted the potential to reduce fuelwood consumption (and the correspondent need to purchase or collect fuelwood) by introducing a fuel-efficient cookstove. The three-stone fire is the least efficient way to cook, with typical efficiencies of 5 to 6 percent, owing to incomplete combustion and ineffective heat transfer to the pot.

The team collected user assessments of four different types of existing improved cookstoves, including the mud stove ubiquitous in Darfur. After demonstrations, systematic key informant interviews, and efficiency tests, a metal stove from India (the Tara stove, designed by Development Alternatives in Delhi India) was determined to be, on the whole, the most liked, most efficient, and most appropriate for Darfur. While the Tara was deemed the best fit, it required further modification to suit the food type, cooking style, pot shapes, and environmental conditions in Darfur.

The stove, now called the Berkeley-Darfur Stove (BDS), has undergone 14 iterations since that initial fact-finding mission, each further tailoring it to meet Darfuri women's needs. Scientific and technical staff at LBNL and University of California, Berkeley students designed and tested each iteration, with design advice from the San Francisco professional branch of Engineers without Borders. Recognizing that the smartest scientific efforts are worthless unless the users accept the improved stove, the team worked hard to keep the users at the center of testing, redesign, and implementation. The team also worked hard to make the stove easy to assemble without mistakes, moving all the complexity in the stove design away from final assembly, so the final assembly could be performed by IDPs using relatively simple equipment. The stove is customized to fit the two most common sizes of round-bottomed pots found in Darfur, and the metal sheet used for baking a traditional bread called *kisra*. The engineers added feet, through which stakes can be easily driven into the sandy ground, fully stabilizing the stoves during the vigorous stirring necessary to make the local *assida* porridge. This user-centered design approach has ensured that the stove meets women's needs, which has led to high adoption rates. A 2010 independent survey found that women who have received the Berkeley-Darfur Stove now use it to cook all of their meals, and have ceased cooking over an inefficient three-stone fire,9 and an internal impact evaluation survey found a 100 percent adoption rate eight months after distributing the Berkeley-Darfur Stove to 100 IDP women in Zamzam camp.10

The Field of Stoves

For decades, development professionals and engineers have attempted to mitigate the health effects of cooking with biomass fuel by providing families with fuel-efficient stoves. There were two notable waves of interest in fuel-efficient stoves, one in the 1970s and another in the 1990s. However, few of these projects have seen sustained support over long periods and there are few success stories to discuss. A flaw of these projects has been the singular focus on the engineering of the stoves, with insufficient emphasis on other parts of the value chain, especially marketing and distribution. Another common flaw has been relative inattention to independent third-party impact assessment and user feedback. In addition, few fuel-efficient stove projects have considered factors that affect the likelihood of adoption of new technologies by the poor, which has been outlined by Xander Slaski and Mark C. Thurber, of Stanford University's Program on Energy and Sustainable Development: inherent motivation (connected to the perceived value of the product), affordability, and magnitude of behavior change required.11 Viewed through this lens, it is not difficult to understand why cookstove projects, particularly those in rural areas, have encountered limited success. Fuel-efficient stoves face all three challenges to adoption: they are expensive, require behavior change, and are not initially valued (despite very substantial health benefits) by users in places where wood is cheap or often easy to come by. This framework suggests that cookstove projects might fare slightly better in urban areas, where users are more likely to have access to financing and to attribute an inherent value to stoves (prior to social marketing campaigns) because of the higher cost of firewood that is not freely collectible locally.

In most of Darfur, fuelwood is inaccessible or practically nonexistent within walking distance—people pay too high a price or risk their safety to collect it—so a stove that reduces wood consumption should be a precious commodity. Slaski and Thurber have studied the barriers to adoption of advanced stoves by the poor. In their framework, cookstoves in Darfur would fall in the same category as malaria nets and fertilizer (valued, expensive, requiring behavior change). Given this analysis, we believe there is potential to create a robust market for fuel-efficient stoves in Darfur if financing is available, and the behavior change required is minimized.

In the arid, sunny camps of Darfur, introducing solar cookers might seem like the perfect way to ease the risks and burdens of burning firewood, but they do poorly at cooking local foods. A solar stove is more like an oven than a stove—it works best with food that is cooked slowly over several hours with no stirring (such as rice). In Darfur, traditional meals are continuously and vigorously stirred over high heat. The promotion of solar ovens would require a complete change of cooking styles, food eaten, and available ingredients—a logistical and social-psychological feat. In addition, solar ovens cannot be used to cook a morning meal (because there is not enough sun), and this meal would still require fuelwood. Given the low durability of low-cost solar ovens (most of those being promoted in IDP campus were made of cardboard), and the comparable amount of fuelwood that could be saved, it is clear that sturdy and durable, metal, fuel-efficient cookstoves that preserve cooking traditions are more likely to be integrated into Darfuri households.

Atima's life was a struggle from the beginning. Her father died before she was born, leaving her mother to raise Atima and her siblings alone. When Atima was a teenager, the Darfur conflict began and the Janjaweed militia attacked the village next door. Atima fled and for two years she was on the run, scared for her life. Finally, she made it to a town in North Darfur where she married and had four children. But her life was still a struggle, a struggle to feel secure in a hut built on land she doesn't own, a struggle to feed her children without outside assistance.

The good news is that Darfur Stoves Project has helped to make Atima's days easier. Before receiving her Berkeley-Darfur Stove, Atima spent hours each day cooking over a smoky fire and used half of her family's meager income to purchase firewood. Atima's fuel-efficient stove uses less than half the amount of wood than that smoky fire, which saves her money. It also saves her lungs, by reducing her exposure to harmful pollutants. Plus, Atima's new stove cooks meals almost four times faster than an open fire, which gives her much more time to learn skills and earn a living. Displaced women like Atima are unlikely to go home any time soon. While it may feel like we can't do anything about the Darfur conflict, we each have the power to make life better for women in Darfur.

It is worthwhile to briefly mention another important issue in thinking about locally appropriate biomass stoves. In the field of fuel-efficient stove design and production, there is a perceived tension, and oft-discussed trade-off, between "scalable" and "locally appropriate." On the one hand, proponents of locally made, simple technologies argue that these appliances will be better liked by users because they are familiar and do not require much behavior modification. On the other, mass manufacturers contend that localized efforts to create different stoves for different populations are not easily scalable and thus will make an insignificant dent in reducing adverse impacts for the world's population that cooks with inefficient stoves using biomass. These mass manufacturers advocate a standardized stove design that is "good enough" for most potential users, in order to reach more people. We argue that our strategy takes the best of each approach: it is both tailored for conditions in Darfur, and easily produced on a mass scale.

In 2010 the Berkeley-Darfur Stove was tested by the Environmental Protection Agency and was found to have the highest thermal efficiency of the natural draft stoves in its cost bracket.12

Design and Manufacturing

An earlier prototype of the Berkeley-Darfur Stove was locally made through hand cutting metal sheets and spot welding them together in Nyala, South Darfur. This production was organized by the nongovernmental organization CHF International. Approximately 6,700 stoves were made in the CHF shop between 2007 and 2009. However, the production capacity of this shop was limited, and quality was inconsistent. Since those early days, the Darfur Stoves Project has gradually upgraded its supply chain, which is now capable of mass production and good quality control.

Today, the stove design is stamped and cut into flat sheets of metal at a workshop in Mumbai and shipped to Darfur, where these flat-kits are assembled into stoves in a workshop that employs 12 residents of a nearby displacement camp. Manufacturing the stove components in India enables us to produce stoves much more rapidly, and for much lower cost, than if we made them entirely in Sudan or any nearby country. Faster, cheaper production means we can help Darfuri women on a large scale.

This flat-kit approach allows for an easy transition from the current small-scale, semi-manual operation to large-scale manufacturing and assembly. The main components of the stoves are designed to use only straight sheet metal cuts and folds. Such a design provides flexibility in parts manufacturing: at the lowest technology end of the spectrum, parts could be fabricated manually at 3,600 stoves per year and, at the high technology end, the parts can be stamped using a fully automated punch press machine at a rate of one set of stove parts every five to ten seconds, or approximately one million units a year, assuming single shift operation. Our manufacturer currently uses hydraulic punch presses that are manually fed and operated, providing a maximum annual production rate of 60,000 units with a single shift on a single production line.

Stove assembly is also designed for scalability by eliminating the need for advanced tools. At the small-scale end of the spectrum, a single individual operating hand tools without electricity can assemble stoves. At the large-scale end of the spectrum, an assembly shop would have 100 specialized workers organized into efficient assembly cells and would include powered assembly tools, conveyor systems, and automated quality control. The Darfur stove assembly shop currently employs a dozen workers using mostly hand-powered tools and has an output capacity of 26,000 units per year.

Large-scale assembly of up to 200,000 units per year can be achieved through a combination of additional assembly shops, upgrading the existing site with more advanced assembly tools, and expanding staff size to enable greater task specialization. It now costs about $20 to provide a stove to a user in a North Darfur IDP camp, including the cost of transport, distribution, and training to use the stove (the unit cost varies somewhat with prices of steel, shipping, etc.).

Distribution Model

To simplify and speed up delivery during the Darfur humanitarian crisis, the more than 22,000 stoves distributed to date have mostly been given free of charge to IDP women. However, as Darfur slowly moves from relief to recovery, we are beginning to explore more sustainable, market-oriented approaches to distribution. The conflict-affected population of Darfur includes IDPs in displacement camps, IDPs in mixed (i.e., IDP/host) communities (rural and urban), and rural and urban (non-displaced) residents. Most of the 22,000 stoves distributed to date have been to IDPs within the camps. However, IDPs and non-displaced residents living in the rural and urban areas have also had their livelihoods stripped by the conflict and they, too, merit assistance. Because markets outside the camps are more established than those within them, we are beginning our first efforts at selling the stoves in these markets. In 2011 we began a small-scale marketing trial with our local partners to begin selling the stoves via existing Women's Development Associations in the town of El Fasher and several villages in Darfur. Leveraging these existing structures is cost effective and will enable us to rapidly penetrate the market. Many of the Women's Development Associations have experience with savings programs, having worked many years with other international NGOs. In the long term, we plan to fully replace free distribution with a commercial model, even within the camps.

In designing the marketing trial, we have taken care not to lose our focus on the extreme poor. We have identified and have tried to tackle the most significant barriers to technology adoption by the poorest:

- the major behavior change required to use the technology
- lack of product availability in the market
- lack of liquidity
- fear the product will not do what it says
- fear the product will break

We have addressed the first challenge by employing a user-centered design approach that allows women to preserve their cooking traditions, minimizing the behavior change required. We will continue to address the challenge of market availability through supply chain upgrading.

The remaining three challenges will be addressed by novel contracts.

First, we will address customers' lack of liquidity through a rent-to-own model. Every customer will be given a savings box where they will put their fuelwood savings (nearly $1/day). They will pay back a small portion of the savings each week until the full cost of the stove is repaid. With this payment structure, the customer bears no financial risk.

Second, to counter fears that the product will not do what it says, we will offer a free trial period, so women can see for themselves how the stove cooks faster, uses less wood (saving money), and produces less smoke than what they are used to.
Finally, we will alleviate concern that the product will break by allowing customers to return the stove and stop future payments.

A study testing these novel contracts in Uganda found them to be instrumental in selling stoves.9 More than half of the first 200 households randomly offered the novel contract accepted the free trial. In contrast, less than 5 percent of the 200 households offered the traditional (i.e., single up-front payment; no free trial or warranty) contract bought one, although most customers were given a week if they wanted time to gather funds. In addition, only 5 percent of those who accepted a free trial have returned the stove. Although there were some late payments, the rate of payments was high. Fewer than 2 percent of consumers have moved away, and another 3 percent have refused to complete payments (and even they made some payments). The study concluded that, "the novel contract appears to be a viable business model in settings where consumers purchase fuel."13

There is direct evidence for repayment in another stove project in North Darfur, being implemented by Practical Action (PA). The project has sold more than 3,000 liquefied petroleum gas (LPG) stoves on credit since 2007 and reports a 93 percent repayment rate. The project sells stoves via Women's Development Association Networks and requires a 20 percent down payment, followed by nine monthly installments.14 The model we are currently testing in our market trial was informed by PA's experience and has a similar repayment schedule. (However, our project uses an efficient wood-burning stove instead of the LPG stoves because the LPG stoves are two to four times the price of the Berkeley-Darfur

Stove and the supply of LPG to Darfur is inconsistent.)

Promotional messages focus on money and time saving, with slogans such as, “Don’t burn your money, buy the five-minute stove,” replicating a similar promotional approach used by Toyola Enterprises in Ghana with marked success. In addition to traditional promotional channels, such as radio and signs, we will include the community in interactive marketing approaches, such as fuel-efficiency cooking competitions and stove demonstrations.

We are already seeing evidence of strong demand from women willing to pay for the stove. Some of the stoves distributed for free in 2010 were found in camps far from the distribution site and, upon inquiring, we learned these stoves had been sold at prices ranging from 45 to 60 SDG (US$17–23 using the exchange rate at the time). In addition, upon announcing our marketing trial of 500 stoves at a price of 45 SDG (if paid in four installments) or 40 SDG (if paid in one single installment), we immediately sold out and developed a waiting list of customers for the next shipment. We aim to distribute at least 10,000 stoves in Darfur in 2013, and to sell the vast majority of these.

Measuring Impact

Laboratory test results for efficiency, emissions, and time to cook. Scientists at LBNL tested the stove prototype and three-stone method for efficiency and emissions using a surrogate cooking task intended to simulate the cooking of assida, a common food in Darfur. The cooking task involves bringing to boil 2.5 liters water from room temperature, and simmering it for an additional 15 minutes. The time to heat water to boiling is faster with the BDS design at 5.8 C/minute, as compared to the TSF design at 3.6 C/minute. The three-stone fire consumed on average 564 grams of fuelwood in this task. The stove consumed on average 368 grams of fuelwood, for a savings of 35 percent compared to the three-stone fire. The carbon-monoxide emissions from the BDS for the same cooking task were only 59 percent of that of the TSF stove. Thus the BDS emits less carbon-monoxide than the savings in fuelwood. The BDS also emitted 23 percent less black carbon than the three-stone fire.15 These laboratory tests were conducted indoors in quiescent ambient air, different from the strong breeze common in displacement camps six months of the year. This might explain the larger fuel savings found in the field survey (below) than in the lab measurements.

Field impact assessment surveys. In 2010 we conducted a baseline survey of 100 households using TSF stoves for cooking in North Darfur’s Zamzam camp, and a follow-up survey eight months after the women had switched to using BDS stoves for cooking. We found 100 percent of households using the Berkeley-Darfur Stove at the follow-up visit, and 44 percent of households using the Berkeley-Darfur Stove exclusively. The remaining 56 percent reported using the Berkeley-Darfur Stove alongside their open fire or rudimentary mud stove. Further research is being conducted to understand the extent to which (and the reasons why) women employ this practice of “stove stacking,” in which the old method of cooking is not entirely displaced by the new technology.

Even with more than half of the families still using the traditional three-stone fire or mud stove on occasion, the result of incorporating the Berkeley-Darfur Stove into the mix was dramatic. There was no change in fuelwood prices during this interval. Results showed that on average the fuel spending of the 100 respondents was initially 49 percent of their non-fuel spending, which dropped to 20 percent of their non-fuel spending on using the Berkeley-Darfur Stove, a reduction of more than 50 percent. The survey showed that each $20 stove puts approximately $354 a year into the pockets of the women using the stove or $1770 over five years, the estimated stove life—noticeably more than our earlier lab-based estimates.

We conducted the same survey in another IDP camp (Abasi camp, in the Mellit area), farther from the region’s capital of El Fasher, and found a similar impact. Forty Berkeley-Darfur Stove users were surveyed at the baseline and again eight months later. Results showed that this group reduced its spending on fuelwood from 65 percent to 31 percent of their non-fuel spending (using the BDS), again a reduction of larger than 50 percent. One hypothesis for the larger relative proportion of total expenditure devoted to fuel wood purchasing is that this area is closer to farmlands, so less funds are spent on food, while wood is nearly as scarce as it is near the more populated Zamzam camp, which lies close to North Darfur’s capital.

In both locations, we found a 50 percent decline in firewood collection among the survey sample. That is, 50 percent of respondents reported fully switching from collection to purchasing their wood eight months after receiving their BDS. However, because of the small number of cases this represented, further research is being conducted to determine attribution.

Role of Partnerships

Originally started largely as a volunteer effort among scientists and students at LBNL and the University of California, Berkeley, today the Darfur Stoves Project has become the flagship initiative of an independent, nonprofit organization, Potential Energy (PE). Gadgil and several colleagues in the “pro-poor” innovation field founded Potential Energy in order to institutionalize the serendipitous process by which good ideas are conceived, developed, and brought to market in areas of the world most affected by poverty and conflict. The PE founders saw that had it not been for the passion and persistence of motivated individuals, this life-transforming technology would have lingered in the “valley of death.” PE is a uniting force that helps unleash the full potential of the many groups working to help poverty-affected people: engineers, NGOs, and distributors. While many organizations exist to disseminate technologies to poor people in developing countries, we are showing how a new and different model can work. A small project-management organization, such as PE, acts as a technology disseminator, and the bridge between the technology research and development (in this case, LBNL) and the field. This arrangement allows for specialization of expertise and labor, greater efficiency, and an ability to scale to reach millions of people. PE currently partners with Oxfam America, Plan International, and the local Sudanese nonprofit organization, Sustainable Action Group, to assemble and disseminate the stoves in Darfur. PE also organizes and supervises flat-kit production and shipping from Mumbai to Sudan. PE maintains strong ties to LBNL to ensure a tight feedback loop between the end user and the science.

Potential Energy and the Lawrence Berkeley National Laboratory are members of the Global Alliance for Clean Cookstoves. Launched in 2010, the Global Alliance for Clean Cookstoves is a public-private initiative to save lives, improve livelihoods, empower women, and protect the environment by creating a thriving global market for clean and efficient household cooking solutions. The Alliance aims to foster the adoption of clean cookstoves and fuels in 100 million households by 2020. The United Nations Foundation hosts the Alliance’s secretariat, working with more than 400 partners and 37 national governments.

Carbon Finance

We are securing financing to become certified to sell carbon credits and leverage carbon markets. Carbon markets are formed when some sort of regulatory ceiling or cap on emissions is put in place, and trading of emissions under the cap is allowed. Setting a fixed number of tons of carbon (or, in most cases, carbon dioxide) that can be emitted and allowing those tons to be traded gives a value to each of those tons as they are bought and sold to enable market members to meet their regulatory targets. Carbon trading happens when market members that can cheaply and easily reduce their emissions below their limit do so and then sell any extra allowable carbon dioxide emissions (the difference between their actual and allowed emissions) to other market members for whom it is too difficult or expensive to meet their own targets. In this way, the aggregate number of tons of carbon dioxide from all market members stays below the emissions cap, but the flexibility that results from the market means that not every member must make significant reductions. Those that can will have incentive to reduce as much as possible to earn more emissions to sell. The Kyoto Protocol greenhouse gas (GHG) emissions cap that went into effect in 2005 enabled the creation of markets in which the right to emit tons of carbon dioxide equivalent can be bought and sold.

Since one Berkeley-Darfur Stove has the potential to save up to two metric tons of $CO2$ emissions annually, each stove has the potential to sell two carbon credits every year. The money from the sale of carbon credits will be reinvested into the project and further drive expansion.

Looking Ahead

As of December 2012, more than 22,000 stoves have been distributed in Darfur, helping more than 120,000 women and their dependents, with a worth of more than $32 million to their recipients. There are more than 400,000 displaced families in Darfur. So, we have a good start, but a lot more remains to be done. For Darfur IDPs, we have addressed well the technology design, fabrication, supply-chain, and assembly issues. We are rapidly increasing efficiency and sustainability of our distribution channels. The current bottleneck is in raising funds (either directly ourselves or through our NGO partners) to increase the reach and rate of stove dissemination in Darfur IDP camps.

Since Darfuri and Ethiopian cooking styles are similar in many ways, we have started exploring Ethiopia as a possible new market for cookstoves, and initiated plans to implement a pilot project there in 2012. In the recent past, the U.S. Department of Energy and World Vision (a large global NGO) cofunded an effort at LBNL to redesign and test the Berkeley-Darfur Stove for Ethiopian cooking conditions and preferences. Ethiopia has rapidly depleted its forest cover from 50 percent in 1950 to about 5 percent in 2005, and even now 80 percent of the households rely on biomass for their cooking fuel. Thus, the situation is close to desperate, and fuel-efficient stoves can produce immediate and much-needed relief. At the current rate of deforestation, it will take only 27 years before the country is totally deforested.

Researchers at LBNL and UC Berkeley are studying small devices called stove use monitors and plan to mount these small self-contained devices on Berkeley-Darfur and Berkeley-Ethiopia Stoves to monitor and record time-stamped stove temperature data over several months of use. Periodically, a researcher in the field using a personal digital assistant (PDA) or laptop computer will retrieve this information. The stove use monitors will enable us to have a better understanding of how cookstoves are used. Information collected will be anonymized and analyzed to understand the frequency of stove use, the burn time for each use, and the rate at which cooks were feeding firewood into the stove during each burn. Likewise, the data will help reduce uncertainties regarding the reduction in greenhouse gas emissions from the use of improved cookstoves, and thus support obtaining carbon-offset prices for the stoves.

Further resources about Darfur Stoves Project as well as updated news of its progress are available online at www.potentialenergy.org

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