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Prakti Design: the challenge of clean Combustion for the poor

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Abstract. Three billion people rely on open fire or polluting and non-efficient biomass stoves for cooking and heating. These households, mostly women and young children, are exposed to harmful indoor air pollution. This is the fourth mortality cause in the world, and second cause of death in developing countries, below aids but above well-known ailments such as malaria or tuberculosis. The use of these stoves impacts also the environment with unsustainable forestry and biomass exploitation and the livelihoods. In Haiti, 97% of the island is deforested and over 70% of the population depends on biomass (charcoal and firewood) for cooking.

Prakti Design, a clean stove developer, aims at addressing this social issue with an integrated strategy from design to manufacturing and distribution of highly efficient and affordable biomass cookstoves, with a reduction from 40 to 80% of fuel consumption and 60 to 100% decrease of emissions (carbon monoxide and particulate matters). Using state-of-art stove design backed up with participatory field testing with end-users and unique partnership with a stove manufacturer, Prakti has developed stoves responding to the specific needs of Haitian cooking, with fastest and cleanest cooking time and fuel consumption among existing clean stoves distributed in Haiti. This article explains the unique social business model of this efficient stove company and discusses ways for scaling up sustainably the dissemination of energy-efficient and non polluting biomass cookstoves among the poor.

Keywords. Indoor air pollution, Clean stove, Fuel-efficient, Biomass cookstove, Base of the pyramid, Social entrepreneurship, Haiti, India

1. Introduction

Roughly half the world population, three billions people across the planet, is using open fire or traditional biomass stoves, for cooking and/or heating. The design of the basic mud stoves in developing countries in Asia (*named chulha in India*), Africa and South America, are fuel inefficient and large emitters of harmful emissions such as carbon monoxide and particulate matters.

Every day, these stoves' three billion users burn 1kg of biomass a piece, releasing a total of 6 billion kg of carbon dioxide —three times that released by all the private cars in the US daily, and thus a generous contributor to global warming.

But the stove can also injure its user's health as much as the planet's. In a February 2008 paper, Esther Duflo and Michael Greenstone, of the Massachusetts Institute of Technology's Poverty Action Lab, noted that "women and children who congregate near cooking stoves are exposed to pollution levels unheard of in the developed world". This

pollution consists of carbon monoxide, but also of minuscule particles of soot that can ignite virulent cases of lung disease. The new Global Burden of Disease study covering 21 regions over the last 20 years and published recently in the Lancet shows that the scale of household air pollution's health impact is important, being the 2nd risk factor for girls and women in terms of Disability-Adjusted Life Years.¹

In India, in the hot dome of space around a *chulha*, particulate matter concentrations can touch 20,000 micrograms per cubic meter; the recommended limit is a mere 50.

As cooking is mostly a women task within traditional household and that young children are often beside their mother, women and children are the most vulnerable to indoor air pollution. Children are twice as likely to have pneumonia, women are often afflicted by cataracts, and family members often suffer from cancers and respiratory infections. For some of these women and children, it's like smoking

¹ Reference: <http://www.cleancookstoves.org/media-and-events/news/household-air-pollution-findings-from-the-global-burden-of-disease-2010-study.html>

several packets of cigarettes a day. According to the World Health Organization, indoor air pollution from smoky cookstoves is an urgent public health issue as it kills 1.6 million people every year. This is the second death cause in developing countries, above well-known diseases such as malaria.



Figure 1. Indoor air pollution in Nepal

Photo credit Worldbank

Many governments and development stakeholders are now encouraging initiatives to disseminate better, energy-efficient and less polluting cookstoves to the poor such as the Global Alliance for Clean Cookstoves launched by Hillary Clinton, the US secretary of state, in Sept 2010 or the National Biomass Cookstove Initiative (NBCI), launched in 2010 by the Indian government.

The Global Alliance is a UN Foundation-led, public-private initiative that aims at catalyzing the dissemination of 100 million clean cookstoves by 2020 with a budget of USD 250 million. International awareness about indoor air pollution and improved cookstoves is quickly increasing among program implementers and public policy makers and in the academic sphere.

Yet, even though many development organizations, NGOs and now corporate organizations are grasping the issue of clean combustion for the poor for many years, a sustainable social business model is still to be found to scale up adoption of fuel-efficient stoves. This article presents the strategy of Prakti Design, a fuel-efficient biomass cookstove developer, to address this issue of indoor air pollution by developing affordable clean stoves adapted to local cooking habits. Constraints for adoption among the poor and the challenge of a sustainable business model are also discussed.

2. Background and local context

Prakti Design² aims at addressing this issue, through a sustainable social business model, by designing and disseminating at large scale fuel-efficient, clean-burning cookstoves for

² Prakti Design is a social venture founded in 2008 in Pondichery, India, working in India, Nepal, Haiti and Sudan. A recognized technical leader in biomass cookstove design, Prakti Design has won several awards, including the Partnership for Clean Indoor Air (2009), the Global Social Venture Competition (2011), IDEA Award 2012 and Convergences 2015 Forum (2012). Prakti founder's expertise in the field of biomass cookstoves design is widely recognized (GIZ, EPA-USA, UNDP), and he served as the co-chair of the Technology and Fuels Working Group of the Global Alliance for Clean Cookstoves.

the base of the pyramid. Prakti's vision is to bring together best-in-class engineering, production technology, and distribution in order to create the first sustainable and scalable stove dissemination for the poor. Adoption of Prakti stoves will improve health and livelihoods of users and families, empower communities and protect the environment.



Figure 2. Improved double pot stove in Nepal with 50% fuel consumption and no harmful emissions

Photo credit : Prakti Design

Being one of the few dedicated biomass cookstove research firms in the world, Prakti Design's strengths are innovation, field expertise and openness to partnership with organizations driven by this social cause. Prakti Design has already created a portfolio of household stoves, as well as institutional stoves for schools, hospitals, restaurants, and other large-kitchen applications.

2.1 The technical issue of clean combustion at low pricing

Mankind has been burning wood for thousands of years but combustion is not a simple, easily mastered process. There are many factors to get a "clean combustion": air flow but also effective heat transfer to pot, insulation, durability of stove material, cost, usability and last but not least the stove has to fit with cooking traditions and habits. The challenge—as yet unmet—is to craft a better stove without making it prohibitively expensive for the poor people who are its main users.

The main obstacle for the adoption of clean stoves is the economics of biomass cookstoves for the poor. Crude village clay stove are popular precisely because they can be cobbled together for almost nothing: Indian traditional mud stoves or *chulhas* cost as little as 50 rupees (1\$), and because firewood and cow dung, though painstaking to collect, are readily available. Clean stove developers such as Prakti Design are competing with stoves that cost next to nothing. There is a big market out there but very risky. The technology challenge is to make a biomass cookstove that is affordable for poor people, with good performance even with highly heterogeneous fuel, durable even with biomass combustion that is unique combination of high temperatures (up to 1000°C) and

corrosive environment (sulfuric and fluoric acids in biomass).

Most traditional stoves are unable to allow in the precise volume of air to be efficient. Too little air produces thick smoke; too much air cools the flames. Mud bodies have the ability to absorb high amount of energy from the fire ((mud high specific heat), and to conduct heat from fire to body and to the outside effectively (mud high heat conductivity). For this reason, mud bodies steal heat from the fire, wasting fuel. By stealing heat from the fire, mud buddies reduce the temperature inside the combustion chamber which increases the amount of smoke produced in this combustion chamber. Traditional cookstoves often don't have chimneys, and when they do, the outlet is constricted.

In homes, improved cookstoves compete with the traditional, free alternatives of three-stone and open fires.

There is also a distribution challenge as stoves are products mostly for women (only), while men who often make purchase decision usually do not know anything about stoves.

2.2 Cultural issues to tackle for greater adoption

Cuisine and cooking techniques are deeply ingrained, locally specific cultural features with profound psycho-social importance. Prakti employs user-focused product design to adapt state-of-the-art engineering to the local context such as the dimensions of cooking recipients. Thorough field testing with end-user feeds back the research and development process.

Another cultural issue is gender. In many traditional poor household, often the man of the household doesn't make the decision about a stove—the woman does, as she is the one cooking, thus knowing the associated constraints. That is why Prakti is encouraging women to become stove sellers, best placed to deliver the right messages to convince the potential buyer. However, women often can't take a decision to spend that much on a stove. This issue of intra-household purchasing power has to be well understood to address it in an appropriate way.

2.3 Haitian context: deforestation, skyrocketing fuel prices and humanitarian situation

The island has long been deforested due to intensive and unsustainable use of wood and charcoal; biomass fuel prices rocketed high after the 2010 earthquake, and over 70% of the population still relies on biomass for their cooking needs.

Haiti is the poorest country in the Western hemisphere with extremely limited access to modern energy services. Long-term use of charcoal has depleted its forests and the country is estimated to be deforested at 98%. Local fuel is supplemented by an illegal charcoal trade from the neighboring Dominican Republic, and this will likely continue until an efficient and sustainable production is set up in the country and charcoal demand is reduced. Other fuel alternatives such as solar cooking or LPG are either unreliable and/or face high barriers to adoption.³

³ Stoves Images – A documentation of improved and traditional stoves in Africa, Asia, and Latin America, GTZ, Beatrix Westhoff and Dorsi Germann, 1995. Solar cookers for UN-HCR refugee projects?, GTZ,



Figure 3. Fuel-efficient institutional stove using locally made biomass briquettes in Haiti Credit Prakti

Over 70% of the Haitian households rely on biomass – mainly charcoal – for their cooking needs. The traditional food consists of rice and/or beans and sauce; this type of meal requires a stove/fuel option that offers both high power and low simmering power. In Port-au-Prince alone, with a population of 3.5 million and an average household size of 4.9, this equates to a market for improved charcoal stoves of 500,000 households. While rural charcoal usage is more difficult to quantify, there is no doubt that a large market exists there, too. Even for families which may use wood as fuel during the dry seasons, most households still have charcoal stoves to use during the rainy seasons.

Given the high retail price of charcoal (as high as \$0.51/kg in Port-au-Prince), it is cheaper for many poor Haitians to buy small street food meals (fried food or hot dogs) than to pay for fuel and food for one meal as cooking on a large pot and/or continuously, consume less fuel than small size cooking done once. Small street food vendors, called *manjekwit* or *marchann fritay* sell these small meals; according to USAID, they are “prolific and constitute a significant portion of charcoal demand and use in Haiti. An improved stove, sustainable charcoal and/or fuel switching program targeted at this informal industry could have a significant and rapid impact on deforestation rates, user health and economic security.” These food vendors are often women who take their household stoves on the street; there are estimated to be over 12,000 *manjekwit* in Port-au-Prince alone.⁴

Large kitchens such as those found in schools, orphanages, community centers and IDP camps are numerous in Haiti. For instance the School Feeding Program run by the World Food Program in many public schools feeds on its own 800,000 school children every day.

Agnes Klingshim, 2005. Also see USAID/Nexant report below.

⁴ Assessment and Design of Haiti Alternative Cooking Technologies Program, USAID/Nexant 2010 [also source for Haiti fuel usage data in this section]: <http://dl.dropbox.com/u/9514421/Nexant%20USAID%20Final%20Report%20Haiti%20021011.pdf>

2.4 What previous and ongoing initiatives for greater access to clean stoves

Several previous improved stove efforts in Haiti failed because of improper stove education and instructions to the end-user or poor technical design resulted in low-efficiency stoves that were not sustainable market solutions. The difficulty of procuring raw materials locally and lack of a strong logistics infrastructure were already obstacles to large-scale cookstove manufacture in Haiti prior to the 2010 earthquake; despite post-earthquake aid funds and new government initiatives, these problems remain.

Many initiatives are being launched to reduce the tremendous burden of charcoal expense for Haitians and the detriment to the local environment that the current over-consumption of charcoal represents. USAID has just launched a three-year initiative to support the development and distribution of clean cooking technology in Haiti. Similarly, the World Bank, IADB, and other international and Haitian entities have demonstrated an eagerness to support new energy solutions in Haiti.

2.5 Methods:

Although improved stove designs have been plentiful in the past 20 years, not many have succeeded in replacing traditional open fires on a large scale and with much higher performance (over 30% fuel saving and multi year life span). We could quote as examples of successful uptake of improved stoves China, Cambodia (GERES), Sri Lanka (double burner Anagi stove).

However, the tremendous majority of improved stove designs were attempts to combine decent stove technology with very low retail prices. Such stoves will barely compete in many regions with the easy and free alternative that the traditional three-stone and open fires represent. Prakti believes that poor people do not need more cheap products, including improved stoves low in durability and fuel savings. Prakti's philosophy is to design and distribute stoves that will bring a radical added value to their users. An advanced improved stove will never succeed by competing with traditional cooking methods on the basis of price alone. But if a stove empowers users to realize significant savings, it can gain high market traction.

While price is an important purchase factor for low-income stove users, the aim of improved-cookstove developers should not be to produce the cheapest stove if it sacrifices the usability, durability, and performance of the stoves. Energy-efficient cookstoves can not be price competitive with traditional mud stove with value almost nil. The strategy must be shifted to designing and distributing stoves that embody value: only then will improved cookstoves be competitive and attractive to their potential users.

Starting from this basis, Prakti addresses the failures of previous attempts in cookstove dissemination with sound engineering, performance-driven product design, rigorous field study, and careful attention to the special challenges of addressing a customer market which is fragmented and often

difficult to reach.

Our approach to develop fuel-efficient cookstoves adapted to local context with embedded value for large-scale adoption in 8 points:

Technical innovation: Prakti has developed a varied portfolio of institutional and household biomass stoves to reach out an heterogeneous local demand for fuel-efficient cooking. Orka institutional stove for instance is an hybrid biomass stove able to use fire wood or greener products such as briquettes from recycled agricultural or urban waste with high performance (eg up to 80% reduction in fuel consumption, 70% less cooking time than three stone fire). The design is user-friendly (portable, three-in-one cookstove -pot, fryer, plancha-) and carefully researched, eg skirt, fuel inlet and grate of specific dimensions for best performance at low cost.

The institutional stoves distributed through humanitarian programme are interesting to strengthen Prakti "Branding" (Prakti = quality, healthy and saving) and develop local demand for household stoves by word of mouth. They can be used also as demonstration sites.

A strong partnership with a manufacturer: Prakti is the only stove developer with its own factory, thanks to strong partnership with Skillmech, a Chennai-based metal work manufacturer. Through its partnership with SkillMech, Prakti Design has access since 2008 to prototyping, industrial design and development facilities, thus has acquired a valuable expertise in stove production.

Investing in quality and well-engineered production technology with cutting-edge performance: Prakti stoves are designed to have among the best value for end-user, the highest performance [fuel use and toxic emissions are cut by 43-45% for the Prakti Wouj charcoal stove to 80% for institutional stove] and be affordable for poor families⁵. Even though for the base of the pyramid, Prakti stoves provide durability, functionality, and aesthetic appeal not ordinarily found in products marketed to the poor. The stoves come with a one-year warranty and a maintenance plan to last at least five years.

Co-designing the stove with end-user for better adaptation to local needs: By hiring local cooks for stove field testing during pilot projects, Prakti values user experience to design an attractive product, adapted to their cooking and usability requirements, including complementary functions (heating, drying...). Orka institutional stove for instance is designed for the large pots used by Haitian cooks to boil beans or rice. Prakti works with various local stakeholders, including aid agencies, local NGOs, private companies for pilot implementation and distribution of its stoves, being receptive to the partners' needs. For instance, in Haiti to be able to use locally-produced recycled paper briquettes as fuel, Prakti has created within weeks an additional fitting, a specific tray, allowing cleaner combustion of these briquettes, without increase

⁵ The most rigorous cookstove testing study up to date is from Berkeley Lab in 2011; Reference : Kathleen Lask and al, Berkeley Lab report, Performance of Charcoal Cookstoves for Haiti, Part 2: Results from the Controlled Cooking Test, November 2011, page 13. A more recent test conducted by Elisha/Chemonics reported a 35% fuel saving but stove users were not trained and did not use the Prakti wouj stove properly [you need to close the door when simmering, saving extra 15%-25% fuel.

of smoke.

Decentralizing the production: from local assembly to local production: Prakti designs and produces its stoves in a fashion that directly allows local repair and assembly. We have developed a factory-in-a-box system to rapidly transfer cost-effective, quality-controlled local manufacturing anywhere in the world.

During the first phase, stoves are produced in India. Prakti is experienced with logistics between India and Haiti, being the sole provider of institutional and household stoves for the World Food Programme and other charity organizations since 2011. However, import and customs processes can pose lengthy delays and arbitrary taxes may be imposed. The next step is to set up local assembly of stoves (already operational in Nepal) to limit logistics risk and costs by importing stove components only – because they can be imported in greater quantities per container than finished stoves, we will need to deal with customs less frequently. Additionally, components are generally subject to more favorable tax rates and less scrutiny by customs than finished products. The final stage will be to be able to assemble all stoves in Haiti, which should be encouraged by the local authorities.

This decentralization of production means you are able to provide after-sale follow up for longer life span and collect quickly end-user feedback for continuous improvement. Working with local partners, eg NGOs that knows the target population is essential for marketing and distribution as they can convey the right messages about fuel efficiency and health hazards, according to local culture and context.

The production technology used is not mass-scale but enables easy repair of the stoves, local assembly, and, eventually, partial-to-total production transfer. Until now, Prakti Design has built a strong partnership with Skillmech an Indian manufacturer but the vision is local capacity building. We will begin by contracting local assembly of Prakti stoves in Haiti, and then gradually transfer skills and know-how to foster local production.

Hybrid distribution and marketing strategy: Embodying economic value of fuel saving, Prakti partners with grassroot organizations and NGOs to recruit first users, which will be the best advocate among their community for adoption of efficient stoves. The varied stove portfolio allows Prakti to target households and institutions (schools). Through WFP programme, hundreds of Prakti institutional stoves have been disseminated in Haiti. Flagship stores and existing users will serve as demonstration tools to increase local demand.

Promoting local female entrepreneurship: Prakti believes that “early-adopter” women among the targeted communities will be the best stove sellers. Prakti stoves target the whole community as they fit the needs of both households and high-volume kitchens. Stoves are distributed by development agencies, existing retailers, and in an increasing portion by trained female salespersons. IN general, Women are better seller than man, because women cook and man don’t. Women are best positioned to understand the benefit of an improved cookstoves, and therefore better positioned to explain these benefits to other women/customers.

Financing the stoves, pricing and purchase power: Prakti is collaborating with microfinance institutions and is in talks

with Kiva , a peer-to-peer online lending platform, so that a micro-credit offer adapted to saleswomen entrepreneurs and stove customers is developed. Micro-financing schemes allow users to buy household stoves at retail price [\$50] with the stream of benefits (fuel savings) more closely matched to the stream of stove purchase cost. The stoves pay for themselves after 5-6 months of daily use (see microcredit scheme calculations further down).

Below is explained in more details Prakti’s experience in Haiti.

Prakti Design had started operating in Haiti shortly before the January 2010 earthquake, with a commitment made in 2009 at the Clinton Global Initiative⁶ to provide the country with alternative and sustainable cooking solutions. The needs for clean biomass stoves are tremendous in this island as explained previously.

Prakti targeted two type of users: schools (institutional stove for school feeding programs) and households (individual charcoal cookstove).

After a successful pilot starting in 2010 that has benefited displaced persons in urban camps and schools through the World Food Program’s projects, Prakti aims at developing a sustainable commercial entity to reach out poor households with fuel-efficient, low emission and low cost charcoal cookstove.

Although Haiti has experienced terrible catastrophes over the past few years and is a country where emergency still largely rules today, aid should not be seen as the only solution. Indeed, due to high deforestation rates and expensive costs of fuel, alternative fuels and improved cookstoves represent market solutions that can be sustainably implemented and can bring wealth to Haitians.

About institutional cookstoves, following a pilot project with International Lifeline Fund and the World Food Program (WFP) over 2010/2011, Prakti supplied WFP with 600 institutional stoves to equip schools with fuel-efficient cookstoves (Figure 3). In Haiti, schools provide the midday meal for the children and the price of charcoal and scarcity of firewood becomes a budget burden.



Figure 4.

For household stoves, Prakti started with a prototype designed according to Haitian needs to fit with local fuel (charcoal), cooking habits (eg size of pot) and other local constraints (even the color preferences). This prototype was tested with 6 cooks hired for three days interactive stove design workshop where they were asked to use the stove everyday, and iterations/stove modifications were done as needed

⁶ CGI 2009 commitment (video): <http://youtu.be/LKuOnHd9bTE>

(reference: ILF UNOCHA report). Another 10 days of stove testing with Haitian cooks was repeated with the new design to verify usability and performance. After stove performance was confirmed (reference USAID-Nexant report), 2,200 charcoal household stoves – the Prakti Wouj – were supplied to UN Haiti to be distributed in urban camps. UNOPS contracted an independent monitoring and evaluation report one year after, indicating high satisfaction rate (98%) for stove performance, durability and usability and indicated a fuel cost saving of 40% (reference: ILF UNOCHA Monitoring and Evaluation Report).⁷ These 2,200 stoves are saving a total of 4,686 metric tons of wood per year⁸, and providing a total of \$396,000 per year in fuel savings to stove owners.

3. Results – Prakti Wouj a high-performance charcoal stove adapted to Haitian households

The Wouj is a charcoal stove developed specifically for the Haitian household market that has been lauded as a stove which is fully adapted to Haitian cooking and highly appealing to the Haitian cook. USAID-Nexant found that the Prakti Wouj had a fuel savings of 43% compared to traditional stoves⁹, and that the stove is “appealing” and “easy to transport.”¹⁰ Tests by Berkeley University in thermal efficiency found that the Prakti Wouj was the best-performing of the newer stoves tested and “clearly superior to the traditional design.”¹¹ UN-OCHA evaluated user satisfaction across a range of household stoves, and found that the Prakti Wouj scored a 99% satisfaction rate.¹² Prakti Wouj also won the title “Best Charcoal Stove” in six focus groups recently completed in Kenya by the Paradigm Project.¹³ The stove can be made in different sizes to accommodate the needs of the largest food vendors as well as those of restaurants. The Wouj consistently cuts fuel consumption by over 42% and toxic emissions by over 50% (source: USAID – Nexant report and Berkeley lab study).

Our initial implementing partner in Haiti International Lifeline Fund said:

“Another genius innovation from Prakti is their household charcoal stove called ‘Prakti Rouge’. Today, Prakti Rouge is considered the best household charcoal stove in Haiti with best performance, durability,

usability, and appeal/aesthetic. ILF have purchased and distributed 2200 such stoves for Urban Camps in Haiti where the earthquake victims are now residing. The community satisfaction has been very high due to economical and environmental savings. Each household living in the camps are experiencing over 40% economic savings.”

According to a recent Berkeley study, Prakti stoves are among the most efficient biomass stoves in Haiti with fastest cooking time and lowest fuel consumption per kilo of food to cook. Most locally crafted stoves costs from 2.5 to 12.5\$ with short life span (usually from 1-3 month to 1-2 year) and very low energy efficiency, just a little bit better than open fire. First generation mild efficient stoves (Eco Recho, Recho Mirak) cost from 5 to 15\$, tends to release fumes and have also short life span around 6 months. Apart from Prakti, other advanced, imported improved stoves such as Envirofit and Stovetec were not yet present actively in Haiti in 2012. New clean stoves initiatives however are taking off such as the subsidized Plop plop stove (International Lifeline Fund). The non-biomass stoves present in Haiti include LPG and kerosene stoves but they can not reach out the whole population, especially the poor. Due to its costs and difficulty of supply, LPG is limited to urban area and upper class. Kerosene is not popular because of the smell.

In Haiti the high fuel price is a strong incentive for adopting a fuel-efficient stove. Customers generally will not pay a premium for health benefits. Stove price, appropriateness to local cooking practices, and appeal to customer behavior are key elements for selling clean stoves.

3.1 Evaluation of performance of Prakti Wouj and other stoves, November 2011

The tests conducted by the Lawrence Berkeley Lab were based on the ‘Controlled Cooking Test’ (CCT) protocol. The controlled cooking test (CCT) is designed to assess the performance of the improved stove relative to the common or traditional stoves that the improved model is meant to replace. Stoves are compared as they perform a standard cooking task that is closer to the actual cooking that local people do every day (reference: link to protocol: http://www.pciaonline.org/files/CCT_Version_2.0_0.pdf)

Common cooking task in Haiti, rice and beans, was used to evaluate performance of the various cookstoves. The tests measure amount of charcoal consumed and time it took to complete the cooking task (table 1), and the amount of Carbon monoxide produced during the cooking task (table 2). If in table A, the X axis labeled ‘Burn time’, represent the time from when the stove was fired till the cooking task was completed (rice and bean fully cooked). A lower ‘burn time’, means a faster stove, which is a characteristic highly prized by cooks (cooks usually don’t buy a stove if it is slower than their traditional stove). There a high variability in stove performance between different cooks (how they cook, how they tend the fire, when do they decide that cooking is done). For this reason, each stove is tested multiple times by different cooks. All tests for each stove are represented by a series of points in both table 1 and table 2.

⁷ UN-OCHA report: <http://dl.dropbox.com/u/9514421/ILF-UNOCHA%20-Haiti%20Final%20Report.pdf>

⁸ From field experience, we estimate household uses 2.27 kg charcoal a day, around 828kg a year. Using the conservative 43% fuel saving field testing data – USAID Nexant report- these households save 356kg charcoal a year when adopting Prakti Wouj stove. IPCC default value of conversion ration from wood to charcoal is 6 to 1 (6 ton of wood produce 1 ton of charcoal); 356kg charcoal = 2,13 ton wood; price of charcoal around 0.5\$ the kilo.

⁹ Based on cooking practices in Haiti, stove performance test results and UNFCCC values.

¹⁰ USAID Nexant report <http://dl.dropbox.com/u/9514421/Nexant%20USAID%20Final%20Report%20Haiti%20021011.pdf>

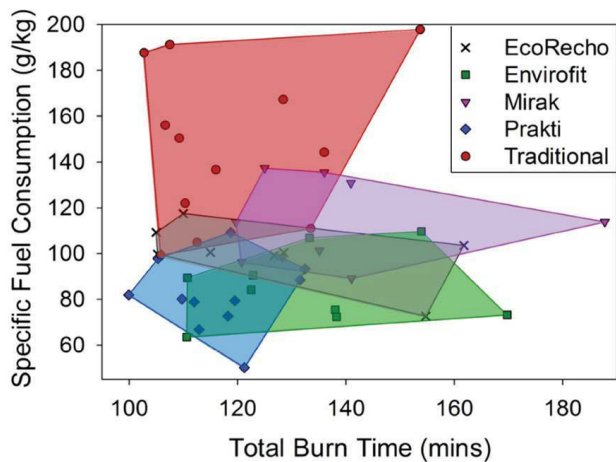
¹¹ Kathleen Lask and al, Berkeley lab, 2011, <http://cookstoves.lbl.gov/haiti/lbnl-5341e.pdf>

¹² <http://dl.dropbox.com/u/9514421/ILF-UNOCHA%20-Haiti%20Final%20Report.pdf>

¹³ http://dl.dropbox.com/u/9514421/Paradigm_PRAKTI%20-Charcoal-Kenya_Focus%20Group%20Mfgs%20Report-1.pdf

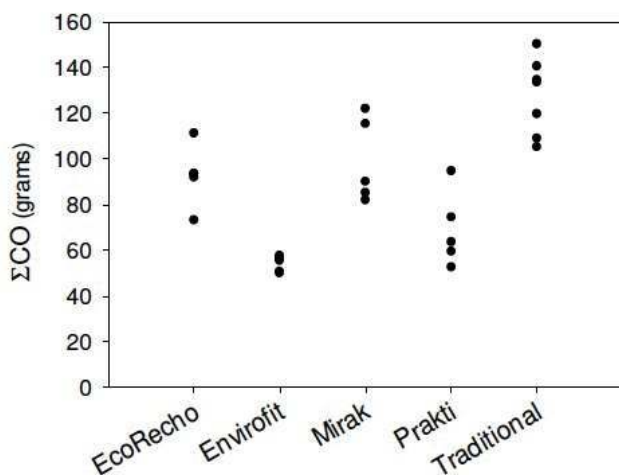
CO was measured by using a hood and fan over the stove to collect all emission from the stoves. Using a CO sensor to measures CO concentrations in real time, and an air flow meter, the total amount CO produced is measured and reported in table 2.

Table 1. Comparison of various biomass stove performance



Source: Berkeley Laboratory – November 2011 - the lowest burn time, the less fuel consumption the better

Table 2. Total CO per test



Remark : Berkeley research only measured CO. Particulate Matter is not significant for charcoal stoves.

3.2 Impact for the end-users

- **Prakti Wouj household customers** use the Wouj stove between once and three times a day. According to USAID/Nexant studies, the average urban Haitian household consumes 2.27 kg of charcoal per day – this represents \$1.15 spent on fuel, which is 28% of the average income of respondents who are employed (average income is \$4.09/day).

Each household using the Wouj instead of the traditional open fire cooking will see an average savings in fuel cost of \$0.48 daily (43% fuel saving – conservative figure) – \$180 in savings per year, assuming that the stove is used every day

and that the household’s former cooking device was as or less efficient than the baseline. At a retail price of \$50, the stove provides a theoretical return on investment in about 3 months. In practice, the Roi is around 5 to 6 months (field experience). The Wouj has a lifetime of five years¹⁴ with maintenance, and comes with a full warranty of one year. With this high performance charcoal stove, each family will be saving a total of \$1060 in fuel over five years.

- **Street food vendors and restaurants** would use the Wouj stove throughout the day. Estimates show that there are approximately 12,000 street vendors working in Port-au-Prince alone (*manjekwit* or *marchann fritay*). The majority of these are small businesses run by women on their household stoves, which are transported into the street or market near their homes. They use charcoal and will run their stoves long hours each day, consuming on average 22kg of charcoal/day (ranging from 3.6 to 95 kg/day, with majority of smaller vendors using 3.6-6kg/day). With an estimated fuel savings of 43%, a street food vendor using Prakti Wouj could recognize an average savings of \$4.7 per day. Even if the vendor’s business requires multiple Wouj stoves or a larger model at a slightly higher retail cost, the vendor will obviously recoup her investment rapidly.

3.3 Global impact

Table 3. Prakti global impact, situation May 2012

Region	Household Stoves	Institutional Stoves	Human Impact – daily meals
India/Nepal	5,000	50	35,000
Haiti	2,200	650	141,000
Darfur, Sudan	50	168	84,250
Kenya	successful completion of focus group field testing		

Prakti Design’s clean-burning stoves have a major impact on promotion of health, reduction of household fuel costs, and protection of the environment – a 2011 study found that Prakti’s monetized social impact return ratio was 17:1.¹⁵ (see in annex the social impact assessment). Our product design and distribution strategies are easily adapted to local contexts, and the program can be replicated globally.

4. Discussion

Challenges for ensuring ongoing success of the project: maturing a sustainable business model for scaling up - creating an innovative microfinance “value embodied” model - Selling the stoves within micro-financing schemes.

The value proposition for the consumer is simple and compelling: stoves cut fuel consumption by over 40% as proven

¹⁴ Estimated life span from accelerated durability tests, with the replacement of the cast iron grid after 24 months.

¹⁵ Social Return on Investment (SROI), applied to stoves: <http://dl.dropbox.com/u/9514421/Prakti-Social-Return-On-Investment-sroi.pdf>

in lab and controlled cooking tests – with experience gained cooking on the stove after a short time, this savings could approach 50%.

Prakti social business model aims at being economically viable from year 2. Constant research and development, collecting feedback from end-user will help lower the costs of stoves. Prakti is also initiating discussion with key stakeholders for carbon credit registration which ultimately (1.5 years minimum) will also lower the costs.

A crucial factor of success is the ability for mass marketing, which is often the weakness of young/small organizations like Prakti. One key step will be to build strong partnership with grassroot organizations to recruit and train women individual entrepreneurs, within the target community as stove sellers.

Prakti Design has initiated a pilot partnership with Entrepreneurs du Monde (EDM) with the objective to establish Prakti Wouj as a financially viable and popular option for households and vendors in Port au Prince through direct sales. EDM will be also a distributor as well as Prakti Haiti.

This pilot partnership already tested in other countries (India, Nepal) has the following specific objectives:

1. Prove the viability of the Wouj retail price/willingness to pay.
2. Assess the acceptability and appropriateness of microfinance or other payment methods for the Wouj.
3. Create a network of distribution contacts which can be expanded upon as demand for Prakti stoves grows.
4. Develop a training module which can be used by Prakti trainers to introduce the stoves as a worthwhile and cost effective investment for increasing business gains or household savings for users.

Another key of success is the right pricing so that it is “good value” for the target population

The economic benefit of this fuel efficiency enables users to recoup the full purchase price of the stoves after 5-6 months. Stoves are sold with a one-year warranty and last 3 to 5 years; they generate total fuel savings that exceed by 10 fold their retail prices. Still, most of Prakti Design’s targeted users cannot afford the stove in one payment. Therefore Prakti partners with established micro-financing institutions to propose to its customers micro-loans or rent-to-own schemes that allow the users to pay back every month in the fuel savings generated by the stove.

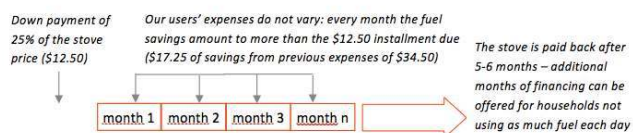


Figure 5. Micro-financing scheme of the Wouj stove for Haiti

4.1 The main pitfalls, and some propositions for avoiding them

- Compromise in design – alliance of engineering and participatory research and development a part of Prakti’s work involves teaching artisans how to build wiser *chulhas*. “But you need the scientists. Sending bureaucrats and consultants to do this is like asking a butcher to design a wedding dress,” Serrar says. “Designing a stove is hot, dirty work, and you need the geeks sitting in the labs, who are willing to get the wood, get down on their knees, and feed a fire. That’s what you need.”
- Counterfeiting : the value of the stoves relies on performance which may be affected if quality is not right. Prakti and Skillmech ensure quality control for highest performance at lowest cost as possible. Prakti has also a branding strategy to be recognized locally as “best stove on the market”, backed up by regular external evaluation such as Berkeley lab.
- Not targeting the poorest – lower social impact value : For sustainability of the social venture, due to challenging stove economics, Prakti targets households / region where biomass fuel is costly, eg Haiti, African urban context. Not necessary the poorest population. Health is not a true marketing argument if not backed up by public health awareness program led by grassroot organisation.

The Prakti Wouj is the most technically sound charcoal stove on the Haitian market, and the retail price of 2000 gourdes reflects its value. While this price may prohibit some customers from purchasing a stove outright, we will overcome this hurdle by identifying appropriate microfinance options and partnering with experienced microfinance institutions.

5. Conclusions and future directions

To get the base of the pyramid adopt clean biomass cookstoves is crucial to improve their health, livelihoods and protect natural resources. To design an affordable and acceptable energy-efficient biomass stoves that fits the local cooking habits and social context is a complex process but even so, the stove will not be adopted if the stove does not embody value for the target population. The strategy to convey worthy messages about health, social or economic benefits is key to succeed scaling up clean stove dissemination. Biomass household economics is key to turn intention to purchase act.

The next stages for Prakti to be economically viable is to develop the network of women stove sellers, the establishment of flagship Prakti stores to help with marketing / visibility / demonstration places. Also Prakti will develop with key microfinance institutions microfinance solutions adapted to clean stoves while initiating carbon credit registration to lower the retail prices of the stoves in the next two years.

Prakti’s integrated clean stove design

– manufacturing – distribution model is replicable in other developing countries. The first target regions are where large population relies on biomass cooking, where fuel is expensive and local government / context is favorable. Prakti is already working in Nepal and India and is investigating opening offices in some African countries such as Rwanda, especially in the cities where population, like Haiti, rely on charcoal as cooking energy.

6. Annex: social impact assessment of Prakti Design (Global Social Venture Competition 2011)

Prakti Design's social value proposition is to provide energy-efficient, clean-burning cookstoves to underserved populations and to promote local female entrepreneurship and local capacity building for doing so. It aims to improve health and alleviate poverty while contributing to women's empowerment, local economic development, and environmental sustainability.

6.1 Theory of change

- If **women** cook on more fuel-efficient and less smoky stoves, the health of the family will improve, their economic development will increase, and women will benefit from lightened chores and better daily material situation.
- If **cooks** in high-volume kitchens cook on more fuel-efficient and less smoky stoves, their health will improve and the economic power of the institution or business will increase.
- If **women** are trained to become stove sales entrepreneurs, their economic power will increase and their social status will improve; their relatives will benefit from this economic advantage.
- If **local workers** are trained to assemble or manufacture the stoves, they gain skills and knowledge that then remain within the community while improving the economic development of the local industry.
- If more fuel-efficient stoves are used, deforestation is reduced and pollution and global warming are diminished.
- The main indicators tracked along the venture's commercial operations are referenced in the IRIS (Impact Reporting & Investment Standards) database; they are:

Number of people impacted

- aggregated using stoves sales volumes, number of female entrepreneurs trained and supported, and the worker body employed for local assembly or manufacture

Fuel savings generated for stoves users

- computed given average baseline fuel consumption and reduction of fuel use generated by the stove and/or assessed over pilot projects and follow-up surveys

Income generated by female entrepreneurs

- tracked in activity reports of monthly sales

Prakti Wouj stove yearly impacts: 54 less sick days and \$212 worth of fuel saved

Following its SROI analysis, Prakti Design has monetized the major outcomes of its activities and has computed a 'social return on investment' ratio: this translates how the venture magnifies the inputs of its stakeholders (mainly in the form of stoves purchases) into substantial social impacts that tremendously benefit these same stakeholders. According to our 2011 analysis and report, this ratio ramps up from 5:1 today to 17:1 in 2014.

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