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Solar Household Energy, Inc.

Solar Household Energy, Incorporated:

A Market-Based Strategy for Introducing Passive Solar Ovens in Kenya

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Table of Contents

Executive Summary

The Solar Household Energy IMAP project team (Team Solar) collaborated with Solar Household Energy, Inc. (SHE) to develop a market-entry strategy in Kenya for SHE's prototype solar oven, the HotPot. The team analyzed manufacturers, distributors, channels, customers, competitors, and other potential partners in Kenya. From the beginning, Team Solar and SHE understood the key to success would be the identification and collaboration of stakeholders that empower local people in the manufacture, distribution and purchase of the HotPot.

Before traveling to Nairobi, Team Solar performed research through phone interviews with organizations in the U.S. and Kenya. While in-country, the team conducted formal interviews with NGOs, potential manufacturers and Kenyan governmental officials as well as informal interviews with Kenyans in Nairobi – most of whom travel home to their rural villages on the weekends. In addition, the team conducted field tests of the HotPot. Team Solar analyzed its findings in an effort to identify the strategy that would best support SHE's mission of the promotion of solar cooking to the very poor in Kenya.

While solar ovens have been available since Kenya's independence in 1961, there are numerous obstacles preventing the widespread acceptance and use of solar cooking, the most significant of which are the cultural and habit changes required to use one and the lack of market knowledge / promotion. Team Solar believes that the key to addressing these issues is to bring together organizations that: (1) are established and have a great deal of in-country experience and an in-country presence, (2) believe that solar cooking offers significant benefits for Kenya and its people, and (3) understand the barriers that have historically prevented the mass distribution and use of solar cookers and have the resources to address them. We therefore propose the SHE establish and lead a Consortium with members from Solar Cookers International, Trans World Radio, and the Kenyan National Federations of Co-operatives. Each organization brings a unique skill set, expertise, and network that can adequately address the issues of PSO dissemination and thus, in the long-term, help each organization achieve its common goals of reducing poverty, improving health, and reducing society's impact on climate change.

I. Introduction

A. The Problem

Wanjiku, a wife, mother, and member of the local women's co-op, has been collecting firewood for several hours under the hot sun and is now heading home with a back-breaking load of sticks, dried grass, and roots. The firewood will be used later that night to cook dinner for her family. In a few days, she will again be on the search for wood, and over time, she will need to travel further from the village to obtain a sufficient supply of fuel. This process will be repeated hundreds, if not thousands, of times throughout her life, and will negatively affect her health, and the environment around her. Meanwhile, Wanjiku's fellow Kikuyu tribeswoman, Njeri, is at home in a slum outside Nairobi. Having scraped a few shillings together, she can afford to purchase enough charcoal tonight to cook dinner and feed her children. Half of her husband's meager income goes to charcoal, and the prices continue to increase.

There are millions of people around the world who expend a great deal of personal resources to harvest or purchase fuel for cooking. The social, economic, and environmental impacts are significant. Second to supplies of clean water, fuel scarcity is one of the most serious resource problems plaguing developing economies and unless this pattern changes, the quality of life for the poor in those countries will continue to decline. The leaders at the Rio Earth Summit in 1990 and the Johannesburg World Summit in 2000 believe that the economies of the future should shift their fuel needs from biomass and fossil fuels to ones based on renewable energies such as wind and solar power. Wind power and photovoltaic cells remain an expensive option, but the tools necessary to trap sunlight and cook food are inexpensive, simple to manufacture, and easy to use. Since 1980, several hundred programs around the world have focused on developing and disseminating solar ovens to villages and urban slums of the developing world. These programs seek to accelerate the natural trend for people to move towards renewable energies, when they are available and affordable. Given various political, social and economic factors, the acceptance and penetration of solar ovens in emerging markets has been minimal at best. Armed with this knowledge, Team Solar set out for Kenya, to find a market-based solution to distribute this technology to those who need it most.

B. Overview of Solar Cooking

Solar cooking is a food preparation method that relies on a reflector to amplify the energy from sunlight and in some models, an insulation device that traps the heat that radiates from the pot and creates a greenhouse. Since there are no mechanical devices or moving parts (as there are in photovoltaic cells), these devices are known as passive solar ovens, herein referred to as PSOs.

1. Why is it important?

Product value chains are often evaluated on economics alone, an exercise that omits several important components that make up the entire product lifecycle. Given that many products provide both intrinsic and extrinsic benefits to end users, it is critical that these aspects are analyzed. The Triple-Bottom Line is a framework that helps achieve this goal. It is used in many corporate responsibility circles[1] and is used throughout this report as a means of evaluating benefits, products, and business decisions along social, environmental, and economic dimensions. In our analysis of solar cooking, we take the triple-bottom line one step further. In addition to categorizing benefits into one of three categories (social, environmental and economic) we stretch the benefits across the different stakeholders to highlight the value that PSOs have in the marketplace. The analysis in Table 1 is specific for Kenya; were these PSOs offered to target market in say, the U.S., the stakeholders would be somewhat different.

Solar cooking is an environmentally-friendly alternative to traditional cooking methods. Since solar cooking does not rely on firewood and charcoal, it helps to alleviate dependence on Kenya's already sparse forests and thus reduce deforestation rates. Wide-spread solar cooking would reduce the amount of greenhouse gases generated through traditional cooking and also reduce deforestation which, particularly with Sub-Sahara Africa's climate, often results in soil erosion, heat-islands, and desertification.

The social benefits of solar cooking are numerous and varied. Solar cooked food contains greater nutritional value than food cooked through other methods, and solar cooking devices provide another means by which to pasteurize water which can reduce infant/child morbidity and mortality. As the number of meals cooked over an open flame is reduced, the incidence of burns from open flame accidents may be reduced as well. Additionally, solar cooking can reduce the incidence of respiratory and ocular diseases associated with long-term expose to indoor air pollution.

Solar cooking also provides many economic benefits. It is a means to poverty reduction as the funds that would typically go toward fuel purchases can be cut (some estimates claim by up to 50%). Finally, solar cooking frees up time for the cook to pursue other activities that may be economically beneficial.

In addition to social, economic, and environmental benefits to the end user, manufacturers and distributors stand to gain from adding solar cookers to their portfolio of products. Not only do they gain new sources of income, but they also could improve their social standing in the community, by furnishing a product that improves the lives of community members.

[1] See http://www.net-impact.org/

Table 1. PSO Triple Bottom Line for PSOs by Stakeholder

	End User	Manufacturers and Distributors	SHE, NGOs, and Society
Social	**Health** • Decreases incidences of respiratory and ocular diseases associated with long-term exposure to indoor air pollution. • Reduces the frequency of burns from open-flame accidents. • Reduces the frequency of accidental property destruction from fires that spread uncontrollably. • Reduces the physical strain, slips, and falls associated with transporting heavy loads of fuel. • Water pasteurization can reduce infant and child morbidity and mortality which is commonly caused by the transmission of water-borne pathogens. **Nutrition** • Reduced fuel consumption increases money savings which can be allocated to purchasing food and thus improve nutritional health. • PSO cooking increases nutritional value. Meats and vegetables are cooked without excess water. Therefore vitamins and minerals are not poured off with the water. The tender food is more easily digested by seniors and small children. • Some PSOs bring the option of baking to most homes in developing countries.	• Empowers local entrepreneurs to engage in business with a sustainable product. • Local entrepreneurs may increase their social standing by providing a product that improves the lives of community members.	• Creates educational and employment opportunities that bring organizations closer to the goal of reducing poverty and improving the health of those who living in developing nations. • Addresses health and nutritional issues.
Economic	• Money savings from reduced fuel consumption (e.g., charcoal, kerosene). • Reduces the amount of time normally required to collect fuel (e.g., wood, dung, other biomass).	• Provides new sources of income by expanding existing product lines for manufactures and creating new business opportunities for entrepreneurs through PSO distribution. • Increases capital investments from micro-credit institutions.	• Reduces government's healthcare burden.
Environ-mental	• Reduces the consumers' ecological footprints and makes their lifestyles more environmentally sustainable.[2]	• As carbon trading mechanisms already in place in Europe and emerging in the US become more common, manufacturers may be able to earn CO_2 permits and then sell them for a profit. • Improves the environmental quality of the country in which their products are distributed.	• Reduces anthropogenic degradation of local air quality by reducing the amount of smoke, particulates, nitrous oxides, and sulfur dioxide otherwise emitted into the atmosphere. • Reduces contribution to climate change by reducing greenhouse gas emissions associated with traditional fuel burning. • Reduces deforestation, and thus decreases anthropogenic impacts on biodiversity, soil erosion, desertification, and heat-island effects.

[2] UN Volunteer Programme Report "Our love for nature runs deeper than you think." December 1998 *Sunworld Magazine*.

The remaining stakeholders (relevant NGOs, government, etc) obtain value from the social and environmental benefits that the PSOs offer. Both NGOs and the government have goals to stabilize the environment, reduce poverty and improve the quality of life of citizens. Supporting and promoting the use of PSOs certainly fits the scope of their missions.

2. Types of Solar Cookers

There are a variety of solar cookers. Each has a unique value proposition and an associated cost/benefit analysis. The different types of PSOs are described below.

a. Panel Cooker

The panel cooker (see Figure 1) includes a reflector that surrounds the pot, which cooks in the center. The reflector for panel cookers can be manufactured with a variety of materials. The CooKit (shown in Figure 3, far left image) has a reflector that is made of cardboard. Manufactured by Solar Cookers International (SCI), the CooKit is one of the more popular models of panel cookers due to its affordability ($2-3 USD for the reflector and $.30 USD for a bag that can be used 10-20 times). The design for SHE's product, the HotPot, evolved from the CooKit and reflects several enhancements which will be discussed in greater detail later.

While the CooKit's cardboard reflector is the most common, other panel reflectors may be made of wood, sheet metal and plastic. Sunlight is reflected onto the pot from a variety of angles, including the panels from the sides, back, bottom and front. The black pot is usually covered with a plastic bag, which helps raise the temperature and retain heat in the pot.

The panel cooker is a good model for developing countries, because it is less expensive to manufacture than other types of passive solar cookers, can conveniently fold up to be stored, and is easy to use. However, the panel cooker can only cook one pot at a time and does not heat food or water as quickly as the other types of solar cookers. Reflectors made out of cardboard or other light materials are also not very durable and can easily be knocked over by the wind, animals or children.

Figure 1. Illustrations and Photographs of Different Panel Cooker Designs
L: Drawing of a CooKit. Middle: Photograph of a HotPot, note the glass lid. R: Photograph of a panel cooker similar to the HotPot but with a different reflector design and opaque lid.

b. Parabolic Cooker

The parabolic cooker (see Figure 2) reflector casts sunlight onto the dull black pot that is placed at its focal point. The black pot absorbs the sun-generated energy and the cooking process takes place. Apart from being used for cooking, the reflector also helps in distilling water, baking and frying. Parabolic cookers are the most powerful of all of the solar cooking models because they reflect and focus the highest amount of sunlight onto the pot and do not need a greenhouse to capture the heat. Some parabolic models are so efficient that they reach temperatures of 260° C.

Figure 2. Photographs of Different Parabolic Cookers.
L: Satellite dish design that concentrates sunlight outward to one focal point Middle: Butterfly design. R: Satellite dish design that concentrate the light inward.

Parabolic cookers are expensive to manufacture since they require a large area of reflective material. They are also difficult to use: not only are they heavy but much like satellite dishes that track moving objects along an orbit, parabolic cookers need to be moved at least once an hour to ensure that the reflectors concentrate enough sunlight onto the pot. In addition, the reflection is so bright that eye protection is necessary when cooking. Given these factors, parabolic cookers are generally not used in the developing world, with the exception of China, where the government heavily subsidizes them.

c. Box Cooker

The box cooker (see Figure 3) is made of a highly insulated box with black inner-walls. It's double glazed window allows sun rays to penetrate and warm the inside of the box. While it may be used without a reflector, the box cooker often is equipped with a reflector that directs sunlight into the chamber for additional cooking power. It is specialized for boiling and baking but not for frying or browning. A cook can prepare several dishes at the same time in the box although the time required for cooking becomes longer.

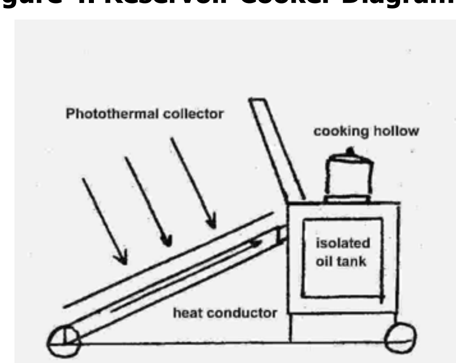
Figure 3. Illustrations and Photographs of Different Box Cooker Designs
L: Cross-sectional rendering of how sunlight enters the box cooker. Note how most of the light comes through the top, while a smaller amount is reflected off the lid. Middle: Photograph of an box cooker in use. R: Photograph of a Sun Oven box cooker with a collapsed lid ready for transport.

The box cooker has an advantage over the panel cooker in that it can be used for cooking on partially sunny days and it retains heat for a longer period of time. Because it is highly insulated, it releases little heat and the temperature rises to 180° C during favorable weather. Food will not overcook or burn in the box cooker, which means the cooking process does not need to be closely monitored. A further advantage of the box cooker is that it does not require much technology to produce. Its raw materials, such as wood, sheet glass (as apposed to molded, tempered glass used for the greenhouse of the HotPot), aluminum, and saw dust/cloth clippings are readily available. Because of the simplicity of the raw materials and the variety of sizes, the cost of box cookers can ranges from $25-200.

d. Reservoir Cooker

The reservoir cooker (see Figure 4) is an appliance that collects solar energy during the day and stores it in an oil-like medium for later use. The oil is kept in a highly insulated container, which can store the heat energy for up to 24 hours. The insulated oil container makes it possible for the cooking system to be used at night. When cooking, the isolation plate is removed so the cooking pot can be placed on the iron plate lying below it. This

Figure 4. Reservoir Cooker Diagram



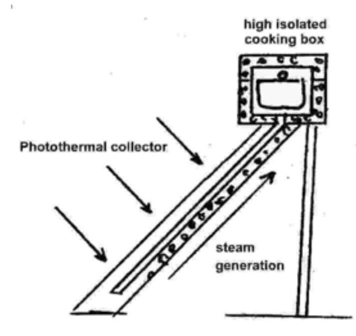
model can be built with at least three reservoirs and three pot spaces.

The reservoir cooker is superior to many other solar ovens because the oil retains heat to cook with when the sun is not out. However, due to difficulty in transporting (due to its weight and size), expense (due to types and quantity of materials required), and required maintenance (the complex design is prone to leaks), the reservoir cooker is a less attractive option for developing markets.

e. Steam Cooker

The steam cooker (see Figure 5) is built with a large surface area for collecting sunshine, which is then transformed into steam. The steam produced spreads upward into the uppermost space of the cooker, where the cooking pot is placed on a highly insulated container. Although this model allows for maximum solar energy collection in the open collector, the energy absorption of this appliance is relatively low and the maximum temperature is only 100° C. This model therefore is not ideal for developing countries, because its cumbersome size does not translate to faster cooking.

Figure 5. Steam Cooker Diagram



The above-descried PSOs types provide value to endusers (as described in Table 1); however, only the panel and box cookers are the most affordable and easy to use. So it should come as no surprise that these are the most common models in found in the developing world. Despite the existence of affordable models, the many benefits that they can provide, and the many years that PSOs have been available, it is somewhat surprising solar cooking is not more widespread. The next section of this paper explores the reasons for why solar cooking remains an uncommon phenomenon.

C. Why Solar Cooking is Not More Prevalent

Acceptance of solar cooking has been slow over the last 30 years despite its great promise for improving quality of life, maintaining health, and preserving the environment. While these benefits provide an intrinsic value to those involved, the lack of an economic reward for these stakeholders presents a risk which as stagnated the introduction of a PSO into the market. Many of the NGOs that work to promote polar cooking, rely on philanthropy to support their efforts, and therefore may not have the economic resources to support a broader PSO product launch. While the government could theoretically realize some long-term gains (e.g., taxes from the manufacture and sale of PSOs, reduced deforestation, etc.), the difficulty in quantifying and supporting these benefits leads to a lack of government support. But most importantly, most end users do not value environmental and social benefits as daily survival takes precedence. Environmental degradation does not impact them directly and while health issues are a concern, the daily impact of these health issues is often overlooked. In addition, very little value is placed on time savings from fuel gathering, partially nullifying any economic benefits.

Even if these issues did resonate with the target market, passive solar cooking is still a difficult product to market. As a whole, the passive solar cooking industry faces significant barriers including:

Primary Barriers

- Less costly alternative products widely available (see section III – 4)
- Cannot cook in the evening for dinner, the major meal of the day for most Kenyan consumers
- Modifies traditional food preparation techniques

Secondary Barrier

- Not a standalone technology
- Takes more time than traditional cooking
- Requires early and flexible planning
- Capacity constraints (for some PSOs)
- Changes in food consistency and taste
- Inadequate training and follow-up.
- Cloud cover results in 30-50% usability
- Using the power of the sun to cook is not understood

Addressing each of these barriers (discussed in greater detail in Section III) is critical to developing a market for PSOs and, as such, became the core focus of Team Solar's research, interviews, and analysis. The project scope and methodology employed in the short seven weeks of this project is discussed in the following section.

D. Project Scope and Methodology

Team Solar set out to work with SHE to develop a market-entry strategy for in Kenya with their prototype solar oven, the HotPot. In order to develop a strategy, the team analyzed manufacturers, distributors, channels, customers, competitors, and potential partners in Kenya. From the beginning, both Team Solar and SHE knew the key to success would be the identification and collaboration of the right stakeholders to empower local people in the manufacture, distribution and purchase of the manufactured goods. Before leaving for Nairobi, Team Solar conducted research through phone interviews, both domestically and with those in Kenya. While in-country, the team conducted formal interviews with NGOs, potential manufacturers and Kenyan government officials as well as informal interviews with average Kenyans in Nairobi – most of who travel home to their rural villages on the weekends. In addition, the team conducted field tests of the HotPot. Team Solar analyzed the findings with an objective eye toward the strategy that would best support SHE's mission of the promotion of solar cooking to the very poor.

The methodology employed and the key findings from this project, can serve as a template for SHE's analysis of potential markets in other developing countries. Continual identification of viable markets will help move SHE toward its goal of improving the lives of the very poor by providing cooking fuel alternatives through solar cooking.

II. Solar Household Energy, Inc. and the HotPot

A. Overview of Solar Household Energy, Inc.

Solar Household Energy Inc. was founded in 1998 with the purpose of worldwide promotion of solar cooking, specifically to the very poor. SHE was founded by three principals: Dr. Barbara Knudson, Louise Meyer and Dar Curtis. While they share a love for solar cooking, each brings unique backgrounds and experiences to the organization. Dr. Knudson is a sociologist specializing in women's issues. She has a particular love for and expertise in solar cooking projects in Kenya. Ms. Meyer is a solar cooking advocate and has managed solar cooking projects and training in a variety of East African countries. Mr. Curtis is a strong advocate of market-based solar cooking promotion.

SHE was born from the founders' independent involvement with the non-governmental organization Solar Cookers International (SCI). These individuals were drawn together by a common mission of developing a product and business model that convincingly demonstrates the commercial viability of solar cooking to investors and business partners, and the social benefits of solar cooking to philanthropic organizations. Specifically, they hope to identify and support local entrepreneurs in the eventual for-profit production and distribution of their first product, the HotPot.

Historically, the promotion of solar cooking in developing nations has occurred only through charitable donations (gifts to individuals or communities) and/or heavy government subsidies. Since SHE is focused on developing nations, those who would be motivated to make such a purchase and have the means to pay are generally restricted to philanthropic organizations that could either resell or giveaway the HotPot to the poor. This arrangement disrupts market-based strategies and could stagnate the promotion and acceptance of this product. Solar ovens that are given away often do not get used since the enduser did not invest in the product and is less incentivized to reap its benefits. Thus, SHE wishes to utilize micro-credit offered through local co-ops to promote their product.

B. Opportunity & Threat Analysis

1. Opportunities

a. Market with Unmet Needs

Solar cooking is beneficial to the Kenyan population because it can reduce their cost of fuel and/or lighten the burdens of their daily life. For example, the need to search for and collect fuel wood is reduced, and solar cooking makes "light work" of meal preparation. The cook is not required to stand over a hot fire, constantly stirring the food and is not exposed to the soot or dirt associated with open fire cooking. Finally, since solar cooking reduces the need for an open fire during the day, it provides a healthier and safer living environment by reducing household air pollution and reducing the opportunity for injury due to burns.

As described earlier, many of the needs of a segment of the Kenyan population can be met by solar cooking. However, there are many options of solar cookers and competing technologies. SHE is not expecting to compete with larger / higher-end ovens that, due to their size and cost, better serve a collective of families or wealthier consumers. SHE's target segment's needs could be met – to some degree – by the CooKit. SHE is targeting a broader population or wider distribution than the CooKit has attempted to date through its focus on refugee camps. In addition, the HotPot has a more durable reflector and does not require cooking bags, which require regular replacement, thus making the HotPot more cost efficient than the CooKit in the long-term.

b. Improving the Economic Environment

Kenya held democratic elections in December 2002, which brought President Mwai Kibaki into power. He has been quite vocal about the elimination of corruption throughout the government; and he has taken steps in this direction. Kenyan's are tremendously hopeful that better economic times are ahead. The reduction of corruption is key in this effort, and if President Kibaki is successful, the result could be increased foreign investment in private funds as well as in the form of re-energized interest by NGOs. Additional funds could directly benefit those promoting solar cooking.

2. Threats

a. Competitive Alternatives

While there are numerous benefits to solar cooking, many reasonable alternatives exist in Kenya. In many locations, free firewood is easily accessible or charcoal is readily available and easier for a novice to use than solar cooking; thus eliminating the consumer's burden-based incentive. Additionally, the new technology of fuel-efficient jikos is growing in popularity. While these stoves still require the use of charcoal, they are an improvement over older versions since they reduce fuel costs by up to 40%. These improved jikos are significant threats because, not only do they require fewer changes in cooking habits that solar cookers, but the Kenyan government is offering subsidies for the improved jikos, if purchased through one of the government run solar centers. With the emergence of the fuel-efficient jiko as an alternative, the HotPot is a less compelling alternate technology.

b. Barriers to Market Creation

SHE is expecting to achieve much more than a product launch into an existing market. To do this, they must also create a market for their product in which there is very little awareness or almost no demand. While their product may provide significant benefits, their target population is, by definition, very poor. The purchase of a HotPot would require a significant investment as well as continued expenditures to support their main cooking methods. Martin Fisher of ApproTEC[3], U.S. speculates that the HotPot would be considered for purchase only if it cost less than a chicken (approximately $2). Furthermore, the advancement of solar cooking in Kenya has occurred primarily through the free distribution of cookers by NGOs. SHE and its partners face a considerable challenge in competing with forces that naturally erode any potential market.

c. Barriers to Market Adoption

SHE will face many barriers to broad-based adoption of solar cooking via the HotPot in Kenya. Since much of the target population has access to reasonable alternatives to the HotPot that require far fewer compromises and adjustments, adoption and sustained use of the HotPot is yet another challenge. Solar cooking requires the consumer to adjust their daily routine and cooking method and accept compromises to the perceived quality of their food product. While solar cooking may ease some household concerns, such as household air pollution and injury, it creates new concerns for novice users.

Solar cooking also requires at least twice as much time as traditional cooking. The cook must begin preparing the meal much earlier in the day. Traditional dishes, such as ugali and irio, can be prepared in a PSO, however significant changes in texture and consistency must be tolerated. The food is traditionally prepared to be smooth and porridge-like, but the result from PSO is solid and cake-like. While the cook is not required to stand over and stir the food, concerns about theft and food contamination compel many Kenyan's to watch over their PSO, which prevents activities away from it.

Anecdotal case studies through interviews have consistently shown that the successful introduction of solar cooking requires significant investment training. Each individual cook must be shown how to prepare each variety of food. This exercise may require multiple attempts with continual adjustments for each type of food (grains, vegetables, meats). Subsequent visits and follow-ups are needed to encourage cooks to continue to use the PSOs. Inadequate training and follow-up and the lack of re-supply of parts have been reasons for past project failures. Such anecdotes suggest a trial and adoption period that is lengthy, tedious and costly. The extensive training that seems to be required will further increase the cost of bringing the HotPot to market and deter rapid adoption of solar cooking.

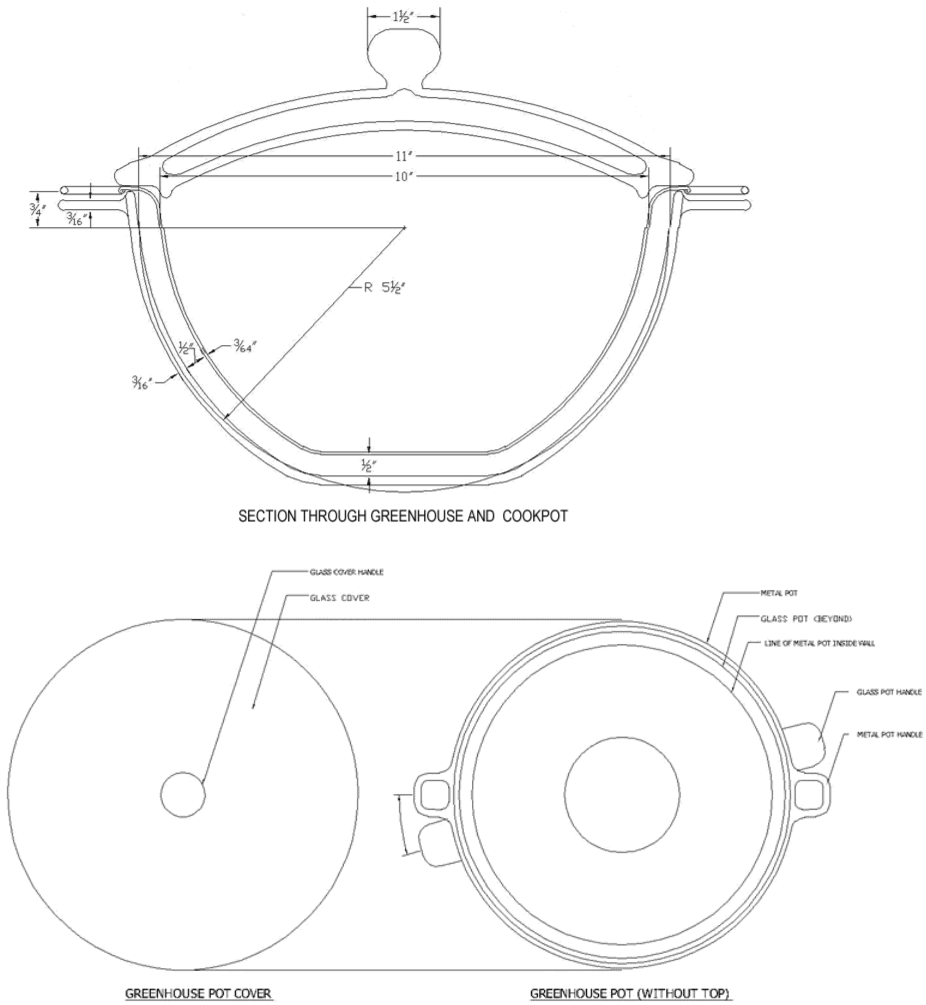
C. HotPot Design, Features and Value

1. HotPot Design

Given SHE's experience with the CooKit in developing nations, their knowledge of the market, and their understanding of users' needs, SHE along with the Florida Solar Energy Center, designed the HotPot (see Figure 7), an affordable PSO that is an improvement over the CooKit.

[3] ApproTEC is a multi-national NGO who's mission is "To promote sustainable economic growth and employment creation by developing and promoting technologies which can be used by local entrepreneurs to establish profitable, small scale enterprises."

Figure 7. Schematic of the HotPot
Dimensions of the HotPot designed by SHE and the Florida Solar Energy Center[4]



Much like the CooKit, the HotPot is placed in the center of a panel reflector, which directs sunlight into the black pot. The heat that radiates from the warming pot is trapped by the glass greenhouse (see Figure 8).

Figure 8. Photograph of HotPot with Reflector Panel[1]

2. Value of the HotPot to End-users

Preliminary tests by the Florida Scientific Energy Center (FSEC) show that the HotPot heats food at approximately 10° C higher than the CooKit, a

[4] Technical specifications are available at http://www.fsec.ucf.edu/Solar/PROJECTS/SolarCooker/thefinalreportjun02.pdf

notable improvement.[5] In addition, the HotPot has several features that provide greater value than the CooKit to end users (see Table 2).

Table 2. HotPot features, benefits, and value that supercede the CooKit.

Feature	Benefit	Value
Reflector panel is constructed of corrugated plastic	More durable than cardboard	Economic savings to the user.[6]
Glass greenhouse and lid	Better heat insulator than the oven bag	Faster cooking with higher temperatures than the CooKit
Glass greenhouse and lid	Eliminates the need for disposable oven bags	Economic savings to the user (Each CooKit bag costs $.30 USD and can be used 5-7 times resulting in an annually cost of $10.40 USD versus a one-time ~$5 USD[7] expense for the HotPot's greenhouse.)

3. Technical Specifications

a. Panel Material

The HotPot reflector is made of corrugated plastic, the same material used to make outdoor signs. This is a structural improvement from SCI's CooKit, which has a reflector that is made of cardboard. The corrugated plastic is lightweight and flexible, so it can be shaped and formed to match the structural requirements of the SHE Hotpot reflector (shown in Figure 9). Durability is the main benefit of using plastic, which will hold up much longer than cardboard as cardboard is susceptible to deterioration due to rain water, moisture and standard wear and tear.

Corrugated plastic is manufactured from recycled plastic, which is impact resistant and will not tear or puncture. Although the corrugated plastic is stiff in its original configuration, it can be cut and molded with specific creases to ensure the required design folding and storage of manufactured units. The reflector can be customized by size and shape by being die-cut, scored, creased, stapled, nailed, stitched, folded, drilled, and sonic welded. The material is unaffected by water, so it will not rust, rot, mildew or corrode. In an environment that is dusty and dirty, the plastic can resist dirt, grease and other chemicals.

Although it is more durable than and as lightweight as the CooKit's cardboard reflector, the plastic version seems to be less effective that the cardboard is in its folding capability. The cardboard reflector folds and collapses easily to either transport or store. The current plastic reflector prototype, however, is not easy to fold or break down after use. This may be improved in later models, but it was a recurring concern by experts during our field testing of the HotPot in Kenya.

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[5] http://www.fsec.ucf.edu/Solar/PROJECTS/SolarCooker/thefinalreportjun02.pdf
[6] Preliminary cost estimates show the plastic reflector to be comparable to the cardboard one in Kenya. Savings is realized if replacement occurs less frequently.
[7] Greenhouse cost estimate based on Mexico manufacture costs not Kenyan.

b. Reflective Material

Many different types of reflective materials were tested with the Hotpot. Flexible Solar Material, manufactured by ClearDome Inc., is a thin, highly-reflective material sold to NASA for space travel and has the highest reflectivity rating on the market (>95%). While the most ideal reflective material for the HotPot, this material is expensive and difficult to obtain so SHE resorted to using aluminum foil (a.k.a. metallized aluminum) which is reasonably reflective and is currently used with other panel cookers.

c. Pot and Greenhouse Material

A standard 4-quart stainless steel mixing pot was found to be the optimal size and shape for cooking with the HotPot. The steel mixing pot must be painted black for optimal heat retaining capabilities. A circular aluminum ring can be applied with a silicone sealant to the lip of the pot, which will ensure the lid forms a tight seal with the pot.[8] Originally, SHE requested a 5-quart pot to be used with the Hotpot. In the first round of their testing, this size was not as successful as the 4-quart pot because (1) the surface area to volume ratio prevented the center of the pot from cooking (e.g., consider the cool center one obtains when cooking in the microwave) and (2) the size of the glass bowl required for a 5-quart pot was far too large to be practical in the field (see Figure 9).

Most panel cookers use a standard pot, with or without a cover, and a greenhouse surrounding the pot. The CooKit uses an oven bag for a greenhouse. Although practical and cheap, this method has several drawbacks. Heat loss through the plastic bag is significant, thus making it difficult to maintain the greenhouse effect. Also, the oven bags degrade over time and can only be used approximately five to seven times. The Hotpot, on the other hand, has a glass container and lid that are used to create the greenhouse effect. Glass is a much better insulator than plastic and, with proper care, can last for many years.

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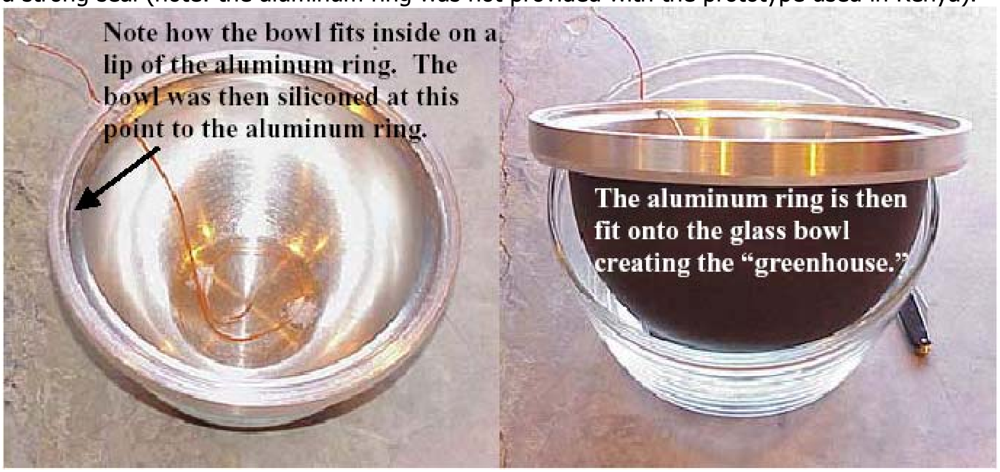
[8] The HotPot prototype tested by Team Solar in Kenya did not have an aluminum ring, but the seal between the glass lid, metal pot, and glass greenhouse were sufficient to create the desired greenhouse effect.

Figure 9. The HotPot Greenhouse
The greenhouse is created by trapping the air between the metal pot and the glass bowl. The aluminum ring creates a strong seal (note: the aluminum ring was not provided with the prototype used in Kenya).



4. Capital Investments

There are four different types of manufacturers necessary to build the Hotpot including a manufacturer for corrugated plastic, glass bowls, steel pots, and an acceptable reflective material. In most cases, the manufacturers selected to supply the parts needed will already be using their tooling and manufacturing capabilities to produce similar products for other uses. Locating manufacturers that already have the production capabilities to produce the materials needed to build the Hotpot will therefore depend on leveraging these companies' current manufacturing potential. Team Solar identified a manufacturer for the plastic reflector in Kenya (see Appendix F for an assessment of the option).

III. Market Attractiveness of Kenya for Passive Solar Ovens

A. Quantifying Size of Market Segments

There are numerous ways in which we could define "market size" in this specific situation. Currently, Dr. Dan Kammen of Berkeley's Renewable and Appropriate Energies Laboratory estimates that only between 3,000 and 5,000 rural Kenyans own and use PSOs. In our attempt to quantify the size of the potential market in Kenya, we primarily focused on the rural market. While we recognize the potential interest of members of peri-urban markets in solar cooking, we did not include them in this analysis since issues of theft and lack of space will likely make use of solar ovens less feasible in those communities. Each of these segments faces many of the same challenging barriers for using PSOs, although there are some different market dynamics that makes the rural segment more viable for PSO product acceptance.

1. Rural Kenya

As deforestation continues, the supply of wood continues to decline, making harvests longer and more frequent, and also increasing the cost of purchasing firewood. Since the vast majority of rural Kenyans continue to rely almost exclusively on wood as fuel (they cannot afford paraffin or charcoal), the rural wood-burning population represents the most likely potential market for PSOs. We attempted to quantify the "likelihood" that rural Kenyans would convert to PSOs based on their level of income and the scarcity of fuel in the region. While we feel this is the best method of quantifying the potential market size, we recognize that it is not perfect:

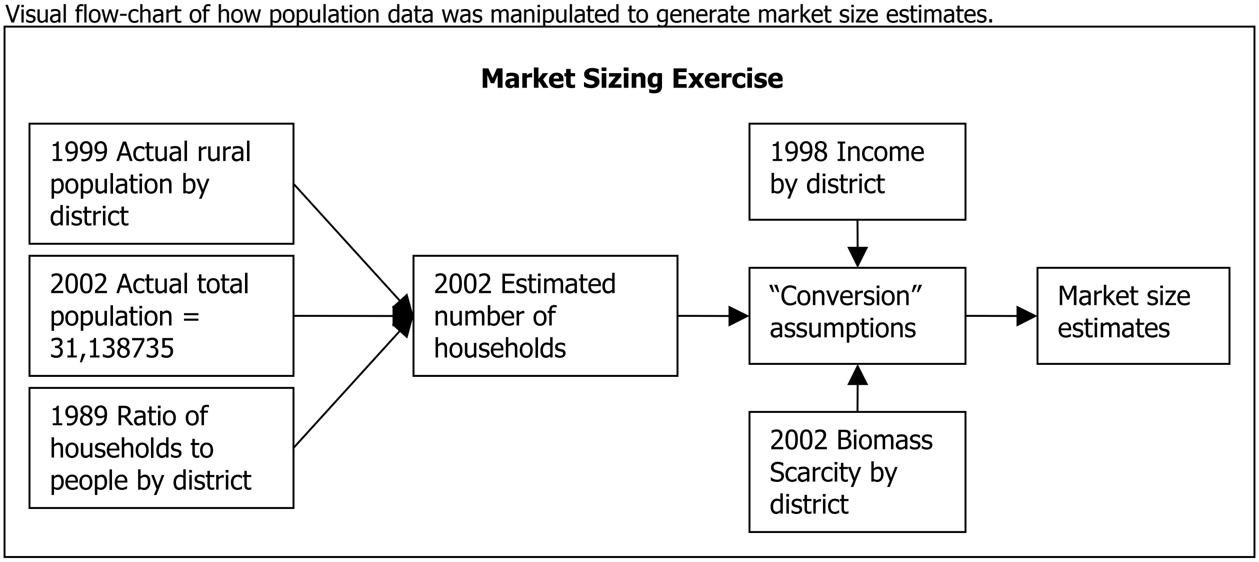
> "The trouble with the fuel cost approach is that fuel-wood in rural Kenya is gathered for free and the only way to approximate a cost is to estimate the opportunity cost of the gatherer's time. This is tricky for several reasons: wood gathering is often incorporated with other activities - e.g. a woman may collect the day's fuel when she returns from tending to the fields. Also, children are frequently sent for wood and the family probably assigns a lower value to their time than to an adult's time. I think people would value fuel savings, but there are other ways to save fuel. e.g when wood is scarce, people can opt to conserve by using less or cooking less fuel intensive meals, they can buy efficient stoves, or switch fuels from wood to crop residues, dung, charcoal or kerosene. None of these require the drastic behavioral changes that solar cookers require."[9]

For our analysis of the market in rural Kenya, we took census data[10] which gave us both the population

[9] Dr. Daniel Kammen, Professor, UC Berkeley, 2003
[10] Central Bureau of Statistics, Nairobi Kenya, 1999 Statistical Abstract

and number of households within a given district. Then we took the breakdown of fuel sources for cooking for those regions.[11] Based on the biomass scarcity[12] and income levels[13] within the given districts, we estimated the "likelihood" that people would convert to PSOs. Figure 10 represents a schematic of the process we followed to estimate the size of the market.

Figure 10. Market Size Derivation
Visual flow-chart of how population data was manipulated to generate market size estimates.



As a result of this analysis, we have forecasted the size of the PSO market under three different scenarios. It should be noted that this is a market analysis for all PSOs, not just for HotPots. Scenario A represents the estimated total number of households in rural Kenya; while we do not think it is realistic to assume that 100% of households would be interested in PSOs, it serves as a good reference point for the other scenarios. Scenario B represents what we consider "aggressive" assumptions and scenario C represents what we consider "conservative" assumptions. A summary of the three different scenarios appears in Table 3. A break down by district can be found in Appendix B along with a detailed explanation of our assumptions.

[11] The World Bank, 1993, "Welfare Monitoring Survey Statistical Tables"
[12] Kamfor Company Limited, 2002, "Study on Kenya's Energy Demand, Supply, Supply and Policy Strategy for Households, Small Scale Industries and Service Establishments"
[13] Central Bureau of Statistics, Nairobi Kenya, 1999 Statistical Abstract

Table 3. Potential PSO Market by Head of Households (HH)

Potential PSO Market (HH)					
	Scenario A	Scenario B - Aggressive		Scenario C - Conservative	
Province / District	Maximum (Total HH)	Forecasted Number of HH	Penetration	Forecasted Number of HH	Penetration
Central	769,121	344,021	45%	163,956	21%
Coast	302,612	80,565	27%	49,053	16%
Eastern	892,829	147,568	17%	97,966	11%
North Eastern	165,939	31,430	19%	20,138	12%
Nyanza	891,875	438,385	49%	186,336	21%
Rift Valley	1,339,105	344,287	26%	210,560	16%
Western	615,427	303,732	49%	130,054	21%
Total	4,976,908	1,689,988	34%	858,064	17%

*For a detailed explanation of the assumptions utilized in this analysis, please see Appendix 5

Key takeaways from Table 3:

1. There are an estimated 5 million households in rural Kenya whom would stand to benefit from solar cooking, however, it is unlikely that they would all accept the technology.
2. Given their income levels and biomass scarcity, the regions of Central, Nyanza and Western Kenya are the most likely accept solar cooking.
3. The regions of Eastern and North Eastern Kenya, where biomass scarcity is less of an issue, will be slow to adopt solar cooking.

2. Peri-Urban Kenya

We divided up the potential PSO markets in Kenya into rural and peri-urban segments. Relative to the rural market, the peri-urban population has many more barriers. Most notably, there are more alternatives available to consumers in peri-urban areas than there are to people living in rural areas of Kenya. Residents in peri-urban Kenya have better access to buy coal for their jikos or can gather materials like trash to burn. The threat of PSO theft also makes the peri-urban segment less attractive than the rural segment. In rural villages, there is often more trust between the tribes of families who have lived in the same place and known each other for their entire lives. That is not the case in peri-urban areas, which is made up of a collection of people from different villages, tribes and even countries who are not above stealing in order to survive.

Many people living in the peri-urban areas are from rural villages who come to city to find employment. Since they commute from the peri-urban areas into the city, they are not around during the day to make their meals. Also, they live in the city during the week and spend either their weekends or their holidays in their villages. These part-time peri-urbanites would not purchase a PSO for their city dwelling, but would most likely be interested in buying a PSO for their family in their rural village. In fact, many peri-urban residents come to SCI's PSO shows in Nairobi to specifically buy a PSO for their relatives living in their hometown village.[14]

Successfully introducing PSOs into Kenya is a challenging proposition. Given the myriad of additional factors that their peri-urban market presents, we concentrated our research on the rural market segment. While there may be a market for the peri-urban segment in the future, the barriers are more difficult to address at this time.

B. Market Drivers for Affordable Passive Solar Ovens

1. Factors Creating Demand

Demand for PSOs is driven largely by economics; however there are also significant environmental and health benefits that will motivate the different partners in any PSO manufacture / distribution entity. While motivating other participants is necessary, in this section we focus on creating demand. Hence, motivation to end-users is vital.

a. Economic

Roughly 97%[15] of rural Kenyans do not have access to grid electricity and therefore utilize kerosene for lighting and wood, coal, kerosene, etc. for cooking. The majority of rural Kenyan communities cannot afford to obtain access to the grid or small-scale generation such as micro-hydro, wind power or fuel-powered generators, which could provide off-grid power. While some rural Kenyans have access to cheap fuel (e.g., wood), a significant portion spends up to 50%[16] of their annual income on fuel. Thus the demand for PSOs is driven primarily by the scarcity and cost of coal and kerosene.

If a solar technology solution addresses enough barriers, the economic rationale can be significant as biomass fuel (wood and agriculture refuse) is essentially the only option for cooking. In addition, biomass fuel is becoming increasingly scarce and costly. To quantify the target non-subsidized price point, Team Solar conducted an analysis of fuel costs by region and estimated fuel savings from the use of solar ovens to establish its value to an end user within a given region. The analysis was conducted as follows:

1. Estimated the monthly cost of fuel used for cooking by region
2. Apply a range of fuel savings to the monthly cost of cooking fuel to establish monetary savings
3. Calculate the present value of those monthly savings over the life of the solar oven

[14] Interview: Margaret Owino, Director of Solar Cookers International – East Africa, 4/9/2003
[15] Hankins, Mark. 2002. The Role of PV in Africa: Misconceptions and Realities. SolarNet – Solar Energy Network Magazine, Vol. 4 No. 2 July – December 2002.
[16] Interview: Paul Munson of Sun Ovens International, 3/22/2003

Table 4 represents the present value of estimated fuel savings among the poor over ten year expected life of a solar cooker[17] (see Appendix J for the full financial analysis including a more detailed explanation and a broader range of assumptions).

Table 4: Present Value of Estimated Monthly Fuel Savings (USD) Over a 10-Year Life

Levels of Fuel Savings	Central	Coast	Eastern	Nyanza	Rift Valley	Western	Nairobi	Mombasa	Kisumu	Nakuru	Other Urban
20%	10	4	3	3	5	3	15	12	29	33	26
25%	12	5	4	4	6	3	19	15	36	42	33
30%	15	7	4	5	8	4	23	18	43	50	40
35%	17	8	5	6	9	4	27	21	51	58	46
40%	19	9	6	7	10	5	31	24	58	67	53
45%	22	10	7	8	11	6	35	27	65	75	59
50%	24	11	7	9	13	6	39	30	72	83	66
55%	27	12	8	10	14	7	42	33	80	92	72
60%	29	13	9	10	15	8	46	36	87	100	79

Key takeaways from Table 4:

1. In order for it to be attractive to the bulk of the rural poor, the unsubsidized price of a PSO will have to drop to roughly $10-12 USD.
2. By reducing the price to roughly $20 USD, urban regions (Nairobi, Mombasa, Kisumu and Nakuru) will find a PSO attractive (present values above $20 USD).
3. Most of the rural population (Central, Costal, Eastern, Nyanza, Rift Valley and Western) will need further price reductions or subsidizes before they find PSOs attractive (present values below $20 USD).

b. Environmental

While the economics seem to indicate that further price reductions or continued subsidization will be necessary, demand for PSOs is driven primarily by fuel cost savings. However, there are also several health and environmental factors that may drive demand to a lesser extent. In terms of environmental factors, the continued use of wood and charcoal as fuel contributes to deforestation in the region.[18] Environmental motivation is unlikely to resonate with rural Kenyans whose sole focus is on survival but may entice those who wish to reduce their impact on the environment.

[17] While the life of a solar cooker varies greatly based on maintenance and frequency of use, our research shows that 10 years is a reasonable assumption

[18] Replanting is an option, but few countries outside of the US, Canada and Europe, mandate proper forestry practices.

c. Health

Many Kenyan children under the age of five are exposed to water-borne illness from the consumption of unsanitary water[19]. Cholera, amoebic dysentery, etc. are common causes of infant and child mortality. PSOs offer another option for heating and pasteurizing water, which could dramatically reduce these morbity rates. A temperature of 60-65 °C, (which is easily achieved through a PSO), is sufficient to eliminate most water-borne infectious diseases. Since fuel is scarce / expensive, most Kenyans chose not to use it for pasteurization. Since PSOs offer the ability to pasteurize water without the use of any fuel, the likelihood that Kenyans would be willing to pasteurize their water should increase with adequate education.

In addition to the reduction of water-borne illness, PSOs offer two key health benefits when compared to traditional cooking methods. First, emissions from fuel burning cooking sources cause acute respiratory infection (ARI), particularly pneumonia, and other ailments. Numerous studies demonstrate a consistent positive correlation between exposure to smoke from indoor biomass burning and acute respiratory infection (ARI), particularly pneumonia, and other ailments. Those most continuously exposed to indoor air pollution are women - who perform over 90 percent of domestic chores, including cooking - and children. ARI is the leading health hazard to children in developing countries, and results in an estimated 4.3 million deaths per year among the overall population.[20]

Second, burns from open flames pose a severe health threat to women cooking and children playing around the fire. Each year, there are many cases of burns that result in injury, sickness through infection, and even death. The medical attention required to treat these burns is usually not available to the victims. Potential consumers may identify the ability to reduce exposure to smoke and flames through solar cooking as a valuable health benefit.

2. Factors Limiting Demand

Despite the conditions that clearly create potential demand, there are political, social, economic, and environmental factors that serve to narrow the potential market.

a. Economic

A significant portion of the rural population is so poverty stricken that they cannot afford even the low-end PSOs which cost around $5-6 USD without large subsidies (the give-away model). Additionally, fuel-efficient jikos are available at a cost of only $2-3 USD, creating a disincentive to purchase affordable PSOs. While extreme poverty limits the demand for affordable PSOs, such as the HotPot, demand is also

[19] Interview: Dr. Barbara Knudson of Solar Household Energy Inc, 3/12/2003

[20] N.M.H. Graham, "The Epidemiology of Acute Respiratory Infections in Children and Adults: Global Perspectives," Epidemiological Review 12 (1990), pp. 149-78; K.R. Smith, "The Health Impact of Cookstove Smoke in Africa," in African Development Perspectives Yearbook 3 (Muenster: Lit Verlag, 1994), pp. 417-34

limited by the decreasing cost for more efficient, yet more costly, PSOs such as box cookers (box cookers are available for as little as $25 USD[21]). If the cost of superior products like box cookers continues to decrease, the size of the affordable market and demand for panel cookers will rapidly diminish.

b. Environmental

In terms of environmental factors, there are several rural regions within Kenya where cheap fuel is readily available, thus eliminating the primary economic motivator driving PSO demand. Additionally, a base level of solar insolation (solar insolation is a measure of the strength and angle of the sun's rays) is necessary to make PSOs work. Climate data indicated that almost all regions of Kenya receive the sufficiently high levels of insolation throughout the year.[22] While solar insolation is not a limiting factor in Kenya, at some higher altitudes the average ambient air temperature is low enough to have a negative impact on the effectiveness of PSOs.

c. Social

Environmental and economic factors certainly limit demand for affordable PSOs, however, the biggest hurdles in introducing solar cooking are the social and behavioral changes necessary for its long-term use. In order for solar cooking to be accepted, Kenyan communities and households must modify long-standing cooking habits and traditions. Attitudes toward solar cooking must first be addressed before any behavioral change can take effect. Fostering the major change in cooking habits and educating end-users on how to use the solar cookers effectively will require a great deal of initial training and continuous, consistent follow-up, all of which are further complicated by the high level of illiteracy among the rural population. Social hurdles include the following:

Takes more time than traditional cooking

Compared with traditional cooking (firewood, kerosene, etc…) solar cookers are much less flexible regarding cooking time. While solar cooking takes less effort (there is no need to constantly stir the food so the user can complete other tasks while the food is cooking), solar cooking in itself requires good planning and early preparation for each cooking session. This is a significant cultural change for Kenyan women who traditionally buy their food for that evening from markets that opens each day at 11am. When using a solar cooker, women have to start cooking by 10am, which requires them to buy and then store their food the day before they plan on cooking it (storage may not be an option).

Since solar cookers take longer to cook food than the traditional three-stone fire, meats must be chopped into small pieces so they can be cooked sufficiently. Larger pieces of meat are preferred to smaller

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[21] The smallest box cooker manufactured by Trans World Radio in Nairobi sells for $25 USD
[22] University of Massachusetts Lowell Photovoltaic Program. International Solar Irradiation Database, Version 1.0. http://energy.caeds.eng.uml.edu/solbase.html

pieces of meat by Kenyans, and Kenyan families can be perceived as inhospitable by not offering the larger chunks of meat to their guests.

Changes in food consistency and taste

Taste, texture, consistency and color of solar-cooked food vary from those prepared through traditional cooking methods. Therefore families that adopt solar cooking will need to train in food preparation techniques and to accept and adjust to changes in their cuisine and food taste. Additionally, some Kenyans complain that meals prepared in solar cookers lack the smoky taste which they prefer. Finally, in some regions where diets rely heavily on cooking styles outside of boiling or baking, solar cookers are less viable.

Perception – Fear of the Unknown and Unusual

Many rural Kenyans have inhibitions over solar cooking, largely because they are unaware that the sun has the power to cook food. Without an open flame or heat source, they believe food cooked in the sun must be a result of "black magic"[23], which discourages them from using a PSO. Trainers have to convince new cooks that solar cooked food is safe to eat via taste tests to prove that they will not get sick. In some areas of Kenya there is also a fear that if food is left outside without a sentinel, an enemy may pass by and give the "evil eye" (which is equivalent to poison) by looking at the unattended meal[24].

Domestic abuse

Kenyan men expect a hot meal ready and waiting for them when they come home at night. Weather changes throughout the day (cloudiness, high winds, etc.) may result in the possibility that the meal will not be ready when the man returns home. Dinner that is not hot and ready to be served to the man of the house when he wants it may lead to domestic abuse in some Kenyan families.

Little value placed on women's time

Most men in Kenya do not place a high priority on the time that their wives spend on collecting fuel. Thus, the time saving factor a PSO affords is not a compelling benefit for some Kenyan men. This obstacle to PSO acceptance is further perpetuated if children collect firewood for the family, as many men will place even less value on their time. Since men usually make the purchasing decisions for their families in Kenya, their lack of appreciation for their wives' time and their lack of experience cooking will limit the value that the men place on PSOs. This patriarchal dominance over finances and disregard for women's time may preclude men from purchasing a PSO.

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[23] Interview: Margaret Owino, Director of Solar Cookers International – East Africa, 4/9/2003
[24] Interview: Margaret Owino, Director of Solar Cookers International – East Africa, 4/9/2003

Quantity constraints

In Kenyan culture, relatives and other village members may arrive unexpectedly for dinner on any given night. There is an expectation that the family will have enough food to feed these visitors; if a meal does not provide enough food to satisfy everyone and still have leftovers, it is seen as an embarrassment to the family. Since many solar cookers only hold a limited quantity of food, a woman may fear that her family will not have enough food for guests and leftovers at the end of the meal. In addition, the average Kenyan family has 4-6 members. Many affordable PSOs claim to feed six people, however many of our interviewees told us that many Kenyans have physically demanding jobs and appetites to match, so these portions only feed up to four people. Finally, the traditional Kenyan meal involves multiple dishes, yet most solar cookers can only cook one dish at a time thus creating another obstacle.

Need for alternative cooking source

Nightfall and cloud cover allow PSOs to be used approximately 30-50% of the time. Therefore, potential PSO owners will need to own and operate a supplementary fuel burning mechanism. The average Kenyan family eats dinner at 8 PM, yet with a solar cooking device, optimal cooking time ends at 4 PM, requiring that the family own another device to continue cooking or to keep the food warm (like an insulated hay basket). Many potential PSO owners do not see the logic in owning two cooking devices when one device like a jiko or firewood can work all the time. Additionally, it is very difficult to convince people to switch to a new technology, let alone convince them to have to keep switching back and forth between the old and new technologies.

Threat of theft

By cooking outside there is a threat of theft not only of the meal but also of the PSO itself. Some models of PSBCs (Passive Solar Box Cookers) have incorporated a latch or lock, but locks can be broken or the entire solar cooker can be stolen. In refugee camps, SCI has observed groups of 4-5 women cooking together so that one can watch over the meals while others attend to chores.

d. Political

The new Kenyan government recognizes the severe health and environmental problems being perpetuated by the use of firewood for cooking. To solve these problems, the Ministry of Energy is encouraging the use of the improved Kenyan Ceramic Jiko (which utilizes charcoal) to decrease the pressure on wood resources. According to the Poverty Reduction Strategy Paper, the government is targeting a 10% increase in the use of efficient stoves.[25] In addition, the government is promoting inter-fuel substitution through removal of tax levies on kerosene, LPG (propane) and related end use

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[25] Poverty Reduction Strategy Paper for the Period 2001-2004, Republic of Kenya Ministry of Finance and Planning, September 2001.

applications.[26] Currently, there is a 35% tax levy on LPG appliances and the gas itself. The government is promoting energy alternatives including solar technology through ten Energy Centers located throughout Kenya. Some locations include Jamhuri, Kitui, Mtwapa, Mombassa, Wambugu, Nuyamira, Kisii, Kakamega, and Machakos. Demonstrations of several alternative energy sources take place at the Energy Centers including wind, solar photovoltaic, solar thermal, biogas and cookers. Unfortunately, the Energy Centers are not well advertised, and as a result few Kenyan know they exist.

According to the Ministry of Energy, market penetration for solar cookers is low. People are aware of the technology, but are uncomfortable using it. It will take a great deal of time and effort to get people to adapt to solar cookers, as cultural inhibitions often times negate the cost savings associated with solar cooking. To achieve the goal of increasing the efficient stove usage of the population by 10%, the government offers a high quality jiko for KES 250 (approximately 3 USD) in their Energy Centers. A jiko of this quality retails for approximately KES 500 (approximately 6 USD) on the open market. Although the Ministry of Energy is not dismissing the value of PSOs, their focus on promoting jikos and apathy in investing resources to promote PSOs will limit the dissemination and widespread use of solar cooking in Kenya. While the new jikos that the government is supporting offer improved fuel efficiency, they still require some fuel (50% or more relative to a traditional jiko) and do not provide the health and environmental benefits that PSOs offer.

C. Competitive Analysis

1. PSO Manufacturing Market Orientation

The solar cooking industry includes a number of organizations that manufacture and/or sell solar cookers to different segments of end users. Research and interviews with PSO manufacturers revealed that solar cooking organizations fit into two major categories: those targeting the relatively wealthy in developed markets and those targeting the poor in emerging markets. The first group consists of companies that sell PSOs to middle and upper class consumers in the US market. These solar cooker organizations target outdoor enthusiasts, "Y2K'ers",[27] and environmentalists alike, with higher-end PSOs that start at prices of $150 and beyond. Given the cost of their products, it is unlikely that they will market PSOs in developing countries.

The second group manufactures and distributes their PSOs primarily to poverty-stricken people in third-world countries. Though the variety of models offered by these companies differs substantially, the common goal to improve the lives of people through the use of PSOs is strikingly similar. Though SHE's goal is to find a manufacturer that can commercially produce and sell HotPots, their mission to alleviate

[26] National Development Plan 2002-2008, Republic of Kenya, p. 90.

[27] Y2K'ers are individuals concerned about the fate of humanity as a result of the "Year 2000" computer glitch and represent a market that has substantially decreased in size since January 1, 2000 when it became clear that doomsday would be postponed.

poverty in third-world countries rather than selling their PSO to US customers for a profit put them in this second category.

2. Industry Players: Solar Cooking Organizations

The industry players listed below in Table 5 are organizations that fit in this second group, although a few of the companies sell to both customer segments. Some of the organizations that distribute their PSOs to the very poor began by first selling their solar cookers to the US market (ClearDome, Sun Ovens). Other groups have always concentrated on emerging markets and only focus their efforts on consumers that cannot afford to buy PSOs at the manufactured cost (TWR, GTZ).

Table 5. International PSO Organizations

Organization	**Solar Cooker's International (SCI)**
Overview	The mission of SCI, a non-profit organization based in Sacramento, CA, is to "assist communities to use the power of the sun to cook food and pasteurize water for the benefit of people and environments."
Product	• **CooKit**: A foil covered cardboard panel which directs sunshine onto a dark covered pot which sits inside a clear plastic bag. • Costs $8 for panel reflector, pot, and 4 oven bags
Strengths	• Leading organization in manufacturing and distributing solar ovens to refugee camps in developing countries • CooKit is cheapest solar oven on the market • Ability to train and teach trainers how to use solar ovens • Office in Kenya managed by Margaret Owino is perhaps one of the most knowledgeable organizations on solar cooking in East Africa
Weaknesses	• CooKit is not durable (cardboard) • CooKit requires a supply of plastic oven bags for more effective cooking • CooKit can only cook one small meal at a time
Contacts	• Terry Grumley, Ramon Coyle (Sacramento, CA), Margaret Owino (Nairobi, Kenya)

Table 5. International PSO Organization Analysis (Continued)

Organization	Trans World Radio (TWR)
Overview	TWR is a Christian organization, have a radio programs on Kenya Broadcasting Channel, which has programs on AIDS & agriculture projects. The TWR group in Switzerland started making solar box cookers several years ago and the Kenyan partnership is modeled after that group.
Product	• **TWR Box Cooker**: Made of plywood, aluminum sheets (from printing presses), glass & wood shavings. After exposure to the sun for several hours, the box cooker can stay warm for 1.5 hours after sun goes down. It comes in blue & green colors, legs lift the box cooker off the ground for easier cooking and reduces wood rot, handles make it easier to move, 5 different sizes, can hold multiple pots for cooking, can bake cakes and breads, 10-year life with proper care • Costs $25 for smallest box cooker, $50 for medium box cooker, & ~$80 for larger box cookers
Strengths	• Advertising on TWR radio about box cooker targeting people in hardship areas, awareness through national shows, women groups, churches • Box cooker manufactured at TWR's offices • Refugees trained as carpenters to manufacture box cookers for camps • Refugee recipients plant 10 trees, when the trees mature after 2 years the refugee is eligible for a solar cooker
Weaknesses	• TWR primarily focuses distributing its box cookers in refugee camps • TWR sells their box cookers for 1/3 of the manufacture cost, TWR & NGO's subsidize the remainder of the cost • Capacity issues at the shop--300 box cooker are manufactured a year, more could be made but there is time spent training carpenters
Contacts	• Horst Rettberg (Nairobi, Kenya)

Organization	ClearDome Solar Systems
Overview	ClearDome Solar Systems produce solar thermal products for everyday living, including parabolic cookers, air heaters, heating panels and drapes, hot tub pads, thermal fabric, reflective material and absorption foil.
Product	• **Square parabolic cooking reflector (2' x 2')**: Parabolic cooker that heats up to 400 degrees Fahrenheit, weighs 5 pounds, and costs $89 plus shipping • **SolarFlex 600 Parabolic Round Cooker**: Parabolic round cooker that heats up to 600 degrees Fahrenheit, 24" x 26" galvanized and painted steel oval, costs $169 (est.) plus shipping • **ClearDome SolarFlex 2' x 4' piece:** Reflector sheet to be used building a solar oven, SolarFlex is laminated to stiff ABS Plastic backing material, four sheets cost $18 plus $6 to ship in US and $12 for international shipping
Strengths	• Developed a highly reflective material they call "SolarFlex" and use it in several applications, including solar cooking • Setting up a regional office in Nigeria to promote their products in Western Africa
Weaknesses	• Concentrating primarily on US market with higher priced products • Solar cookers are just one part of product portfolio, ClearDome sells many other types of solar products
Contacts	• Derris Jeanette (US)

Organization	Sun Ovens International
Overview	Sun Ovens International is a for profit company which produces a deluxe solar box cooker. They are the leading US company in the manufacturing and distribution of their Sun Ovens in developing countries. Sun Ovens also produce a giant-sized solar box cooker for community kitchens and bakeries.
Product	• **Global Sun Oven**: Box cooker that heats up to 360 – 400 degrees Fahrenheit, 19" by 19" length and width, weighs 21 pounds, 15 year warranty, and costs $240 (plus shipping) • **Villager Sun Oven**: Box cooker for a community that heats up to 500 degrees Fahrenheit, over 10 feet high when opened, 20 year warranty, can be used for bakery operations, comes with over 150 pans and bowls, has propane back up system, typically the Villager is purchased by Rotary Club projects and donated to villages, total cost (including training & shipping) is $25,000
Strengths	• Their products have been introduced to needy communities through the world by several US-based NGOs. • Global Sun Oven is the best affordable solar oven in terms of its construction, size (accommodates multiple pots), and thermal efficiency • The Villager can create a commercial market overnight, given its size, efficiency, and capacity.
Weaknesses	• Both products are expensive, relative to similar products.
Contacts	• Paul Munson (US)

Table 5. International PSO Organization Analysis (Continued)

Organization	EG Solar e.V.
Overview	EG Solar is a registered charitable organization that disseminates its parabolic solar cookers in developing countries, widely thought of as the best known parabolic designs in the western world.
Product	• **SK14 Parabolic Cooker**: Parabolic model has a mirror which reflects the sun's rays toward a matte-black pot, which sits atop the point of heat concentration in the center of the dish, durable, light, cost effective to build and easy to use, production capacity is 600 Watts, weight is 60 pounds, comes with wheels and brakes, price ranges from $270 - $430 depending on the type of model • **K14 Parabolic Cooker**: Parabolic model, industrial manufactured building kit for cookers, all pieces are pre-fabricated and assembly is accomplished by following simple illustrated directions, price cheaper due to assembly, ranging from $100 - $180 depending on the size of the model • **SK Parabolic Cooker**: Parabolic model, smaller and lighter than SK14 and K14 lines, prices similar to K14 lines • **NR Papillon Solar Cooker**: Parabolic model, powerful solar cooker with a foldable aluminum sun-collector developed for large families and restaurants, larger diameter, but only 53 pounds, price is $650 • **Eloxal & SolarLack Coated Solar Panels**: Sold individually for all model lines, ranging from $35 - $70, includes two different types of coatings
Strengths	• Considered best parabolic design in the Western World • EG Solar's solar cookers are used in more than 80 countries • Working in collaboration with the industrial school, EG Solar develops new model cookers based on suggestions for improvements made by users all over the world • Unemployed adults build SK14 solar cookers
Weaknesses	• Parabolic cookers require more fragile, heavier, less portable, and require more tinkering to get the appropriate reflection.
Contacts	• N/A

Organization	SunStove Solar Cookers
Overview	SunStove's goal is to expand the use of SunStoves in areas that can be supplied by the current producers, from South Africa and India to their neighboring countries. SunStove promotes relatively low-cost, fairly durable box cookers. SunStove advocates profit-making as a way to ensure good products and sustainable dissemination.
Product	• **Molded SunStove**: A high quality solar cooker that is aesthetic, user-friendly, affordable and rugged. It cooks for 6 persons, which is 4 to 5 liters of corn-meal or rice with 1 to 2 liters of vegetables or meat. It has been mass produced in lots of 1,000 at a cost of $20 per piece in South Africa, it weighs 8 pounds, and heats up to 300 degrees Fahrenheit • **Fabricated SunStove**: A solar cooker is designed to be mass produced with hand tools and materials that are available in every country. The unit is affordable (materials cost less than USD $10) it weighs under 5 kilograms, and cooks 5 to 6 liters of food for a family. The unit is an ideal cottage industry because it does not require expensive machinery or facilities. It uses local materials, and only needs hand tools to manufacture
Strengths	• SunStove has found a few countries, including India, where they have joint venture arrangements for local production and distribution • Over 10,000 SunStoves have been sold to Southern Africa users, which attests to the quality, viability and success of international expansion • Time payment programs ($2.00 per month in local currency) have been successful in South Africa
Weaknesses	• Early solar oven models had problems with warping of the glazing, but the problem is now supposedly resolved (per SCI)
Contacts	• N/A

Table 5. International PSO Organization Analysis (Continued)

Organization	BSW Energy e.V
Overview	BSW Energy's has experience in some countries in Africa and South America and believes that self-help projects for building the solar cooker provide employment opportunities. BSW Energy produces the "papillon" concentrator cooker, which is similar to Chinese style concentrator cookers.
Product	• **Papillon Solar Cooker**: The Papillon is a concentrated solar oven, which uses direct solar radiation from the sun. The radiation enters the mirrors and is concentrated on a point where the cooking equipment sits. On the cooking surface up to 4 pots can be used simultaneously. This model suffices for a family with about 15 people or can be used in a small street restaurant. A user can cook, fry, bake and even grill with the oven. The Papillon has two wheels and easily fits through standard doorways.
Strengths	• BSW is a private aid organization that gives credits to purchasers through wood purchase savings to buy its solar cooker. • BSW sends engineers to developing countries who arrange workshops to train entrepreneurs to make solar cookers. • Educates and trains specialists in villages.
Weaknesses	• BSW relies on donations for its existence
Contacts	• N/A

Organization	SolarBake Ovens
Overview	SolarBake Ovens has recently developed a high performance, durable solar box cooker at prices substantially lower than the Sun Oven. It is interested in assembly of its solar cookers in developing countries.
Product	• **SolarBake Oven**: Box cooker wither temperature's ranging from 325 degrees to 425 degrees Fahrenheit, total weight is less than 35 lbs, tempered safety glass oven door, light weight highly reflective mirrors, price is $175 + Shipping & Handling
Strengths	• Recently shipped 400 units to Afghanistan • Strong product model that heats to high temperatures and is lightweight
Weaknesses	• No in-country experience as of yet, only starting to enter into emerging markets • Although cheaper than Sun Oven, price is expensive
Contacts	• N/A

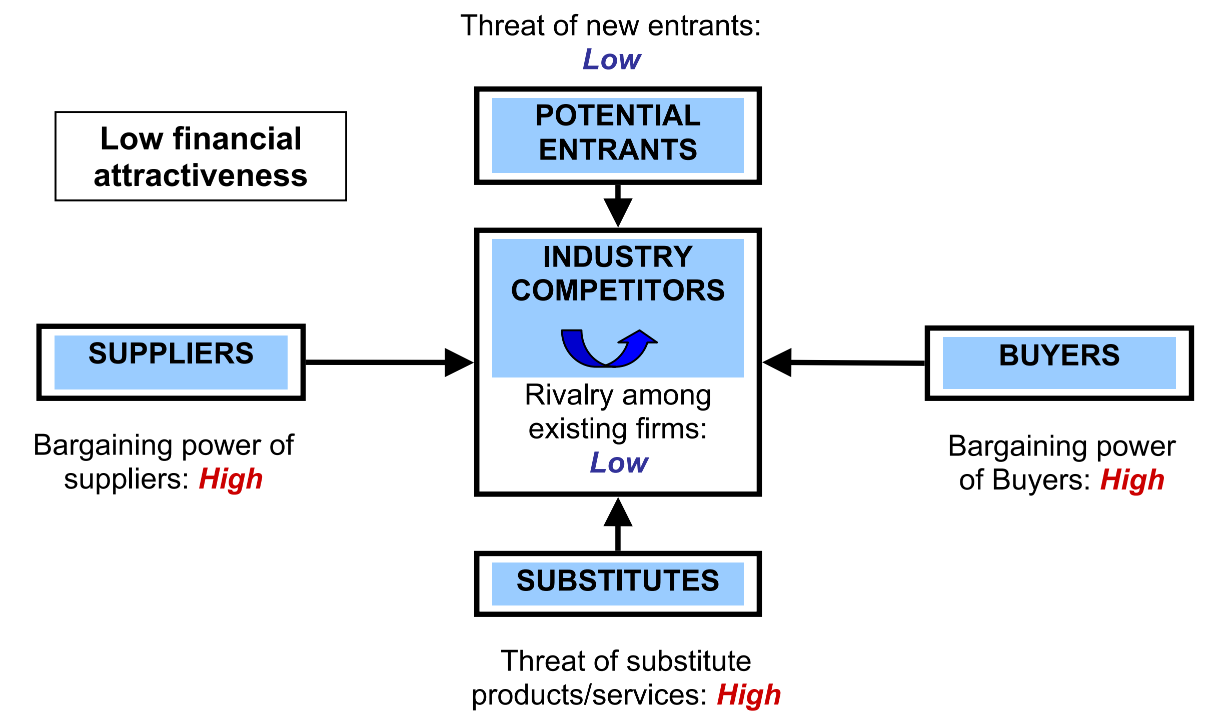
3. Industry Analysis

A closer analysis of the competitive forces in the PSO industry within Kenya provided mixed reviews on its attractiveness (see Table 6). The industry is also unique since most of the PSO providers are NGOs who work collaboratively with one another by sharing information, knowledge and resources. In order to fully assess the industry we made use of a framework known as "Porter's Five Forces"[28] (see Figure 11). This analysis looks at the industry from the perspective of a member of the industry, and identifies the threats posed from five sources; suppliers, potential entrants, buyers, substitutes and other competitors in the industry.

The threat that suppliers pose to a PSO manufacturer in Kenya is a notable concern. Unless an organization plans to import their PSOs into Kenya, subjecting their goods to taxes and shipping costs, the organization will be constrained to a limited supplier base for raw materials in Kenya. PSO buyers are also a significant threat, since solar cooking is a new technology that requires a significant change in their habits and behavior. Combining the time, money, and training required to change consumers' habits to solar cooking, and their options for substitute products, including wood, charcoal, jikos, and propane, tempers an optimistic assessment of the PSO market. Given these forces, it appears that the PSO market has low financial attractiveness in Kenya.

[28] Porter, Michael E., Competitive Strategy: Techniques for Analyzing Industries and Competitors, Free Press; 1998

Figure 11. Passive Solar Oven Industry Analysis: Michael Porter's "Five Forces".
Given the high threats from suppliers, substitutes, and buyers, the PSO industry in Kenya has a low financial attractiveness.



Source: Porter, Michael E., Competitive Strategy: Techniques for Analyzing Industries and Competitors, Free Press; 1998

Table 6. PSO Industry Environment Detailed Analysis

Industry Environment	Potential Entrants
Competitive Threat	Low
Industry Detail & Facts	• Capital requirements for manufacturing solar ovens vary depending on the type of model being produced. Capital requirements are low for the CooKit model, which is made out of cardboard, while they are higher for more specialized and expensive ovens like the Sun Oven Villager. • Potential competitor retaliation is low, as the industry is collaborative rather than competitive. • Competition for distribution is not a threat, because there is not a set course for distribution. There are alternatives available to distribute solar cookers. • Industry growth and need for solar ovens is growing, which may encourage more entrants to enter the market if opportunities continue to expand. • Product differentiation is a moderate threat, based on tastes, preferences and disposable income. Solar ovens vary due to size, model and capability. Some solar ovens can cook very rapidly in cooler temperatures, while other models are cheaper but lack cooking efficiency. • Economies of Scale & Scope are minimal at this time and not a major threat, because the current manufacturers of solar ovens in Kenya only produce a few solar ovens per year. TWR, for example, only makes 300 PSBC's per year. The potential economies of scale in manufacturing will be dependant on distribution capabilities.

Industry Environment	Firm Rivalry
Competitive Threat	Low
Industry Detail & Facts	• The industry players are mainly NGOs based either in Kenya or importing PSOs into Kenya. • Although there is some differentiation between the primary competitors, the strategies and primary goals (reducing poverty, stopping environmental degradation) are very similar. • Most of the models of solar cookers do not have patents to encourage other companies to manufacture and distribute similar copies of their PSOs. • Although no companies have successfully commercialized PSOs in Kenya, most organizations rely on subsidies and donations to sell their PSOs to those who need them. • There is tremendous cooperation between the NGOs (they all know each other), so no apparent rivalries exists

Industry Environment	Suppliers
Competitive Threat	High
Industry Detail & Facts	**PSOs** • The supply products for affordable solar ovens are not differentiated, although there are limited suppliers of these types of goods in emerging markets. • The fixed costs of PSOs are high, with raw materials accounting for almost all of total manufacturing costs • TWR is a rare manufacturer that has low supplier risk because all of their supplies for the PSBC, including wood, sheet metal, cloth, thin flat glass and wood shavings, are commonly available. • There are not many known substitute suppliers, but the supplier threat is high because there are limited suppliers for most of these materials in Kenya. **HotPot** • Corrugated Plastic – The supplier for the reflector is a high risk. Only one supplier can manufacture the reflector (Pressmaster) and they know the only alternative is to import the reflector from another country. • Reflective Material – This is a high cost risk, has to be imported to meet the specs • Glass Container & Lid – There are no available suppliers that can produce the glass container and lid to the specs required by the hot pot. The only viable option is to import the glass unless a retail model can be located. • Pot – Pots are purchased at wholesale prices by SCI, so finding a pot for the HotPot will be easy.

Table 6. PSO Industry Environment Detailed Analysis (Continued)

Industry Environment	Buyer
Competitive Threat	High
Industry Detail & Facts	• Buyers have other viable cooking alternatives, including biomass materials, charcoal, jikos, and propane. Due to the many substitutes available, the buyer has a distinct advantage. • A great deal of selling and training is necessary in order to convince buyers to purchase PSOs and change their lifelong habits & traditions. • Switching costs are high. Buyers can barely afford to purchase one solar oven, so they will not be able to switch to another model easily if they do not like the first solar cooker they buy. This puts the buyers at a disadvantage. • The influencers (trainers) in the industry have a strong relationship with the buyers. Cooking behaviors and habits will not change without constant training and reinforcement from trainers, who will be interacting with buyers on a consistent basis and can impact their purchase decision.

Industry Environment	Substitutes
Competitive Threat	High
Industry Detail & Facts	• Solar cooking is not a stand-alone technology; other complimentary products are needed to compliment the PSO. • There are other viable alternative sources of cooking outside of solar ovens, most notably is the jiko, which can be used during cloudy days or at night. The jiko can be used as a stand-alone cooker, which puts the PSO at a major disadvantage. • Continuing to cook with wood, coal or other biomass materials (available to 60% of Kenyans) is a substitute and high threat to solar cookers.

4. Alternative Cooking Devices

Jiko Cookstoves

At least 700,000 jiko stoves are now in use in Kenya, in more than 50% of urban homes and 16% of rural homes. About 200 small-scale businesses and artisans produce more than 13,000 stoves each month. Both the stove itself and the general program for disseminating it have been adapted for use in a number of other African nations.

Table 7. Number of Improved Stoves (Jikos) Disseminated in East and S. Africa, 1995[29]

Country	Urban	Rural	Total
Kenya	600,000	180,000	780,000
Tanzania	54,000	n.a.	54,000
Uganda	52,000	n.a.	52,000
Ethiopia	23,000	22,000	45,000
Rwanda	30,000	n.a.	30,000
Sudan	27,000	1,400	28,400
Zimbabwe	11,000	10,000	21,000
Burundi	20,500	n.a.	20,500
Somalia	15,400	n.a.	15,400

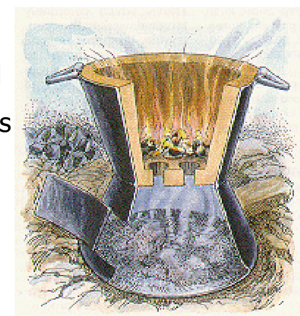
The process of research, development, demonstration and commercialization that first led to the improved jiko and then to other high-efficiency stoves was seeded by international and local development funds. Because the stoves were relatively expensive (US $15) and their quality was highly variable, sales

[29] Source: Goldemberg, José. World Energy Assessment: Energy and the Challenge of Sustainability. Chapter 10: Rural Energy in Developing Countries.

were slow at first. But continued research and increased competition among manufacturers and vendors spurred innovations in materials used the methods of production. An extensive marketing network for jikos is flourishing. With the help of government promotions, the jiko now has a price of $1-3, depending on size, design, and quality.

Jiko Charcoal Stove: The Jiko, which is the Swahili world for "oven", is a ceramic and metal pot that uses charcoal to cook. The body of the jiko consists of a metal casing with a ceramic lining that helps to direct 25 to 40% of the heat from a fire to a cooking pot. The jiko increases stove efficiency by addition of a ceramic insulating liner, which enables 25 to 40% of the heat to be delivered to the pot, the remainder of the hear is lost to the environment.

Figure 12. Image of KCJ Jiko



KCJ (Kenyan Ceramic) Jiko: Produced by local manufacturers, the KCJ jiko (see Figure 12) is an improved jiko, made only of clay that absorbs the heat and contains it. It is mobile and light, including handles to move it while cooking. It is the most efficient of the jikos, because it is not made of any metal. The KCJ jiko is heavily promoted by the Kenyan government.

UPESI Stove: The UPESI Stove, meaning "Quick" stove in Swahili, is a one mouth stove that is made of ceramic. It is very mobile and lightweight, and equipped with handles to move it while cooking. The UPESI stove utilizes less charcoal than the standard jiko. The cost of this stove is $3.50, which is a little bit higher than the standard jiko cost.[30]

Figure 13. Image of an All Metal Stove

All Metal Stove: The Metal Stove (see Figure 13) is only made of scrap metal and is not built with ceramic, the latter material has better heat insulation properties. The traditional metal stove used by Kenyans delivers only 10 to 20% of the heat generated to a pot and therefore wastes much more charcoal. From 50 to 70% of the heat is lost through the stove's metal sides, and another 10 to 30% escapes as carbon monoxide, methane and other flue gases.[31] The Metal Stove is rapidly being replaced by the ceramic jiko.

Figure 14. Image of a Fireless Cooker

Fireless Cooker: The Fireless Cooker or Renewable Heat Cooker (see Figure 14) is designed to complete the cooking process of food after a solar cooker (or other cooking method) has cooked it. It is also used to keep food warm hours after it has been cooked. The Fireless Cooker is made with a basket, which is

[30] Interview: Margaret Owino, Director of Solar Cookers International – East Africa, 4/9/2003
[31] Cookstoves for the Developing Poor, http://socrates.berkeley.edu/~kammen/cookstoves.html

then lined with old scraps of clothes on the inside of the basket. The inside of the basket is then lined by one piece to seal off the insulation and a pillow is added as a lid.

Women can easily make Fireless Cookers with scrap clothing material and a basket. The Fireless Cooker can also be purchased at a cost of $10 or less. Some solar cooking promoters, such as SCI, consider the Fireless Cooker a necessary complement to a solar cooker, so more than one dish can be prepared for meals, and so food can be kept warm into the evening after the sun goes down.

Photovoltaic Energy: A photovoltaic system is a complete set of components that converts direct sunlight into electricity. The electricity is then stored in photovoltaic cells to be used at a later time in the form of light. The amount of electricity that can be converted and stored depends on the number and quality of panels that are used to direct the sunlight, although the average electricity yield from sunlight is around 11%.[32]

The Kenyan government is pushing photovoltaic energy as a primary alternative source of energy. For example, there are no duties imposed on photovoltaic equipment when it is imported into Kenya.[33] In addition, many businesses and NGOs such as ITDG are trying to promote photovoltaic energy through new companies and programs.

Although still expensive, the price of photovoltaic energy is getting much cheaper for households. Smaller scale lighting systems can be installed for around $1,000 USD. However, although photovoltaic energy is a viable alternative for powering lights, it cannot be used for solar cooking. The amount of energy that is required for cooking is much too high and the 11% energy yield rate too low to make photovoltaic energy a feasible alternative at this time. However, as the technology for photovoltaic equipment improves, the increased capacity and the decreased cost may make it a viable source for cooking in the near future.

D. Summary

The overall attractiveness of the PSO market in Kenya is not favorable, as many social, environmental, and economic barriers exist. There are not many PSO organizations located in Kenya, but there are many NGOs that have provided PSOs to Kenyan people, particularly the poor. The industry analysis indicates a low financial attractiveness, with high threats of supplier power, buyer power and available substitutes. Finally, finding the necessary collaborators with which to partner will be difficult without an in-country presence.

[32] Interview: Bernard Owawa, Project Engineer, Energy Alternatives Africa, 4/10/2003
[33] Interview: Bernard Owawa, Project Engineer, Energy Alternatives Africa, 4/10/2003

There are, however, a few factors in Kenya that may make the PSO market viable. The primary market driver is the need for an inexpensive alternative to traditional cooking methods. There also exists an informal but large manufacturing sector, a relatively well-developed supply-chain/distribution system (particularly for coffee and tea), and several NGOs with PSO training/education experience. The preliminary analysis, while financially unfavorable, does indicate that a potential role for PSOs and an organization like SHE exists.

IV. Strategic Recommendation

A. Overview of Recommended Strategy

Passive solar ovens provide many benefits to all stakeholders involved in the value chain. While this promising technology has been available for several decades, there are numerous obstacles preventing widespread acceptance and use of passive solar cooking. These hurdles come from two directions: (1) consumers having acceptable alternatives or constrained by economic, social, and environmental hurdles and (2) manufacturers and distributors failing to properly promote PSOs to compete with alternatives and overcome barriers.

Team Solar believes that the key to addressing this two-pronged issue is to bring together organizations that: (1) are established and have a great deal of in-country experience, (2) believe that solar cooking offers significant benefits for Kenya and its people, and (3) understand the barriers that have historically prevented mass distribution and use. We therefore propose the establishment of a Consortium organized and partially-funded by Solar Household Energy. We recommend that SHE invites members of Solar Cookers International, Trans World Radio, the Kenyan National Federations of Co-operatives, and potentially others to join this Consortium. Each organization brings a unique skill set, expertise, and network of contacts that can adequately address the issues of PSO dissemination and thus, in the long-term, help each organization achieve their common goals of reducing poverty, improving health, and reducing the impact of society on the environment.

B. Who's Who in the SHE Consortium

1. Solar Household Energy Inc.

SHE was incorporated in 1998 to identify and support promising entrepreneurs in areas of the world with adequate sunshine, promote solar cooking, and improve the quality of life of the poor in the developing world. They recognize that using a market-based approach to the manufacturing, distribution, and purchasing of PSOs may address most of the obstacles faced by organizations, which have attempted to promote solar cooking in the past.

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2. Trans World Radio

Trans World Radio is an international Christian broadcasting network, founded in 1952 by a missionary who recognized that radio was an untapped medium for missionary work. Since then, TWR has expanded to a weekly broadcast schedule of more than 1,800 hours of Christian programming from 13 primary super-power transmitting sites and by satellite. TWR has radio programs on Kenya Broadcasting Channel and on short-wave radio, which can be received anywhere in Kenya. Programs include religion, AIDS, agriculture projects, solar cooking etc.

TWR has manufactured and distributed solar box cookers to refuge camps between 1999 and 2003. Based on experience, feedback, and field-testing, its solar ovens have been improved to increase their value to the Kenyan consumer. TWR visits refugee camps on a regular basis to follow up with cookers, carpenters, and trainers to ensure the products are being properly used and to supply them with the necessary tools to manufacture and promote the product. Due to capacity issues, only 300 PSBCs/year are manufactured in the Nairobi workshop leading to demand outstripping supply. Profit is not TWR's goal but it recognizes that solar cooking is key to its mission in alleviating poverty while it continues to lose money with each sale. TWR is therefore eager to have its product copied and promoted by other organizations.

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3. Kenyan National Federation of Cooperatives

"The Kenyan Cooperative Movement consists of about 4.9 million registered members who have voluntarily united together to form economic associations called Cooperatives. Today, there are about 9000 registered Cooperatives that cut across all our Kenyan economic spheres of life. The most dominant sub sectors of Cooperatives being the Agricultural Sector where they handle supply of farm inputs, farm credit, agricultural produce marketing and transport of farmers produce. The other major sub-sector is financial sector in what is commonly called SACCO Societies that cover, urban employed labor force, rural agricultural farmers and Jua Kali or Informal sector workers. The financial sector is supported at National level by the Cooperative Bank of Kenya, Cooperative Insurance Company, Kenya Union of Savings and Credit Cooperatives, Kenya Union of Rural Saccos and National Housing Cooperative Union."[34]

[34] http://www.kenyaconstitution.org/docs/11d029.htm

Contact Information		
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4. Solar Cookers International – East Africa

SCI's mission is to improve the lives of the rural poor and reduce environmental degradation in developing countries through the use of their panel solar oven, the CooKit. The SCI office in Kenya has concentrated on educating, training, and promoting solar ovens in refuge camps for several years. Its efforts are heavily subsidized through NGOs and government bodies. SCI's participatory style and sensitivity to local cultural concerns and interests is evident in its training and recipes.

Contact Information
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C. Roles of Key Players

Team Solar has identified what we feel will be the major roles for each Consortium member, capitalizing on their strengths and mitigates their weaknesses. We expect that these roles will evolve over time and, perhaps, additional organizations may join.

1. Solar Household Energy, Inc.

SHE has a critical role in ensuring that the Consortium functions as a coherent organization. Given that any Consortium member can withdraw at any time, SHE needs to make certain that each Consortium's needs and issues are deftly addressed. SHE will utilize its grant writing ability to generate seed funding and leverage its technical expertise to create new and enhance current PSBCs. As the Consortium's international representative, advisor, and organizer, SHE's responsibilities will include:

- *Provide oversight to the Consortium*. SHE should hire an independent, in-country representative who will serve as a project manager. This is particularly important in the early stages of the Consortium where a great deal of ambiguity exists.
- *Raise seed money*. It is expected that this project will take about one year before revenues are generated and potentially many more years before the model is financially self sufficient. SHE should

financially float the Consortium in this interim period until it can support itself. Given SHE's connections in the US, SHE can be responsible for the bulk of the grant writing in the preliminary phases of the program.

- *Box Cooker Enhancement.* The Consortium will need to reduce the cost of the Box Cooker before the product role out and manage ongoing improvements. SHE's technical expertise will enable it to play an important role in the cost reduction and performance enhancement of the existing PSBC model.

The experience that SHE will gain from managing a consortium will serve it well in helping it reach its ultimate goal of globalizing solar cooking.

2. Trans World Radio

TWR brings a proven PSBC product design and training experience to the Consortium. TWR's existing PSBC can be manufactured locally on a small scale and is cost competitive with other technologies (see Section V, Part E for an analysis of the TWR box cooker). Its training experience stems from its work in refugee camps, where it has distributed its PSBCs free of charge in order to alleviate dire humanitarian needs. TWR has a successful "train the trainer" education program where it provide refugees with the supplies, tools, and training necessary to make their own PSBCs. Outside of these small-scale efforts, TWR has had limited exposure to market-based approaches to promoting their PSBCs. Given that its primary focus is on missionary work, it is less inclined in using its resources to increase production capacity and promote the product, but it is eager to promote solar cooking through other venues. As a member and primary advisor to the consortium, TWR's responsibilities will include:

- *Box cooker design.* Provide the box cooker designs to the Consortium and work with the "Product Enhancement Team" to develop and incorporate product enhancements (reduce manufacturing costs and improve box cooker performance).
- *Finances.* Use its financial data on manufacturing, salaries, supplies, etc. to determine costs for the first year, establish financial benchmarks, and build a financial model.
- *Training the Jua Kali sector manufacturers.* Use and improve upon its training manuals that have been written to date to train Jua Kali manufactures in how to build the cookers. (The Jua Kali is a formal, small scale, manufacturing sector in Kenya.)

3. Kenyan National Federation of Co-operatives Ltd.

In addition to its existing infrastructure for distribution, promotion, and financing, the KNFC has strong connections with the Jua Kali manufacturing sector and an audience of potential end users (5 million members). The channels that KNFC brings to the Consortium are what the SCI and TWR lack. The three Kenyan Consortium members compliment each others strengths and weaknesses and thus strengthen the organization. As a member and primary advisor to the consortium, KNFC's responsibilities will include:

- *Manufacturing.* Once the PSBC has been redesigned, the KNFC will leverage its access to Jua Kali sector to establish the manufacture of the cookers.
- *Distribution.* Access to some of the coffee and tea coops, both of which have the largest distribution channels in the country and will value the diversification that the cookers offer to their product line.
- *Education and Training.* Given that the change of cooking habits is such a significant barrier to wide spread use of PSOs, the KNFC existing training and education organization will be a critical resource to the Consortium.
- *Promotion*. Access to five million members. Additionally, the KNFC will leverage its contacts in media such as Forward Vision, to provide the wide spread promotion of the box cooking concept and create "pull demand" from the end user.
- *Micro-financing.* Even with an improved product and reduced cost, financing will be necessary to enable end user acceptance and purchase. The KNFC already has an extensive network in place of community based financing mechanisms.

4. Solar Cookers International – East Africa

SCI has extensive knowledge of how to train people on the use of solar cookers, as well as a model for working with people on changing their cooking habits and monitoring PSO use to improve the likelihood of success. Additionally, SCI has extensive experience working with end users and can provide many suggestions for product enhancement. As a member and primary advisor to the Consortium, SCI's responsibilities should include:

- *Training and Education.* Work with KNFC training and education organization to establish manuals, policies and plan for disseminating the training and monitoring of the use of the cookers.
- *Product Enhancement.* Work with the Product Enhancement Team to develop the next generation of the Box Cooker.

D. The Consortium Product: The Passive Solar Box Cooker (PSBC)

In choosing the PSO that is most appropriate for the Kenyan market, we evaluated the three primary types of PSO models based on ease to manufacture, required capital investments, and their appropriateness for developing economies:

- **The parabolic cooker** is the most efficient cooker, producing high temperatures and providing the quickest cooking time of all PSOs. However, the high cost of the parabolic reflective material puts it out of reach of nearly the entire Kenyan marketplace. Additionally, a parabolic reflector can only cook one pot at a time, which is a major drawback.
- **The panel cooker**, including the CooKit and Hotpot, are on the opposite end of the product spectrum from the Parabolic Cooker. While more affordable, they are not nearly as effective in cooking food. Further, a plethora of product drawbacks and severe limitations makes them far less attractive for consumers.

- **The box cooker** fits into the middle of the product spectrum. It does not produce as high of cooking temperatures as the Parabolic Cooker, but it is much more affordable. It is also not as cheap as the Panel Cooker CooKit, but the Box Cooker is far more proven and effective. The Box Cooker also allows users to cook multiple pots at a time, a feature the other two models do not possess.

Of the Parabolic Cooker, the Panel Cooker, and the Box Cooker, we feel that the latter option is the best. Not only do Box Cookers addresses the capacity issues that the others do not (Box Cookers can be built to cook multiple items at once) they are more efficient than Panel Cookers and more affordable than Parabolic Cookers. We feel that for these reasons, Box Cookers represent the most optimal option for the Kenyan market, and with modest product design innovation, their superiority will only increase.

1. TWR's Box Cooker

There are a number of box cooker manufactures in the US, and some of these companies (most notably Sun Ovens) import their box cookers into Kenya. Trans World Radio is the only box cooker manufacturer operating in Kenya. Their products (see figure 15) range in size from a model that holds one 4-quart pot to a large 6-foot long model that holds six large pots. The quality, functionality, and reasonable cost of TWR's box cooker makes it one of the most affordable and proven PSOs in Kenya. In addition, TWR's simplified manufacturing process and ability to procure all of their raw materials in-country qualifies TWR as one the most effective PSO producers located in Africa.

The TWR box cooker is made of a highly insulated box with black inner-walls that are designed to enclose a cooking pot or multiple cooking pots and trays. It's double glazed glass window allow sun rays to penetrate and heat the inside of the box. The box cooker is equipped with an adjustable reflector lid that directs sunlight into the chamber for additional cooking power. When not cooking, the lid closes down over the window panes to protect the glass. Below is an analysis of TWR's box cooker's features, enhancements, and drawbacks:

Figure 15. Trans World Radio's PSBCs
Left: Medium size PSBC baking a batch of muffins. Right: Large PSBC

2. Product Features

Table 8. Product Features of PSBCs vs. Panel Cookers

PSBCs have many features that match the needs of the Kenyan customer.

Feature	Value	PSBC vs. Panel Cooker
Durability	The TWR Box Cooker has a life expectancy of 10 years if the user properly maintains it.[35] The high quality materials and manufacturing create a durable product that can be used in harsh environments on a daily basis. Enhancements such as legs and metal covering continue to increase product life.	The materials and design of the box cooker can withstand rain and intense heat much more effectively than the panel cooker.
Cooking Capacity	The large PSBC can hold up to six 4-quart pots. Smaller versions hold one to three 4-quart pots. This ability to cook several meals at once is important since Kenyans always cook one dish and one sauce. The extra capacity allows users to meet the cultural expectancy of having leftovers.	Panel cookers have one 4-quart pot that cooks enough food for a small family, does not allow for multiple dishes, and introduces the risk of not having leftovers (the latter is a social taboo).[36]
Cooking Efficiency	Because the box cooker is highly insulated, it releases little heat and the temperature can rise to 180 degrees Celsius during good weather. Food will not overcook or burn in the PSBC, which means the cooking process does not need to be closely monitored.	Panel cookers and PSBCs usually rise to the same temperature under similar conditions.
Heat Retention	The box cooker retains heat and stays warm for over 1.5 hours after it is "turned off".[37] No need for a hay basket. This enables a cook to keep food warm or to continue cooking after the sun has set, which is important for families that eat at night.	Panel cookers do not retain heat as long as box cookers and need to be transferred to hay baskets for further insulation
Baking Function	PSBCs can be used for baking cakes, muffins and bread. Although baked goods are not a regular part of Kenyans diets, they are considered a luxury item and can be baked for personal consumption or sold to others.[38]	Panel cookers cannot bake thus not accommodating different consumer tastes.
Different Sizes	TWR manufactures PSBCs in a variety of sizes. The range of sizes allows the consumer to choose the capacity that best meets their cooking needs.	Panel cookers come in one size thus limiting consumer choice.
Quality Appearance	PSBCs are well-built and sturdy, which confers an appearance of quality and durability. It is not surprising that they are perceived as valuable pieces of equipment. This is a key aspect of any product whose cost is a sizeable portion of one's income.	Some Kenyans believe that panel cookers look like toys, making them skeptical about its performance and durability and creating another obstacle to solar cooking.[39]
Stability	The box cooker is heavy and balanced, which makes it both durable and stable. It cannot be knocked over by wind, animals, or children.	One of the main deficiencies of panel cookers is that it can be knocked over easily, ruining a meal.
Less Sunlight Required	The insulated box cooker works well under low sunlight (partly cloudy days in Kenya).	The panel cooker retains less heat on low sunlight days, thus requiring alternative cooking methods
Brand Name	The TWR box cooker displays the brand name on the side: "TWR Solar Cooker: Made in Kenya." This branding is effective in explaining the function of the PSBC. Refer to Interview Appendix for Team Solar experience at the Inter-Continental Hotel in Kenya.[40]	Panel cookers have no visible branding
Manufacturing Simplicity	Compared to other PSOs, TWR's box cooker is easier to manufacture and does not require much technology to produce. Its raw materials, such as wood, glass, aluminum, and saw dust/cloth clippings are readily available in Kenya and most developing countries.	Panel cookers, particularly the HotPot, require industry to produce the product, thus requiring major capital investments, and large production runs in order to achieve economies of scale.

[35] Interview with Horst Rettberg, Director, Trans World Radio – Solar Box Cookers, 4/10/2003
[36] Interview with Margaret Owino, Director, Solar Cookers International – East Africa, 4/9/2003
[37] Interview with Horst Rettberg, Director, Trans World Radio – Solar Box Cookers, 4/10/2003
[38] Interview with Margaret Owino, Director, Solar Cookers International – East Africa, 4/22/2003
[39] Interview with Margaret Owino, Solar Cookers International, 4/9/2003
[40] Interview in Inter-Continental Hotel, Brad Hiranaga & Bryan Magnus, 4/15.2003

3. Product Improvements

TWR has made a number of improvements to their box cooker models over the past few years. To determine which features need to be improved, TWR distributed a questionnaire to the refugees that had used the box cooker over a long period of time. From this survey data, they gained tremendous insight into the most frequent problems and biggest limitations of their box cooker design.

Table 9. TWR's Improvements to its Box Cooker

TWR has made many enhancements to their PSBCs, a list of the most recent improvements is provided below.

Problem	Description of Problem	Enhancement	Value Added
Image	Users complained that the larger, unpainted wood box cookers looked like coffins[41] (a particularly negative image in light of the AIDS epidemic) that reduced the acceptance of this technology.	Blue & Green Paint	TWR began painting the box cookers a cheerful blue or green to avoid reminding users of cemeteries. Users like the bright colors, making this simple product improvement a major product enhancement that provides additional value.
Security	Users expressed problems of other people opening up their box cooker and stealing the food when they were not watching it.	Latch	A latch on to the lid of the box cooker allows users to lock their PSBC and lets them complete other activities while their food cooks. *Note*: Non-latched PSO's like the HotPot and the CooKit still face the problem of food theft.
Portability	The large box cookers are difficult to move inside and outside of homes, creating a major hassle in the daily routine of cooking during the day and storing it at night..	Handles	Large, reinforced handles were added to the sides and backs of the PSBCs, to make them easier to transport. Although the larger box cookers still require two people to move them, the smaller models can be easily transported by one person.
Portability	The large box cookers are difficult to move.	Wheels	Larger box cookers are now equipped with wheels. Designed much like luggage, the wheels are added to one end of the PSBC and a long handle to the other for easy, ergonomic transport.
Durability	The original PSBCs rested with the entire bottom-side on the ground allowing direct contact with moisture and causing the wood to rot and deteriorate quickly.	Legs	Legs were added to lift the PSBC off the ground to reduce water rot. The legs also made the PSBC easier for users to reach while cooking (less bending over, squatting, etc.). *Note*: In lieu of legs, CooKit and HotPot users need platforms or tables to make them easier to use and protect the meal from animals. This drawback is a major inconvenience.[42]
Durability	Termite infestation is common in Kenya, ruining those PSBCs that were in contact with ground.	Metal on Legs	Adding sheet metal to the bottom of each leg provides a protective shield against termites & water damage.
Maintenance	A significant design problem with the PSBC is that dust, steam, and oil from cooking was getting trapped between the two sheets of glass. The dirt reduced light transparency and cooking efficiency.	Blanket Liner	A liner added to the gap between the two pieces of glass eliminated this problem.
Ease of use	The bar that holds the reflector in place often came loose in early versions of the PSBC.	Reflector Lid Bar	Much like the bar that holds the car hood (or car bonnet) in place, TWR created a bar that acts as a well-fitted level, thus preventing the lid from falling onto the glass plate.

[41] Interview with Horst Rettberg, TWR, 4/10/2003
[42] Interview with Margaret Owino, Solar Cookers International, 4/9/2003

4. Product Drawbacks

Although many improvements have been made, the box cooker, like any other product, still has weaknesses that need to be addressed (see Table 4). TWR's continuous innovation and SCI's extraordinary amount of in-country knowledge should help improve these product shortcomings in the near future.

Double-paned Glass Window

From a design standpoint, the double-paned glass window is the major weakness point in the box cooker. The glass panes are fragile and can easily be cracked or broken by setting a pot on them or dropping the box cooker. In addition to the somewhat prohibitive cost,[43] the owner cannot fix the damaged glass themselves because they do not have the equipment nor skills to repair it on their own. Many owners would rather let their box cookers sit in the corner of their home with broken glass than take them in to be fixed by TWR.

Portability

A benefit of the box cookers is that they come in large sizes, which allows the user to cook large quantities and many different types of food. While the expanded size was optimal for cooking, the large size made the box cookers difficult to move and store. The handles and wheels enhancements have helped in improving the portability issue, but the larger cookers are still very heavy and hard for one person to move. Also, unlike the panel cookers, the box cookers do not fold down and store away easily, so they take up a lot of valuable space inside the user's home.

Tracking the Sun

An issue that may not be correctable but still warrants mentioning is that the box cookers do require some supervision while cooking. The reflector lid needs to be adjusted during the day to reflect the sun and to ensure optimal solar cooking conditions. Although the reflected sunlight on the TWR Box Cooker provides only 10% of the energy during the cooking process, it nonetheless should be adjusted during the day to maximize sunlight reflection.

Cost

Panel cookers are less expensive than TWR PSBCs. The cost for a CooKit, including the cardboard reflector, pot, and stock of plastic bags is $8. The cost for the smallest box cooker, which can hold one 4-liter pot, is $25[44]. This difference in cost is one of the primary reasons the use of the TWR PSBC has not penetrated the solar cooking market. However, relative to other PSBCs, the TWR models are relatively affordable, falling far below the $200 cost range of box cookers that are imported into Kenya.

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[43] $2 per glass pane for the small glass panes
[44] Interview with Horst Rettberg, Director, Trans World Radio – Solar Box Cookers, 4/10/2003

Summary – Passive Solar Box Cooker

Given all the features, enhancements and drawbacks discussed above, Team Solar believes that the TWR PSBC (see Figure 16) is the best option for the Kenyan market. By leveraging TWR's design, and using Kenya National Federations of Co-operatives and to expand manufacturing capacity and financing options, the Consortium is well positioned to achieve its mission.

Figure 16. Photograph of a Small TWR Box Cooker
A freshly painted green box cooker addresses customer concerns.

E. Market Barriers

Outlined below (see Table 10) is a summary of the barriers that have traditionally prevented the widespread acceptance of solar cooking. Unless the Consortium effectively addresses each issue, there will be little to no market penetration of the PSBC. *Team Solar recommends that each member contribute specific resources to addressing the obstacles for which they are best suited*. For example, regarding the issue of training, SCI and TWR will play advisory roles in creating the training program while KNFC will use the capacity in it's Education and Training organization to promote the product to its coop members.

Table 10. Summary of the Market Barriers.
Barriers to the widespread acceptance of solar cooking and how each Consortium member can contribute their resources to address these issues.

Barriers		How the Consortium Addresses Barriers
Social	Change in Habits ○ Twice as much time as traditional cooking ○ Earlier planning of meals ○ Negative perception of outdoor cooking ○ Scared of using sun to cook (black magic)	• Utilize KNFC's existing capacity in their training and education organization to demonstrate PSBC benefits and how the outweigh some habits. • Trainers must revisit PSBC customers for follow-up training. • Use KNFC's printing department to make additional copies of the TWR and SCI training manuals. • Utilize TWR survey knowledge to continue polling end users and use feedback to enhance product and training. • Capitalize on TWR and SCI's experiences in the Kenyan market to address social issues and make PSBCs more appealing.
	Change in taste and texture of meals	• Live product demonstrations are necessary to prove that most Kenyan meals have the same taste and texture with solar cooking.
	Limited awareness and demand	• KNFC has five million members, many of whom meet at local, monthly meetings. Use these meetings to promote the PSBC. • Leverage contacts in media, such as Forward Vision, to promote the product create "pull" from the end user. • Utilize TWR radio programs to promote PSBC
	Men make purchasing decisions, yet women do cooking	• Utilize KNFC's existing channels to promote product to coop members who are often men and head of household. Pass out free SCI and TWR training manuals (or other suitable promotional material) through these channels to reinforce PSBC financial benefits.
	Little value placed on individuals time	• SCI and TWR to advise on how this issue is to be approached. • Use KNFC's training and education organization to stress financial as well as non-financial benefits of PSBCs
	Illiteracy limits training potential	• KNFC's training and education organization and SCI's training expertise will help users from a demonstration standpoint. The Consortium is not strictly relying on manuals and policies for end-users adoption.
Economic	Affordability	• Utilize Jua Kali sector to reduce manufacturing costs. • Utilize existing distribution channels to reduce costs. • Provide micro-credit financing to Coop members. • Heavy promotion may lead to increased demand and ultimately manufacturing and distribution economies of scale.
	Alternative methods of cooking	• Reduce PSBC costs to make them more price competitive with alternative stoves. • Demonstrate the greater value of using PSBCs over alternative methods of cooking. • Highlight "non-financial" benefits of PSBC (e.g., improved health, more free time, etc.) in product demonstrations.
Environmental	Users do not recognize the impact they have on the environment	• Demonstrate that the PSBCs are an environmental friendly solution to the otherwise resource-intensive way of traditional cooking.

F. Implementation Plan

Our recommended implementation plan (see Figure 17) calls for three distinct phases: 1) Planning and organization 2) Launch and ramp-up 3) Systematic monitoring and expansion. We expect that nine months of systematic planning and organization will be required before the PSBCs reach their target market under the auspices of the Consortium. Following the initial launch, the time that it takes to reach self-sufficiency will depend on acceptance rates and resources. In order to expedite this period, the consortium should initially focus on 1) reducing product costs and 2) structuring financial incentives (income) for not only the manufacture of PSBCs, but also for their distribution and much needed training.

Figure 17. Implementation plan for the consortium
The implementation of the consortium will take place over 3 key phases

Phase 1 **Months 0-9**	**Phase 2** **Months 9-18**	**Phase 3** **Year 2 and beyond**
Plan & Organize • Assemble key players • Clearly define roles • Create charter • Establish milestones • Improve / enhance product • Field testing • Set up manufacture • Design and train distribution and education	**Launch & Ramp-up** • Small scale trial (2-5 regions / co-ops) • Re-tool model based on lessons learned • Round 2 product enhancements • Systematically roll out to other regions / co-ops	**Monitor & Expand** • Constant product enhancements • On-going training and education • International expansion
Have manufacturing, distribution, and training in place.	One hundred PSBCs delivered to multiple markets.	Country-wide penetration. Begin international plans.

Identify In-Country Coordinator (Time Zero)

Recognizing that the Consortium will be made up of several different parties with a variety of objectives and priorities, a critical first step to forming the Consortium is the establishment of a full-time coordinator to manage the goals, objectives, and actions. This coordinator needs to be locally established, fully committed to the Consortium and salaried. While all members of the Consortium should have voting rights, the in-country coordinator will be necessary to gather everyone together, facilitate meetings, foster relationships with new Consortium members (i.e.: Jua Kali sector manufacturers) and ultimately run the on-going operations. Team Solar would anticipate that SHE and the KNFC would work together to establish funding for the position, identify candidates and select the individual for the position.

Kick-off Meeting (Month 1)

The purpose of this initial meeting is to get everyone together for two days of brainstorming as well as for the members to get to know each other and what each of their organizations brings to the table. Prior to the meeting, the facilitator (SHE, Michigan Business School, and/or William Davidson Institute) should construct a specific agenda and objectives for the meeting.

- Write Consortium charter and establish major milestones and expectations of both participants and the Consortium as a whole
- Clearly define the roles of all key players in the Consortium, both short- and long-term
- Identify target groups / regions for initial launch and prioritize regions for future role-out

- Develop a sound financial model for the Consortium including:
    - Break-even analysis
        - Capacity for Jua Kali manufacturers
        - Target price point for mass distribution
    - Salary of consortium coordinator and other overhead
    - Distribution and training costs and incentive scheme for employees
    - Manufacture costs and incentive scheme for Jua Kali manufacturers

Phase 1: Planning and Organization (0-9 Months)

While many short-term objectives will emerge from the initial kick-off meeting, we *strongly recommend* that the Consortium form teams around the obstacles that exist in solar cooking (as described in Table 11). Some suggested teams could focus on the following obstacles:

- Product Enhancement
- Cost reduction
- Education and Training
- Promotion and Advertising
- Branding

Recommended milestone: manufacturing, distribution, and training systems in place.

Phase 2: Launch and Ramp-up (9-18 Months)

Once the manufacturing and distribution mechanisms are in place, the Consortium will launch the product to a small group of users. Over the next nine months, feedback from all stakeholders should be collected and evaluated before the product is rolled out to a larger market.

- Initial field test of prototype
    - Identify and address customer needs (product specs and training)
    - Secondary box cooker enhancements
- Scale up production and distribution
    - Work w/ Jua Kali
- Launch and rollout
    - Launch marketing campaign
    - Research market segments in Kenya
    - Ensure quality training and monitor use (demonstrate value to end-user)
    - Guarantee product performance
- Collect feedback from all stakeholders and evaluate strengths and weaknesses

Recommended milestone: At least 100 PSBCs being used by customers.

Phase 3: Ongoing Monitoring and Expansion (Year 2 and Beyond)

As the model grows and PSBC use become increasingly widespread, the Consortium should expand the product line to meet the needs of specific market niches (e.g., passive solar food dryer) and attempt to gain greater market share with preliminary models. The Consortium should also lobby to eliminate harmful government subsidies and mandates that make the PSBC less competitive (e.g., promotion of Jiko stoves.)

- Establish community groups to reinforce the use of PSBCs
- Ongoing product enhancement
- SHE to expand the Consortium internationally

Recommended milestone: Country-wide market penetration. Begin planning for international expansion.

V. Conclusion

From the start of this project, Team Solar recognized the magnitude of the problems that solar cooking attempts to address. Utilizing mass manufacturing and distribution to access a large market segment would bring the PSO's health, economic and environmental benefits to those Kenyans who need it most, the rural poor. Based on our extensive in-country research, Team Solar found that, at least in Kenya, this target market is understandably more focused on day-to-day survival rather than on the value of environmental and health benefits.

While the financial benefits of solar cooking through fuel savings are significant, there are many cultural issues that are difficult to overcome, complicating the value proposition of passive solar cooking. In addition to these obstacles, panel cookers have design-specific issues: Panel models (1) only cook one pot at a time, (2) are easily knocked over by wind, animals, or children, and (3) do not have a latch on the pot to secure food.

Despite the obstacles to solar cooking in Kenya, Team Solar did find widespread and significant interest in solar cooking, both with the organizations that the team met in Kenya and through our informal interactions with local Kenyans. Given this level of interest and the renewed belief in the potential benefits of solar cooking, Team Solar believes that, with the right product (an improved box cooker), a consortium can be formed to effectively lead the mass distribution and utilization of solar cookers in Kenya. As this project draws to a close, Team Solar is hopeful for the future of solar cooking in Kenya and in other developing markets around the world.