



# Renewable Energy at the Base of the Pyramid in Haiti

*Masters Project Final Report*

U-M School of Natural Resources  
and Environment

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Solar Electric Light Fund



## Executive Summary

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This document presents the work of the University of Michigan, School of Natural Resources and Environment, 2013-2014 Masters Project team comprised of Wan-Ning Chen, Annelise Lemes, Aditi Moorthy, Lukas Strickland, and Yicong Zhu. Our project was presented to the University on April 11, 2014 in the “Sustainable Enterprise” category. The project client was the Solar Electric Light Fund, an international non-profit organization based in Washington, D.C., that focuses on the sustainable development of electrification in the developing world through the construction of renewable energy systems. Additionally, the team collaborated closely with many other organizations, the most relevant of which were Ashoka, Innovators for the Public, an international social entrepreneurship network, and Micama Soley, a Haiti-based for-profit enterprise focusing on developing renewable energy solutions for rural Haitians.

Broadly, the initial goal of our project was to assist an international organization design and implement a renewable energy project that would bring electricity to rural inhabitants in the developing world. Although the Solar Electric Light Fund was not our original client, because of the alignment of our goals with theirs, all parties agreed that a partnership between our team and that organization would make for a stronger project.

After initiating the partnership with the Solar Electric Light Fund, the first stage of our project consisted of extensive primary and secondary research that gave us intimate familiarity with the global energy access challenge, the solar lantern industry, and, more specifically, with Haiti. Our client facilitated a trip to Haiti during which team members conducted a socioeconomic survey that highlighted the extent of the energy needs in one of the world’s poorest countries. It also placed that need in the broader context of other development challenges, including education, sanitation, healthcare, nutrition, and others.

The second, more substantive stage of our project consisted of applying the learnings from the research phase to help our client lay the foundation for a grant project focused on building a self-sustaining lantern distribution network on Haiti’s particularly impoverished Central Plateau. With the blessing of the Solar Electric Light Fund, the Masters Team partnered with local organizations in Haiti, and helped our client build a business plan and partnership network that should allow them to satisfy the terms of their grant project while improving the lives of thousands of rural Haitians.

This document presents all phases of our work in four chapters: Chapter I provides an overview of our primary and secondary research of the global energy access challenge and the solar lantern industry; Chapter II outlines the project building work that the team undertook in the latter half of the project; Chapter III critically analyzes the project design that resulted from stage two of the project; and Chapter IV provides an overview of the risks that the team perceives for successful project implementation and our recommendations for overcoming them.

## Table of Contents

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<b>ACKNOWLEDGEMENTS</b> .....	<b>3</b>
<b>ABBREVIATIONS</b> .....	<b>4</b>
<b>INTRODUCTION</b> .....	<b>6</b>
<b>CHAPTER I. ENERGY ACCESS AT THE BASE OF THE PYRAMID</b> .....	<b>9</b>
SECTION 1. THE GLOBAL CONTEXT OF THE ENERGY CHALLENGE .....	9
<i>Introduction to the Base of the Pyramid</i> .....	9
<i>Energy Access Challenges</i> .....	10
<i>Energy Solutions for the Base of the Pyramid</i> .....	11
SECTION 2. THE DEVELOPMENT CHALLENGE IN HAITI .....	13
<i>Country Overview</i> .....	13
<i>Economic Status</i> .....	13
<i>Business Environment</i> .....	15
<i>Energy Infrastructure in Haiti</i> .....	15
<i>Health &amp; Safety</i> .....	16
<i>Cell-phone Usage</i> .....	17
<i>Case Study: A Field Survey in Fe-Yo Bien, Haiti</i> .....	17
<i>Willingness-to-Pay Study for Electricity Access in Haiti</i> .....	19
SECTION 3. A BUSINESS MODEL APPROACH TO LANTERN DISTRIBUTION.....	21
<i>A Business Approach to Lantern Distribution</i> .....	21
<i>Barriers to Success</i> .....	21
Market Barrier #1. Access to Finance .....	21
Market Barrier #2. Distribution Challenges .....	24
Market Barrier #3. Consumer Awareness.....	27
Market Barrier #4. Poor Product Quality & Market Spoilage.....	27
Market Barrier #5. Policy Challenges.....	29
Market Barrier #6. After-Sales Services.....	30
<i>Case studies</i> .....	30
Case Study #1. Greenlight Planet .....	31
Case Study #2. SELCO India.....	32
Case Study #3. Sunny Money .....	34
Case Study #4: d.Light.....	36
<i>Solar Lantern Projects in Haiti</i> .....	38
Project #1. Global Sustainable Electricity Partnership.....	38
Project #2. WakaWaka .....	39
Project #3. Let's Share the Sun & Phocos North America.....	41
<i>Haiti: Looking to the future</i> .....	42
<b>CHAPTER II. THE SOLAR LANTERN PROJECT IN HAITI – STRATEGY IN ACTION</b> .....	<b>44</b>
INTRODUCTION.....	44
SECTION 1. PROJECT DESIGN .....	45
<i>Overview of the Project Design</i> .....	45
<i>Distribution Plan</i> .....	47
<i>Program Financing</i> .....	48
<i>Marketing, Consumer Awareness, and Entrepreneur Training</i> .....	50
<i>Lantern Product selection</i> .....	52
Lantern Quantity .....	52
Solar Lanterns - Products and Manufacturers.....	52
<i>After-Sales Service and Product Maintenance</i> .....	56
SECTION 2. FUTURE STEPS.....	58

<b>CHAPTER III. A CRITICAL ASSESSMENT OF THE PROJECT .....</b>	<b>59</b>
INTRODUCTION.....	59
SECTION 1. SOCIAL IMPACT ASSESSMENT .....	60
<i>Economic Well-Being</i> .....	60
<i>Capability Well-Being</i> .....	61
<i>Relationship Well-Being</i> .....	61
SECTION 2. ASSESSMENT OF THE BUSINESS MODEL .....	63
<i>Resources</i> .....	63
<i>Metrics</i> .....	63
<i>Structures</i> .....	64
<b>CHAPTER IV. OUTLOOK FOR THE FUTURE: RISK AND RECOMMENDATIONS .....</b>	<b>65</b>
RISK AND SOLUTIONS .....	65
RECOMMENDATIONS .....	66
<b>CONCLUSION.....</b>	<b>68</b>
<b>APPENDIX I. SELECTED SOLAR LANTERN MODELS .....</b>	<b>69</b>
<b>REFERENCES.....</b>	<b>70</b>

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Tom Adamson was instrumental in helping us conclude our project in a meaningful way. During a crucial phase of our project, he took time to Skype with us from Haiti in the evenings, on weekends, and even exchange emails with us while on vacation overseas. Our project would not be the same without the significant role that he played.

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Finally, the team would like to extend a thank you to the many academics and professionals in the solar lantern field who lent us their time and expertise in this endeavor. Xiaowen Lin of Ashoka particularly stands out as having played a very important role in the early stages of our project. Without the contribution of each and every one of these individuals, our efforts would have been for naught.

## Abbreviations

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ARE	Alliance for Rural Electrification
ASCAs	Accumulating Savings and Credit Associations
BOP	Base of the Pyramid
CEO	Chief Executive Officer
CFI	Center for Facilitation of Investments
CFO	Chief Financial Officer
CIA	Central Intelligence Agency
GDP	Gross Domestic Product
GP	Global Partnerships
GSEP	Global Sustainable Electricity Partnership
HREC	Haiti Rural Electric Cooperative
IDB	Inter-America Development Bank
IEA	International Energy Agency
IFC	International Finance Corporation
INR	Indian Rupee
LED	Light Emitting Diode
LSTS	Let's Share the Sun Foundation
mAh	Milliamp Hour
MFI	Microfinance Institution
MNC	Multinational Corporation
MOU	Memorandum of Understanding
NGO	Non-Government Organization
NiMH	Nickel-Metal Hydride
NRECA	National Rural Electric Cooperative Association
PV	Photovoltaic
ROSCAs	Rotating Savings and Credit Associations
SACCOs	Savings and Credit Cooperative Organizations
SELF	Solar Electric Light Fund
SEWA	Self-Employed Women's Association
SHS	Solar Home System
U.K.	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

UNHCR	United Nations Refugee Agency
US	United States
USAID	United States Agency for International Development
USB	Universal Serial Bus
VSLAs	Village Savings Loan Associations
WHO	World Health Organization
WRI	World Resources Institute
WTP	Willingness-to-pay

## Introduction

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Four billion of the earth's people earn an income that is insufficient to support the most basic standards of living. These individuals are commonly referred to as belonging to the "base of the (economic) pyramid" or "BOP" (IFC, 2007). In many cases, BOP communities not only lack income generation opportunities, but crucial infrastructure that are taken for granted in developed economies, including healthcare facilities, schools, running water, sanitation, and electricity. This Masters Team set out to investigate the energy access challenge for BOP communities, the impacts resulting from a lack of energy infrastructure, and most importantly, what can be done to ameliorate the situation.

With this goal in mind, we partnered with a Washington D.C.-based organization, Ashoka, in the early stages of the project to jointly identify clients working to provide energy access solutions for BOP populations. Ashoka is a leading social entrepreneurship organization, founded by Bill Dayton in 1980. It is a global association of the world's leading social entrepreneurs, individuals with system-changing solutions for the world's most urgent social problems (Mars, 2014). The entrepreneurs are selected as "Ashoka Fellows," and are part of the Ashoka Venture and Fellowship Program. Ashoka Fellows engage in meaningful high impact social ventures in developing nations, in fields such as health, education, environment, human rights, economic development and civic participation. Thanks to our work with Ashoka over the course of the first few months of the Masters Project, we gained extensive experience with the energy access challenges faced by the BOP, and were able to make valuable contacts with practitioners in the field. Ashoka introduced us to our eventual client, the Solar Electric Light Fund (SELF), which became our long-term partner for our Masters Project.

SELF – also based in Washington, D.C. – designs and implements solar energy solutions that assist individuals living in energy poverty with their economic, educational, health care and agricultural development challenges (SELF, 2014). SELF has completed projects in more than twenty countries, pioneering unique applications of solar power for drip irrigation in Benin, health care in Haiti, telemedicine in the Amazon rainforest, online learning in South Africa, and microenterprise development in Nigeria (SELF, 2012). The majority of SELF's revenue comes from charitable donations from foundations and individuals (SELF, 2012). After the initial introduction, the U-M team decided to collaborate with SELF on a project involving solar lantern distribution in one of the organization's primary focus areas: Haiti.

SELF and the Inter-American Development Bank are regular collaborators on energy projects in Central America and the Caribbean. IDB eventually became an important behind-the-scenes partner in our Masters Project through its involvement with SELF in Haiti. The IDB is a development bank headquartered in Washington, D.C. that serves as one of the largest sources of development financing for Latin America. The IDB lends to



national, provincial, state and municipal governments and governmental agencies, as well as to private sector companies. By the end of 2013, the IDB had approved nearly \$232 billion in loans and guarantees to finance projects with investments totaling over \$481 billion. The IDB obtains its own financial resources from its 48 member countries, by borrowings from financial markets and trust funds that it administers, and through co-financing for-profit ventures (IDB, 2013a).

In 2013, SELF received a large grant from IDB to develop two projects in Haiti: a solar-powered grid project that will provide electricity for thousands of rural residents on the country's Southern coast, and a solar lantern project geared toward improving energy access for Haitians living in the Central Plateau region. From the beginning of our work with SELF, it was clear that our interests and expertise were best aligned with the solar lantern project. The bulk of our research and work with SELF has been focused on the successful development and implementation of that project.

The primary aim of the lantern project is to provide low cost solar lighting and cellphone charging solutions to low income populations who would not ordinarily have access to clean, affordable energy. It is tailored specifically towards populations with no access to the national power grid or other rural energy programs. In order to maximize social impact, the agreement with IDB stipulates a mix of products that includes a basic, lower cost model (US \$15) and a slightly more expensive one (US \$35-40) with cellphone charging capabilities. The budget for equipment, shipping and storage is set at \$100,000, which will result in an initial purchase of roughly 5,000 lanterns. An additional \$50,000 was reserved for implementation and training.

SELF's goal was to identify the most efficient way of using the funds, and to build a distribution network for the lanterns that would ideally outlast the terms of the grant. The Masters Team was charged with helping SELF assess its distribution options, with emphasis to be placed upon identifying an NGO, private business, or cooperative already operating in the Central Plateau region that could manage the distribution network. Partnering with such an organization would alleviate the need for SELF to materially participate in the distribution network, which is not one of its core areas of expertise. The team provided strategic recommendations on a number of key topics: identifying which solar lantern manufacturers had the best reputations for product quality and would satisfy the needs of the project; researching and summarizing the key challenges of setting up a successful solar lantern distribution network and strategies for mitigating them; and helping SELF set up the distribution network once the plan was finalized and partners were identified.

Since July 2013 the team has been engaged in all of these tasks. The results of these efforts are presented in this document. Chapter I provides an extensive overview of our secondary research, as well as the results of a SELF-facilitated team visit to Fe-Yo Bien, a rural community on the Central Plateau. In Section 1, we summarize our research into the

BOP, the global energy challenge, and the availability of technological solutions. In section 2, we provide an in-depth look at Haiti, including an assessment of its economy, the energy challenges the country faces, the results of our primary research, and willingness to pay information that helped inform our understanding of the feasibility of selling lanterns to rural families. In Section 3, we present a business model approach to lantern distribution, arguing that it has certain advantages over conventional donation-based models. We present the specific challenges associated with establishing a financially self-sustaining distribution model. Through extensive case studies, we outline solutions that organizations have devised to overcome those challenges. Chapter III concludes with an overview of lantern distribution efforts that have been underway to-date in Haiti.

Chapter II outlines the work that the Masters Team completed for SELF toward the actual establishment of a self-sustaining distribution network in Haiti. In particular, we review the ultimate product selection, the distribution model, program financing, training for on-the-ground partners, marketing and consumer awareness, service and maintenance, and the outlook for the future of the project. Chapter III turns the team's analytical eye back upon the work we have completed, and presents a critical assessment of the project design, highlighting the social outcomes it hopes to achieve, as well as its strengths and weaknesses. Chapter IV focuses on risks and recommendations the team sought to highlight for SELF, the IDB, and their on-the-ground partners.

# CHAPTER I. Energy Access at the Base of the Pyramid

## SECTION 1. The Global Context of the Energy Challenge

### Introduction to the Base of the Pyramid

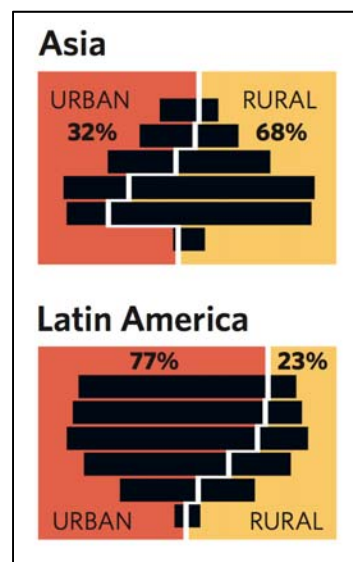
The “Base of the Pyramid” (BOP) is the name given to the 4 billion people with incomes below \$3,000 in local purchasing power (IFC, 2007). As shown in Table 1, the majority of the BOP is concentrated in Asia where approximately 84% of the total population – roughly 2.9 billion people – belongs to the BOP.

**Table 1. BOP Population and Income by Regions (IFC, 2007)**

	BOP population (millions)	BOP share of total population (%)	BOP income (millions)		BOP share of total income (%)
			PPP	US\$	
Africa	486	95.1	429,000	120,000	70.5
Asia	2858	83.4	3,470,000	742,000	41.7
Eastern Europe	254	63.8	458,000	135,000	36.0
Latin America & Caribbean	360	69.9	509,000	229,000	28.2
Haiti	7.8	95.0	4,260.60	958.2	62.9

The convenient term easily lends itself to considering the BOP as a monolithic entity, but this is far from the case. The BOP is divided into six income tiers that range from \$500 to \$3,000 annually in local purchasing power. The bottom tier of the BOP includes individuals whose incomes are equal or less than \$500, or the “BOP500.” Similarly, the “BOP3000” represents the upper tier of the BOP, whose constituents earn \$3,000 or less. There are other factors indicating the heterogeneity of the BOP, for example the challenges faced in rural versus urban segments of the BOP vary drastically, as they do from one continent to another. While the BOP population in Latin America is concentrated in the highest economic strata with a majority of the population located in urban areas, in Asia the vast majority of the BOP population is concentrated in rural areas (Figure 1).

In most cases, mainstream companies and markets do not serve the BOP, which consequently incentivizes the emergence of informal markets. Most individuals depend on the informal market for the provision of goods and as a source of income. Subsistence agriculture is also an important source of income for individuals at the BOP, but what little income they earn from agriculture and informal trade is unreliable as they are often exploited by middlemen (IFC, 2007).



**Figure 1. Total BOP spending by income segment, urban and rural (IFC, 2007)**

Along with the lack of a reliable source of income, the BOP has significant unmet needs. Lack of sanitation, no access to proper health care, and the lack of transportation and electricity are some examples of the unmet needs of this population. It is widely known that the BOP is subject to what it often referred to as the “poverty penalty.” Services and goods available to them are usually of poor quality and more expensive than what a consumer would pay in a developed market (IFC, 2012b). Lack of energy access acts as a major barrier for people in the BOP to establish better foundations for their lives. A number of basic needs can be met easily with reliable access to energy but the energy access challenge still remains an enormous puzzle for the world to solve.

### Energy Access Challenges

The BOP faces significant challenges when it comes to energy access, but the extent of the problem varies significantly. Within the Americas alone, while 62% of the BOP in Haiti lacks access to a reliable source of power, only 2% of the BOP in Brazil is not served by reliable electricity (UNDP, 2012). The greatest concentrations of populations without access to electricity are in rural Asia and Sub-Saharan Africa, which account for 95% of the total BOP population. The International Energy Agency states that over 1.3 billion people lack access to electricity, out of which, 84% are rural BOP inhabitants (Table 2) (IEA, 2011).

**Table 2. Number and share of people without access to modern energy services in selected countries in 2009 (IEA, 2011)**

	Without access to electricity		Relying on the traditional use of biomass for cooking	
	Population (million)	Share of population	Population (million)	Share of population
<b>Latin America</b>	31	7%	85	19%
<b>Developing countries</b>	1314	25%	2662	51%
<b>World</b>	1317	19%	2662	39%

Lack of access to clean and affordable energy exposes the poor to severe health problems due to indoor air pollution from burning cooking and lighting fuels. The most common source of lighting in underserved regions is kerosene-fueled lamps that not only fail to properly light rooms, but also have negative health impacts. Additionally, traditional biomass cook stoves are also used, aggravating health impacts on the lives of those that use them (IEA, 2011). Despite their inefficiency and health impacts, traditional lighting sources are not cheap and alone account for approximately 9% of the total BOP household expenditures (IFC, 2007).

Not only do these current alternatives cause health problems, the lack of access to a reliable source of electricity also keeps people trapped in a poverty cycle (UNDP, 2011). Usually, people in the BOP pay more for less efficiency energy, and this higher energy cost adds burdens to the poor. Access to reliable energy improves lives in a variety of ways: it

increases productivity because businesses are able to stay open longer, it frees up time from activities such as fuel collection that can be allocated to income-generating activities, and it permits children to study at night. Electricity helps increase safety and reduce violence by illuminating dark and potentially unsafe areas; it reduces health problems associated with the use of kerosene-fueled lamps; and finally, it contributes to community mobilization and the empowerment of women through entrepreneurial activities, such as selling lanterns. All these are positive impacts that result from increasing access to affordable sources of clean energy.

### **Energy Solutions for the Base of the Pyramid**

In order to meet the need for energy at the BOP, many private and public sector institutions have been investing in innovative approaches to improve access. One of the biggest challenges to provide reliable energy to the BOP stems from the fact that most BOP communities are distant from urban areas. Expanding grid connections to reach these remote, un-electrified communities can be challenging in terms of high infrastructure costs and geographical limitations. Furthermore, even if the project can be developed, often the recipients of grid-power are too poor to pay electricity rates that can support the maintenance of the infrastructure. Off-grid, decentralized solutions are increasingly getting attention for their potential in powering BOP communities around the world using hydropower, solar photovoltaics (PV), biomass, and wind as energy sources (UNDP, 2013).

Among the available solutions, the use of PV-based options has been on the rise. In the last few years, PV technology's diminishing cost and rising efficiency has made it more appealing as an energy solution for the BOP (IFC, 2010; The Economist, 2012). The dissemination of these decentralized energy solutions is possible due to the relatively small required investment. Other factors have also driven the adoption of these technologies: the increasing price of petroleum-based lighting fuels like kerosene, and the increased access to mobile technology for the BOP, particularly in Africa (IFC, 2010). These systems have also permitted the development of market-based approaches that have been increasingly substituting for traditional product handout models (ARE, 2011).

The solar PV systems category is comprised of different solutions that vary in size to meet different power demands. Two examples commonly adopted to address the energy access challenge at the BOP are solar home systems (SHSs) and solar lanterns (ARE, 2011). SHSs (Figure 2) have been the most widely adopted solar solution over the past thirty years. They are comprised of solar modules, a charge controller, batteries and wiring for local power distribution. Larger SHSs can also include an inverter which provides AC current for typical household devices (ARE, 2011). SHSs have significant upfront costs and require end-user financing options for dissemination in low income communities at the BOP.

Solar lanterns (Figure 3), on the other hand, are a fast growing solution for providing lighting to households at the BOP (IFC, 2012b). These systems are powered by a solar cell, which can be integrated into or separate from the design, and provide 10W of power or less. Furthermore, they can substitute kerosene lamps with the advantages of higher luminosity, fewer health problems associated with the toxic fumes from kerosene combustion, and at the same time, provide a cost-free fuel technology that recharges whenever it is placed directly in the sun. Some of these solar lanterns also include mobile charging capabilities. Their increasing availability at affordable prices has made them an ideal solution for addressing the lighting needs of both urban slums and remote rural populations. More recently, these devices have been given out as part of catastrophe relief operations (WakaWaka, 2013c).



**Figure 2. Solar Home System**



**Figure 3. Solar Portable Light**

## SECTION 2. The Development Challenge in Haiti

### Country Overview

Haiti occupies one third of the island of Hispaniola located between the Caribbean Sea and the North Atlantic Ocean with a total area of 27,750 square kilometers – slightly larger than the state of New Jersey. With most of the land rough and mountainous, only 36% of Haiti’s land is arable yet 38.1% of Haitians depend on agricultural activities for living. The climate of Haiti is tropical, with some variation depending on altitude. Some lowland areas and northern and eastern slopes of mountains get more rain throughout the year compared to other areas. There are two rainy seasons in Haiti, from April to June and from October to November. With a high deforestation rate in the country, Haiti is very vulnerable to periodic droughts and floods. Its tropical location also endows Haiti with excellent solar resources of around 93 million MWh per year (Open EI, 2013), but this source of energy does not yet contribute significantly to Haiti’s energy supply.

Haiti has a population of around 10 million with an annual growth rate of 1% (CIA, 2013). More than half of the population is under 25 years old, giving Haiti a very young population structure (Figure 4). The sex ratio of Haiti is 1:1, and the estimated 62 year life expectancy at birth for Haiti is low compared to other countries (2011 estimate) (CIA, 2013).

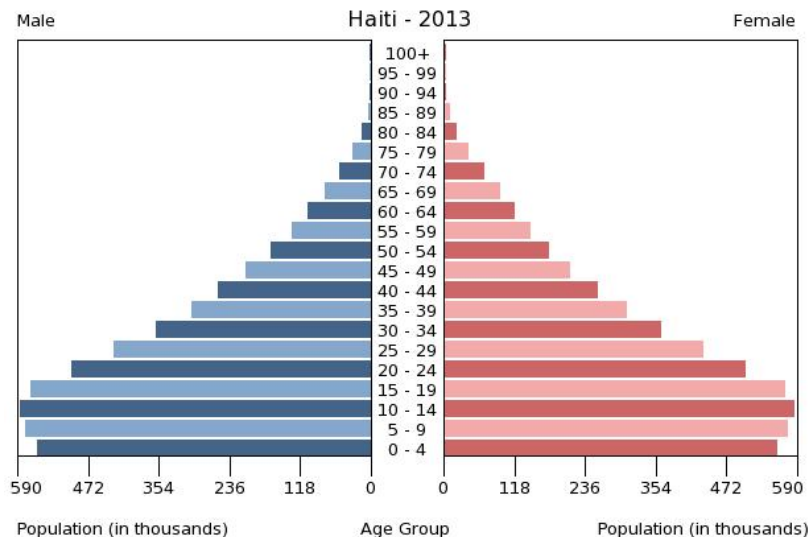


Figure 4. Age Structure of Haiti (CIA, 2013)

### Economic Status

Haiti is the poorest country in the Americas and one of the poorest countries in the world (The World Bank, 2013). In 2012, the country’s GDP ranked 146<sup>th</sup> in the world at an estimated \$7.84 billion, and its per capita GDP was \$1,300 and ranked 208<sup>th</sup> out of all 228 ranked countries (CIA, 2013; The World Bank Database, 2013). With only 36.0% arable

land coverage, agriculture comprises only 24.7% of Haiti’s GDP, but occupies 38.1% of Haiti’s labor forces (CIA, 2013). Approximately 80% of Haiti’s population lives below the poverty line with incomes of less than US \$2 per day, and 40.6% people are unemployed. Lack of education is one of the major factors keeping Haiti from developing more quickly. Less than half of Haitians over age 15 are literate (48.7%) with females having a lower literacy rate than males (CIA, 2013).

On January 12, 2010, a 7.0 magnitude earthquake hit Haiti, killing up to 230,000 people, displacing 1.5 million people more, and incurring economic damages of around \$8 billion – 120% of Haiti’s GDP at the time (The World Bank, 2013). The disaster brought tremendous damage to the country’s already vulnerable economy. In 2010, Haiti’s annual GDP growth crashed -5.4% to \$6.63 billion. In order to help Haiti recover from the damage, international organizations started helping Haiti through rebuilding infrastructure, providing financial help, and improving social services (The World Bank, 2013). With the economic help from outside the country, Haiti’s economy recovered slowly from the earthquake, and reached its highest growth rate since the disaster of 5.6% in 2011 (Figure 5). Unfortunately, in 2012, two hurricanes severely affected Haiti’s agriculture output, short-term aid was rolled back after a year of recovery, and public spending remained slow – all with negative impacts on Haiti’s economic recovery (CIA, 2013). Following these events, Haiti’s GDP retreated to its pre-earthquake growth trend (2.8% in 2012 compared to 2.9% in 2009).

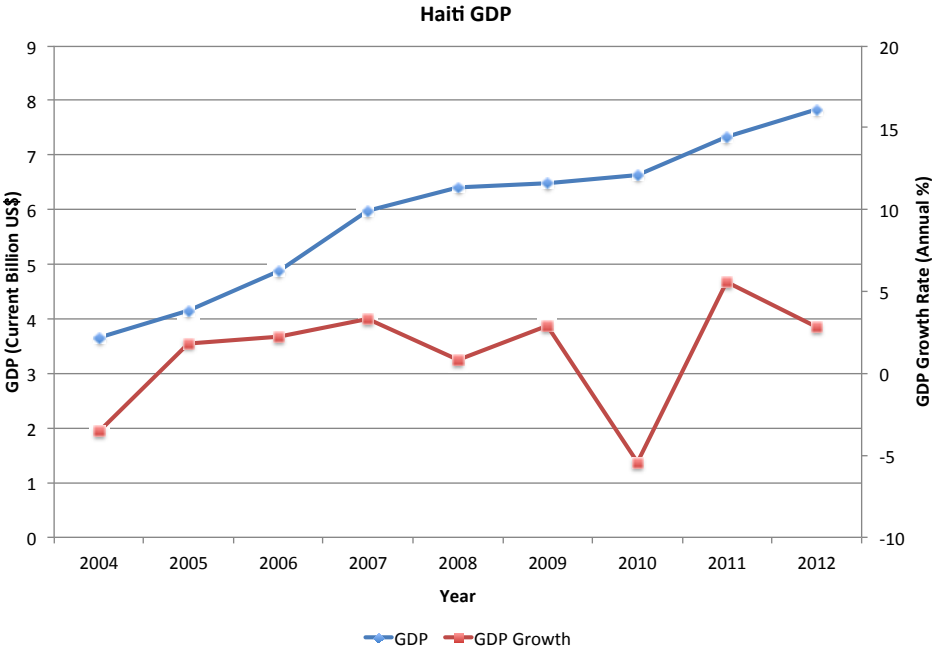


Figure 5. Haiti’s GDP and Growth Rate from 2004 to 2012 (The World Bank, 2013)



## **Business Environment**

Haiti enjoys a low cost of labor and tariff-free access to the US for many of its exports, however, from the perspective of attracting business, Haiti's ranks 151<sup>st</sup> in the global economic freedom index (Index of Economic Freedom, 2013). Overall, the business environment in Haiti remains burdensome, with government institutions being weak and inefficient, and completing a licensing requirement taking up to three years (Index of Economic Freedom, 2013). Moreover, in the wake of the destruction of the 2010 earthquake, a large portion of the workforce in Haiti has been unemployed or operates only in the informal market. Because of the importance of the informal market it is extremely difficult to make accurate estimates of Haiti's economic indicators.

In Haiti, foreign investments are usually granted national treatment, but due to the inefficiency of government institutions, the investment regime remains inefficient. The small financial sector in Haiti is underdeveloped and lacks the ability to provide adequate support for the private sector. Since most financial transactions happen in informal ways, credit lines for new business ventures in Haiti remain severely constrained (Index of Economic Freedom, 2013).

## **Energy Infrastructure in Haiti**

Currently, 79% of Haiti's installed electric generation capacity is powered by fossil fuels and the remaining 21% comes from hydroelectric plants (CIA, 2013). Although Haiti is endowed with abundant solar resources, this energy source hasn't yet significantly contributed to Haiti's energy supply. In 2008, the Haitian Government formally committed to promoting renewable energy, with a national energy policy aimed at generating 50% of electricity supply using renewable energy by 2020 (CFI, 2013), but this policy has not yet resulted in new energy projects.

Haiti's energy market is estimated to be a US \$0.71 billion market, one of the single largest sectors in the country (CFI, 2013; UNDP, 2012). With an estimated annual population growth rate of 1.4%, this market is expected to continue its growth. Despite a positive growth outlook for energy infrastructure, Haiti currently ranks as the country with the lowest level of electrification in the Americas with 70% of its rural population lacking access to electricity (IDB, 2013b). Even in the capital city Port-au-Prince only 45% of residents have access to electricity. Locally harvested biomass and charcoal still remain the most important source of energy for households, and are used primarily for cooking (CFI, 2013). In rural communities, lighting needs are met through a combination of kerosene lanterns, candles, and battery-powered flashlights.

In the absence of modern electricity infrastructure, and with the high cost and feasibility challenges associated with the expansion of the national grid, alternative options for powering remote regions have been promoted. Solar lanterns are becoming increasingly important in providing inexpensive lighting for poor areas that lack access to

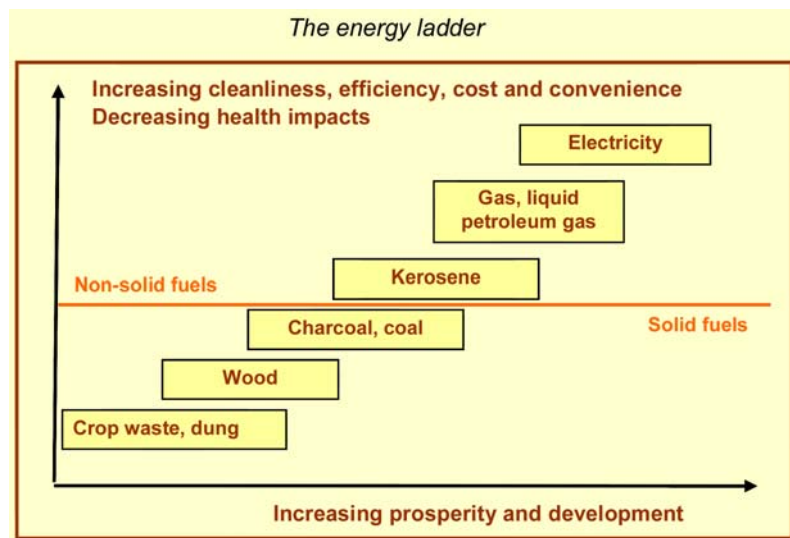
grid power. Compared to kerosene lamps, solar lanterns can provide more stable light at a lower cost, prevent the emission of toxic fumes, and lower the risk of fire (Goering, 2012).

Purchasing a lantern, however, is not an easy decision for a family in Haiti considering the upfront cost the equipment requires. An analysis of the potential drivers that would encourage families to switch from kerosene lamps to solar lanterns is essential to successfully establishing and sustaining a solar lantern business in the long run. A few of these factors, related to the BOP's current situation in Haiti, are considered below.

### Health & Safety

Indoor air pollution is the biggest problem resulting from kerosene use in the home. Indoor air pollution is responsible for 2.7% of the global disease burden (WHO). Burning kerosene produces toxic fumes which contributes to nearly half of the world's 2 million pneumonia deaths among children each year (Goering, 2012). In Haiti, pneumonia is the second leading cause of death among children under five and is also responsible for 10.8% of total deaths according to a recently published WHO report (USAID, 2013). Additionally, it also causes respiratory illnesses for women, who on average spend more time in the home than men. According to the energy ladder (Figure 6), an increased level of cleanliness, efficiency, and decreasing health impacts are associated with the use of more efficient fuels (WHO). As a result, health impacts are an important factor favoring solar lanterns over conventional fuels in off-grid energy applications.

Lanterns are useful for improving women's safety in refugee camps. Rape has been rampant in camps of the displaced families following 2010 Haiti's earthquake, but after introducing lights to the camps at night, the number of rape cases per week was reduced. In addition, lanterns are also useful for children and women to find their way safely to public toilets at night. Although kerosene lanterns present an alternative portable option, they produce toxic fumes and can easily be knocked over, making them unsafe. According to humanitarian aid volunteers in Haiti, kerosene powered lamps are a major cause of burns among students who use them to study at night (Goering, 2012). Combining the need for portability and safety, solar lanterns provide benefits in both these respects.



**Figure 6: Energy Ladder (Prosperity X Health Impacts)(USAID, 2013)**

### Cell-phone Usage

Despite widespread poverty in Haiti, the mobile coverage rate has increased from 6.9% to 40.5% from 2005 to 2010 with an average growth rate of 6.72% per year (UNdata, 2013). After the earthquake, thanks to the reconstruction efforts and a recovering economy, cell phone adoption rates are accelerating. Many models of solar lanterns provide the additional capability of charging cell phones. Because of the rapid growth in cell phone use and the lack of charging sources in most rural areas, solar lanterns with charging capabilities have additional appeal over products that offer only lighting services.

### **Case Study: A Field Survey in Fe-Yo Bien, Haiti**

Whereas the previous paragraphs discuss the challenges faced by the majority of Haiti's population, the present section explores similar issues from the perspective of primary research that was conducted by the Masters Team in the region where the lantern project is under development: the Central Plateau. In October 2013, members of the Masters Project team members made a trip to central Haiti coordinated by the project client SELF. The team was able to collect invaluable on-the-ground information regarding the living conditions and needs of rural Haitians. Highlights of observations collected during the trip are presented below.

Fe-Yo Bien is a village in the mountains in central Haiti. Leaving from the Capital city Port-au-Prince, it takes approximately two hours of driving and one hour of hiking to reach the village. There are no proper roads and no public transportation serving the community. Almost all of the 15,000 Fe-Yo Bien villagers live under the poverty line and fall into the lower brackets of the BOP. Separated from the outer world by mountains, people in Fe-Yo Bien still maintain an old fashioned lifestyle, using horses as a means of transportation and trading goods in small, local markets. In Fe-Yo Bien villagers' opinions, bad road conditions

and lack of access to electricity are clearly the two most important problems that they would like to see being addressed.

Households in Fe-Yo Bien depend heavily on agriculture for survival. Staple agricultural crops in Fe-Yo Bien include corn, millet, potatoes, rice, beans, and bananas. Most agricultural yields are consumed directly rather than sold at a profit. Of the households interviewed by the Masters Team, less than 50% were able to sell some of their yield for a few dollars, and only one household, which belonged to the pastor of Fe-Yo Bien, was able to earn income from selling most of the harvest. For more than 50% of the interviewed households, selling crops is the only way for them to earn income. Because most farmers depend on inconsistent rainfall for irrigation, the amount of money available for many Fe-Yo Bien households varies drastically from season to season.

Food security is a serious problem for inhabitants of Fe-Yo Bien and surrounding areas. Many families reported eating no more than one meal per day in their household, although a minority of interviewees ate two to three meals. When asked about the types of food consumed, it was clear that millet, corn, and rice comprised the bulk of the local diet. Fruits and vegetables – requiring irrigation – were perceived as luxury items only purchased once or twice per week or even month. Meat consumption was even rarer, with very few families consuming chicken more than twice per month.

Water, shelter, sanitation, healthcare and education all pose extreme challenges for villagers. Almost all water is drawn from a nearby river, which also serves as the public bath and area for washing laundry. As a consequence, cholera outbreaks and other waterborne diseases are common, and women and children must spend between fifteen minutes and an hour per day hauling water, depending on the location of the household relative to the river. Sanitation is mostly lacking in the village, exacerbating the risk of contamination of the water source. For healthcare and education beyond middle school, villagers must travel to Boucan Carre, the closest town connected to the national road system. The hike to and from the town takes an hour, and can be completely impassible during the rainy season when the river, which must be crossed twice over the course of the hike, overflows its banks. Making matters worse, cholera and other waterborne disease outbreaks are most common during the rainy season when the road becomes very difficult to navigate.

As Fe-Yo Bien is completely unelectrified, locals depend mostly on kerosene, wood and charcoal as energy sources. Batteries are available but are not affordable for everyone. Most of the interviewed households use kerosene lamps and candles as their primary source of light, with less than 40% of households using flashlights occasionally. At night, they use light for less than 3 hours with some households not using any light at all. Children do not have a steady source of lighting for studying at night: some only study during the daytime, some study by the poor light of kerosene lamps or candles, while some have to go out and study under one of the two solar street lamps that were recently installed in the community. Weekly energy expenditures (excluding transportation expenditures) of the

interviewed households varied from \$2 Haitian dollars (equivalent to US 22 cents) to \$183 Haitian dollars (equivalent to roughly US\$ 20). More than 50% of households spend less than \$10 Haitian dollars (US \$1.11) per week purchasing kerosene, wood or charcoal, candles, and batteries, combined, for energy usage. Cell phones are relatively prevalent in Fe-Yo Bien, with 62% of households owning at least one cell phone. Charging cell phones has been a problem for Fe-Yo Bien villagers. Usually they must travel to Boucan Carre and pay for phone charging services once they arrive.

Solar lanterns use solar energy as an energy source and thus do not incur costs beyond the upfront cost of the lantern. Facing huge challenges of getting reliable and affordable sources of lighting, all interviewed households expressed interest in solar lanterns. Surprisingly, more than half of the households had already heard of solar lanterns and one of the households even owned a solar cell phone charger. The problem of paying for solar lanterns, which retail for an average of US\$ 15, for Fe-Yo Bien villagers still remains, even if they were locally available for purchase. Wealthier households do have extra money for this new technology, but for the majority of poor households, despite the fact that they are interested in solar technology, the amount of money they could afford and would be willing to pay is unclear. The following section presents the results of a comprehensive willingness-to-pay study recently conducted in Haiti. Given the importance of affordability for project success, the study has immediate relevance to the SELF solar lantern project.

### **Willingness-to-Pay Study for Electricity Access in Haiti**

In preparation for a large-scale electrification project on Haiti's southern coast, also in partnership with the IDB, SELF joined forces with NRECA International Ltd. (NRECA), the UNEP, and various other organizations to conduct a willingness-to-pay (WTP) survey of households and businesses. The survey was conducted over a period of five days with a total of 339 households and 126 businesses. In this report, the business data is omitted given the focus of the Masters Project on rural households (HREC, 2014).

Respondents were asked a variety of questions pertaining to the use of different fuels and energy technologies, as well as the regular costs associated with those options. None of the respondents were connected to the national grid, although some reported having access to a private generator. WTP data was "revealed" rather than reported directly – that is, rather than reporting how much they would pay for energy in a month, respondents were asked to calculate their monthly expenditures by accounting for all fuels and energy services purchased in that timeframe. According to the designers of the survey, revealed WTP is more reliable than reported WTP because it reflects current expenditures rather than estimations of willingness to purchase services that are yet unknown to respondents.

Consistent with data collected by the Masters Team in Fe-Yo Bien, 93% of responding households relied on kerosene for their lighting needs, spending an average of US \$15 per month on ten liters of fuel. Batteries came in second, with 51% of households purchasing them regularly, followed closely by candles at 47%. The most crucial take-away of the survey for the purposes of this Masters Project is the WTP data that emerged from the study (Table 3).

**Table 3. Willingness-to-Pay Study Result**

	Percentage of sampled Households					
	90%	80%	70%	50%	25%	5%
<b>Monthly WTP (USD)</b>	\$3.62	\$5.51	\$6.75	\$10.82	\$20.56	\$105.63
<b>Monthly WTP (Gourde)</b>	HTG 156	HTG 237	HTG 290	HTG 465	HTG 884	HTG 4556

These numbers are higher than those collected in the limited survey in Fe-Yo Bien, but not so much so to suggest that the surveyed population is living under significantly different economic circumstances. Understanding WTP is crucial to gauging the potential success or failure of a solar lantern project that will rely on voluntary purchases by rural households. It is encouraging that over 50% of respondents already spend more than US \$10 per month on energy, because this means that a US \$15 lantern could be purchased with less than two months of energy expenditures.

## **SECTION 3. A Business Model Approach to Lantern Distribution**

### **A Business Approach to Lantern Distribution**

Traditional approaches to development have emphasized leveraging philanthropic dollars or government programs to improve living conditions for the world's poor. Over the past decade, there has been an upswing in dialogue between the development community and the business community resulting in each field learning valuable lessons from the other. The movement to explore development issues using the tools of business is exemplified in the work of C.K. Prahalad, late professor of business strategy at the University of Michigan. In 2002, in *The Fortune at the Bottom of the Pyramid*, Prahalad and Stuart Hart laid the foundation for an approach to poverty alleviation that reframed the world's poorest people as rational consumers worthy of consideration from socially-driven or even mainstream businesses, rather than victims in need of assistance (Prahalad & Hart, 2002). This approach – claim its proponents – not only has the potential to revolutionize traditionally underdeveloped regions by providing individuals with useful products and services, but can also open up new markets for corporations facing stiff competition and flat growth in developed economies.

While not taking one side or another of the debate over development strategies in general, this Masters Project does recognize that numerous innovative companies and organizations employing the tools of business have been highly successful at expanding energy access to the BOP over the past ten years. Our team believes that the most fruitful application of the funding for the SELF lanterns project will be to establish a program that can be sustained indefinitely by generating a steady stream of benefits for all involved parties. For this reason, the format of this section and the project presented in Chapter II takes an explicitly business-based approach to the question of expanding energy access. Before engaging in our own attempt to design a financially sustainable lantern distribution network, the Masters Team assiduously studied examples of existing lantern businesses from around the world. The International Finance Corporation's Lighting Africa program highlights many of these successes, as well as the barriers preventing further expansion of current efforts. The following topics explore the barriers that are relevant to lantern distribution in Haiti and possible solutions for overcoming them.

### **Barriers to Success**

#### ***Market Barrier #1. Access to Finance***

Access to finance remains one of the largest barriers on the path to setting up a sustainable solar lantern business (IFC, 2012b). There are a number of significant differences between the solar lantern market and conventional goods market. The BOP requires a tailored financial solution because of the inherent variability of the end-user's income, and the low income brackets to which the lantern market caters. A large majority

of lantern customers spend anywhere between US \$1.25 and \$8.5 per month on traditional energy, largely biomass (IFC, 2012a). Given that the median cost of a solar lantern is US \$15, without financing some consumers are unable to afford lanterns due their high upfront cost relative to their incomes (IFC, 2012b).

Currently, the solar lantern market primarily serves rural populations in India, Africa, South Asia, and other select regions. Although lanterns have the capability to serve both urban and rural areas, most solar lantern initiatives (both for profit and non-profit) are concentrated in rural areas, where populations have little or no grid connectivity and little ambient light at night. Since most of these rural areas are remote, customers typically have limited access to financial institutions. Solar lanterns also require a significant amount of after-sales support. This makes coordination of after sales service and maintenance extremely difficult, which can impact the effectiveness of end-user financing repayment if a product fails due to misuse or lack of a repair network.

End-user financing is one of the solar lantern market's largest entry barriers. As discussed in the section above, end-user financing is challenging because of characteristics intrinsic to the BOP market, including the remoteness and income brackets of the consumers belonging to it. While some interesting projects are underway to address the end-user financing challenge, the availability of financing schemes for end-users is currently low and suffers from limited support from the entire lantern ecosystem – manufacturers, distributors, and the formal financial sector (IFC, 2012b). The following sections outline the existing mechanisms for end-user financing in the solar lantern market.

#### Microfinance Institution Micro-Lending

Microfinance institution (MFI)-based micro-lending is one of the most common forms of end-user financing mechanisms, with organizations like SELCO and Nuru all employing some form of MFI-sponsored end-user financing. MFI micro-lending is an excellent mechanism to help consumers finance their solar lanterns and other devices as it has the potential to fill in the voids that conventional financial institutions are unable to cover. Since rural banks are generally located adjacent to the remote areas lantern markets typically serve, they have a significant amount of penetration in these areas. MFIs are also typically more familiar with local income levels and have a better feel for the funding landscape. This potentially translates into lower interest loans and more flexibility in loan agreements. However, there are also a few disadvantages associated with this type of financing. Since loan amounts for lanterns will be on the order of \$100 or less, there will be a large transaction cost relative to the actual amount of the loan. MFIs also have limited funding and associated constraints, and this may restrict the amount of loans disbursed (IFC, 2012b).

Despite these challenges, MFIs could still be used to finance solar lanterns, especially if the loan amount is increased. MFIs could narrow their scope to customers who already have outstanding loans and simply add the cost of the lanterns to the outstanding



balance. In microfinance, this is known as “topping up.” This method would avoid transaction costs created by a new loan, and the same payment plan could then be extended to include the additional cost of the solar lantern. This method also ensures that all customers have some sort of background check and acceptable credit history to pay off the lantern loan. MFIs could provide financing for a lantern and a complementary product – such as a clean cook stove, water purifier or cell phone charger – to raise the combined loan size to a viable amount, which would mean that transaction costs are in tune with the loan size. For example, the Self-Employed Women’s Association (SEWA) has partnered with IFC to provide solar stoves and lanterns to its 200,000 rural women members in the western Indian state of Gujarat. SEWA provides its members with loans of US \$100-150 to purchase the bundled offering, at a 16% interest rate, repayable in manageable monthly installments (IFC, 2012b).

### Engaging the Semi-Formal and Informal Financial Sector

There exists an extensive informal and semiformal financing network in rural areas around the world. It may be worthwhile to integrate these financial frameworks into financing framework for solar lanterns, because of their proximity to the market itself. These organizations include Savings and Credit Cooperative Organizations (SACCOs), Village Savings Loan Associations (VSLAs), Accumulating Savings and Credit Associations (ASCAs), and Rotating Savings and Credit Association (ROSCAs). They have several advantages over the more formal institutions such as MFIs and banks. Since they are co-located with the market, they have potential to achieve high market penetration. The formal and semiformal financing networks may also have a higher appetite for risk given their community-focused operations. These networks may also show a higher willingness to provide loans for products that improve the standard of living in rural areas (IFC, 2012b). Discussions with stakeholders have revealed that it is difficult to convince conventional financial institutions to invest in loans for products like lanterns, and this represents a tangible opportunity for the more informal financing mechanisms to have an edge over banks.

### Mobile Lending Schemes

Mobile lending for solar lantern financing is a promising alternative that could break free of the current transaction cost constraints on lending. MFIs and other financial institutions can use mobile payment (“m-payment”) platforms to distribute credit and collect repayments, thereby reducing their transaction costs by over 50% (IFC, 2012b). Other non-financial institutions could develop “pay-as-you-go” energy business models enabled by an m-payment platform. This method is gaining popularity with several start-up businesses that are utilizing technology to reduce the transaction size of their energy product/offering, allowing consumers to pay for one day of energy at a time. M-Pesa, a mobile banking and cash transfer service offered by Safaricom is an example of a mobile

banking system used in Kenya that could potentially be used for selling lanterns as well. According to a survey conducted in Kenya, 48% of shopkeepers use M-Pesa, or another mobile banking system either to sell products or to buy products from their distributors (IFC, 2013).

In pay-as-you-go mobile lending schemes, customers initially purchase a scratch card of a small value such as US \$1 or \$2 from a partnering retailer/distributor. The scratch card is validated by a text message, and this provides the customer access to the solar lantern for a specified time period. Once the credit is exhausted, access to the device is barred and the consumer must purchase another scratch card for access. This system provides access to even the poorest of consumers because of the flexibility in the credit amount. The mobile platform also considerably reduces upfront costs (IFC, 2012b).

### Payroll Financing

The payroll financing concept revolves around a large employer partnering with a reputable lantern distributor and financial institution to provide its employees with lanterns and related financing (IFC, 2012b). Payroll financing mandates a tie up with a large organization, and securing such a tie may not be easy.

A payroll financing scheme for lantern distribution was implemented in the Indian state of Andhra Pradesh, through its state-owned road transportation company. Andhra Pradesh is a state in India that has a large rural population and the potential to be the customer base for the solar lantern market. The AP State Road Transport Corporation has more than a million employees, from fairly rural areas. Solar lanterns were provided to them, and the cost of the lantern was collected through monthly deductions from their salaries. The lanterns, which cost US \$44-\$66 at the project's inception in 2004-2005, were made available on equal monthly installments over a period of one to two years. The employer ensured repayment of the cost to the manufacturer, by way of a memorandum of understanding (MOU), and the manufacturer promised to provide adequate servicing during and after the loan period as part of the contract (IFC, 2012b).

### **Market Barrier #2. Distribution Challenges**

Even in the absence of end-user financing difficulties, the logistics of getting solar lanterns into the hands of rural customers can be a prohibitive challenge. The target customers for solar lanterns are typically located in last-mile communities far beyond the reaches of national road networks. Many of these communities are only accessible by motorcycle, horseback, or by foot, meaning that goods must be transported in small quantities. Each additional link in a distribution chain adds risk, cost, and time to the delivery of a shipment at its final destination. The result of this situation is that end-users often pay a "poverty penalty" (IFC, 2012b) for purchased goods: a premium above national average costs that traders charge rural consumers. Lantern distributors are not immune to cost escalations resulting from rural distribution. According to the IFC's Lighting Africa

report (IFC, 2012b), distribution costs can account for 25-50% of the end-user's price for a solar lantern.

To establish successful distribution networks, organizations must identify regions with low rates of electrification, gain an understanding of how goods currently travel in and out of remote communities, and design a distribution system that maximizes existing resources. For lanterns to remain within the purchasing power of end-users, these tasks must be accomplished with a minimal impact on the retail cost. In recent years, two industries have been overwhelmingly successful at scaling distribution networks in remote regions of developing countries: telecommunications and soft drinks. To better understand the challenges of distributing solar lanterns, a brief overview of these two models is warranted.

Coca-Cola has succeeded in generating a high level of demand for its products in rural areas around the world, and has been able to create a distribution network that can supply that demand. In West and Central Africa, soft drinks are bottled in a central hub – typically the primary economic center of the country – and dispatched to remote regions in progressively smaller quantities and vehicles. Ultimately, crates carrying 24 bottles each arrive in small villages strapped to the back seats of motorcycles, which also carry passengers and other consumer goods. The local trader that placed the order pays for the crate plus a small payment to the motorcycle driver for the transportation. The full crate is exchanged for a crate containing empty bottles, which eventually makes its way back to the bottling facility for refilling. This circular flow of bottles and crates is a crucial element in minimizing distribution costs. Coca-Cola also benefits from its success in leveraging micro-entrepreneurs<sup>1</sup> from the moment the product leaves the bottling facility: urban distributors, transporters, and rural merchants all earn a humble income by facilitating the distribution of soft drinks to some of the most remote communities in the continent.

In sub-Saharan Africa, cell phone ownership has risen 30% per year since 2001, rising to a total rate of cell phone usage of 60% of the African population by 2011 (Mitullah & Kamau, 2013). Telecommunication companies have adopted a different strategy to reach their customers on a large scale. Inexpensive or used phones are generally purchased without communication plans in larger urban hubs. To sell credit, telecom companies operate networks of proprietary kiosks selling refill cards and other services, such as cell phone charging. Kiosks may either be owned by the telecom company, or are sometimes operated by independent entrepreneurs. Because of their small size, refill cards are easily

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<sup>1</sup> “Micro-entrepreneur” is a term commonly used in the BOP field to designate an individual who earns a living by selling products to rural consumers. Networks of such entrepreneurs often form the backbone of rural distribution business models, because in many areas brick and mortar stores are not available and would lead to a higher markup on products due to the higher associated overhead. Micro-entrepreneurs are mobile, have personal relationships with the areas they serve, and also are able to communicate with international organizations to place orders, provide sales reports, and sometimes perform other services, such as product repair.

transported to rural market hubs, where last-mile customers travel to purchase products that are unavailable in their remote communities.

In both of the previous examples, companies have found solutions that overcome the challenges of remote distribution without making the cost of their products excessive for the end-user. Unfortunately, neither model is entirely replicable by lantern distributors. Each product requires a tailored solution that accounts for the level of demand, cost of the product, size and weight of the product, and consumer awareness. Although the Coca-Cola model of motorbike distribution could theoretically work for lanterns, they must be accompanied by an educational campaign that demonstrates their usefulness to the end-user. It is this pairing of marketing/consumer awareness with product distribution that makes solar lantern distribution particularly challenging.

For operations to be financially sustainable, most organizations use combinations of multiple strategies to achieve scaled distribution. A survey of 20 lantern manufacturers revealed six different distribution strategies: 1) distributor networks: the manufacturer sells directly to major distributors, who take charge of all downstream distribution (75% of manufacturers employed this model), 2) manufacturer-owned retail outlets (45%), 3) MFI/NGO partnerships: the manufacturer works with a partner with extensive local experience to distribute lanterns (40%), 4) institutional partnerships (25%), 5) micro-franchising (25%), and 6) a rental system, where users pay for using the lanterns, but do not own them (15%) (IFC, 2012b). Distributor-based networks are the most common strategy, because if distributors that already operate at scale in a country exist, they can reach a large number of customers through established outlets. This model is not always possible, however, as distributors of other goods may not yet exist at scale in rural areas, they may not be willing to carry lanterns, or they may not be able finance large orders of relatively expensive lanterns. Proprietary outlets ensure that lanterns will be accompanied by qualified consumer education, but such networks are also more time consuming and costly to establish. Manufacturers also commonly partner with non-profit organizations or branches of government to reach rural customers. Such mission-driven organizations often have established networks in rural areas that can be leveraged for lantern distribution.

In all cases where distribution has been successful, the distribution organization must identify the least expensive means of reaching the greatest number of customers possible. It must carefully consider all partners involved in the network and ensure that incentives are aligned to sustain the partnership. The design of the distribution network also has important implications for other important aspects of maintaining a sustainable lantern business: organizations must consider how product distribution will be paired with consumer education, and how they will coordinate after-sales service and repairs.

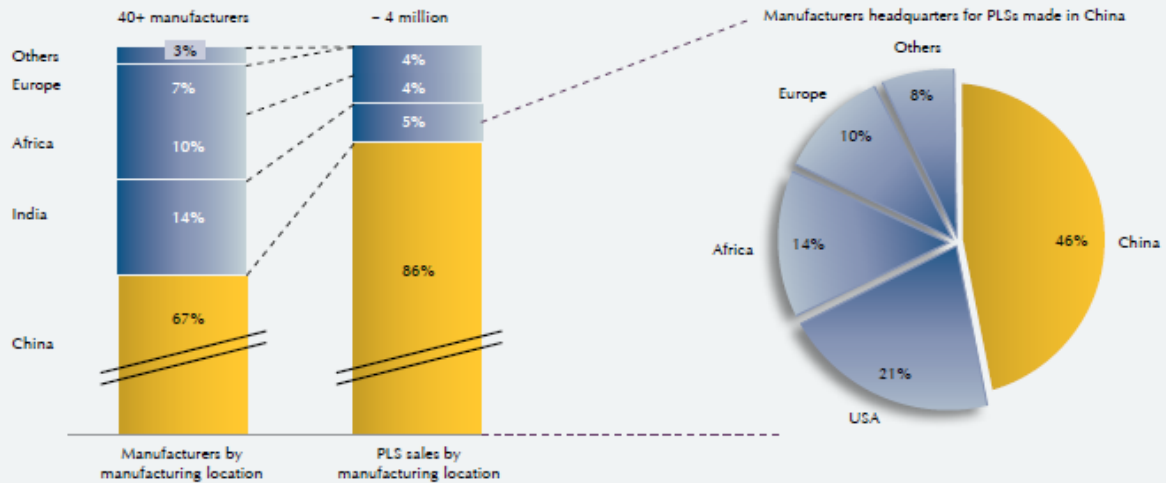
### **Market Barrier #3. Consumer Awareness**

Consumer awareness is an important determinant of success for any solar lantern initiative. Many potential consumers are unaware of quality solar-powered lighting products and the benefits they provide. Among those who are aware of the products, there are many misconceptions that include lanterns being more expensive than kerosene and biomass lighting, which is not the case (IFC, 2012b). Awareness campaigns therefore become vital to convince customers that they are buying better lighting that will improve the quality of their lives in a cost effective manner. There are a number of ways to channel marketing initiatives. Word of mouth remains one of the strongest ways to generate consumer awareness. This approach has been used by Greenlight Planet by making village entrepreneurs called *saathis* market their products. The *saathi* is always a local, and he markets and distributes the lanterns. Leveraging public campaigns is also an efficient way to market your products. Providing warranties may also be a mechanism to increase consumer awareness about your product (IFC, 2012b). As the lantern market matures, marketing and consumer awareness will have a bigger role to play. With large MNCs coming to the forefront, with large investments in and teams dedicated to marketing and consumer research, the focus will shift to brand-building instead of product familiarization.

### **Market Barrier #4. Poor Product Quality & Market Spoilage**

The vast majority of solar lanterns are manufactured in either China (67%) or India (14%) and products from these two countries account for over 90% of global solar lantern sales (Figure 7). China is involved more than strictly as a manufacturer: approximately half of the companies manufacturing lanterns in China have their headquarters there as well. In principle, there is no downside to China-based manufacturing – indeed some of the highest quality lantern companies source their products there – but in the past, some markets have been flooded by cheap products made by Chinese companies (IFC, 2012b). While poor quality products may be affordable for poor populations, the inferior quality ultimately leads to customer mistrust of all solar lanterns: a phenomenon known as “market spoilage.” A market is particularly prone to spoilage if customers are unfamiliar with a product, as is often the case with solar lanterns. Thus, if they or an acquaintance has a bad experience with a lantern, it may taint their impression of all lanterns, not strictly the defective model. Until a market matures, consumers may not be able to differentiate between low quality and high quality goods, and therefore the performance of one product will affect the reputation of all others.

**Figure 16: PLS manufacturing and sales by geography**  
Percentage of total, 2012 (year-end)



1. Database of 40+ major manufacturers with self-reported data for 20-25 manufacturers and estimates for the rest.

Source: *Lighting Africa Sales data; Dalberg Analysis*

**Figure 7. Pico-lighting Systems Manufacturing (IFC, 2012b)**

A major challenge in the global solar lantern market is the lack of a uniform standard that could be used by national governments to direct preferential treatment, or by organizations to determine which products are most suitable for large scale distribution in rural areas. Since its launch in 2007, the IFC's Lighting Global program has sought to combat market spoilage by raising consumer awareness and through the promotion of a quality certification program, whereby manufacturers may voluntarily submit products for testing. Products are tested on the basis of durability, battery longevity, solar panel quality, and truth of advertising (IFC, 2012b). As of the end of 2012, 46 models had achieved the quality verification standard and quality-verified sales had risen to 37% of all sales in Africa from only 6% in 2009.

When entering a new market, lantern distributors must take stock of rural consumers' prior experiences with solar lanterns to assess whether the market has been spoiled by low quality goods. Also, even if an organization distributes a high quality product, they must be careful to pair their distribution efforts with consumer education and after-sales service to ensure proper product usage. Where organizations have failed to educate consumers in the past, studies have shown that users that are unfamiliar with solar technology have failed to properly orient the solar panel toward the sun, resulting in poor performance. In other instances, batteries have been removed from solar lanterns in an attempt to power other appliances or be charged from other sources, such as motorcycle engines (WRI, 2010). It is important to keep in mind that the perception of a product's quality depends as much on the availability of consumer education and repairs as it does on the manufacturing quality of the product.

### **Market Barrier #5. Policy Challenges**

National governments influence most markets in a number of ways, some of them positive for a given industry, some of them negative. Solar lanterns are no exception. Ideally, governments choose policies that make life easier for a majority of a country's inhabitants. In the energy sector in emerging economies, this often means providing subsidies for commonly used fuels, such as kerosene, subsidizing the cost of capital for energy infrastructure development, or imposing import tariffs and taxes on foreign goods to support local enterprise (WRI, 2010). Non-profit and development organizations also influence energy markets by raising awareness of new technology and by distributing subsidized or free products. Finally, companies influence markets by lobbying governments to change policies in their favor.

The most direct policy impact on solar lanterns comes in the form of import tariffs and taxes. A recent IFC report draws attention to the fact that tariff and taxation policies in many countries are hostile to emerging renewable technologies in favor of conventional fuels (IFC, 2012a). For example, in West Africa, import tariffs on solar lanterns can range from 5-30%, and when combined with taxes, can comprise up to half of the cost paid by the end-user. Malawi charges a flat 50% import tariff on solar panels, and India and Cambodia also charge steep duties on solar products (IFC, 2012a). These conditions add considerable challenges to affordable lantern distribution. In certain countries, governments are revising their policies related to renewable energy in recognition of the potential benefits that renewable technology can have for off-grid communities and for the natural environment. Kenya and Tanzania have both made progress toward eliminating discriminatory tariffs on solar product imports, which has partially contributed to the rapid expansion of solar lantern markets in East Africa (IFC, 2012b).

Two other programs that ostensibly favor the poor ultimately harm them by distorting solar lantern markets: the first is the practice in many countries of subsidizing kerosene, which is the primary alternative source of lighting for most un-electrified communities (WRI, 2010), and the second are giveaway programs led by governments or non-profits. In India, kerosene subsidies significantly mask the true cost of the non-renewable alternative to solar lanterns, thereby artificially diminishing demand. Non-profits, seeking to quickly achieve their distribution goals, occasionally give away lanterns at highly subsidized rates or entirely free of charge. While this may help achieve large-scale distribution in the short term, it leads to the perception of lanterns as not having any value and can damage future efforts to build financially self-sustaining distribution networks.

Organizations entering new markets for solar lanterns must assess import duties and taxes associated with solar products, and should proactively engage with the national government to educate officials on the potential health and financial benefits of solar lanterns for off-grid communities. It is also important to identify other charitable efforts that may have spoiled markets through charitable distribution programs. In regions where

free distribution efforts were sustained for long periods of time, it may be very difficult to convince consumers that the benefits of lanterns are worth paying for.

### **Market Barrier #6. After-Sales Services**

After-sales services and maintenance efforts are one of the largest challenges to overcome, as stated various stakeholders. On the supply side, a combination of lantern price points, low levels of product penetration and limited access to the consumers in rural areas have limited manufacturers' ability to provide favorable and comprehensive after-sales services in a cost effective manner. On the demand side, consumers are often unaware that they are entitled to warranty and service, which inhibits demand for such services. This leads to writing off a faulty product as a bad investment without seeking repair or maintenance services. It has also been observed that when consumers do seek maintenance, the complaints arise from improper usage of the products, rather than technical faults within the products themselves (IFC, 2012b).

In the recent years, maintenance has become an integral part of the solar lantern ecosystem. Several existing brands, primarily market leaders such as GreenLight Planet and SELCO India, have begun providing after-sales support to consumers, including basic repairs and technical support, establishment of rural service centers, and replacement of lanterns as per formal warranty agreements (IFC, 2012b). Repairs are generally carried out by technically-trained personnel. Manufacturers typically invest in the distribution network to provide training to local people, following which distributors provide after-sales services to customers on behalf of the manufacturers. This requires significant investment in both training distributors/technicians, as well as managing service centers in different regions (IFC, 2012b). SELCO maintains multiple rural technical centers to cope with maintenance issues (Mukherji, 2011). GreenLight planet maintains a network of rural distributors also known as *saathis*, so that if a lantern stops working it can be returned to these *saathis* who will then pass it on to the centralized manufacturers (IFC, 2012a). Barefoot Power offers repairs by establishing service and repair stations in cooperation with major distributors in its areas of operation. Another manufacturer, Betta Lights, provides regional distributors with stock and training, and has them repair or replace units as needed. Distributors send fault reports and defective components back to Betta Lights (IFC, 2012b). Innovative players are likely to capitalize on modern technologies like mobile phones to develop effective interfaces between customers and after-sales representatives.

### **Case studies**

The previous section presented the numerous significant challenges to establishing self-sustaining lantern distribution networks serving BOP customers. The following case studies serve to highlight four examples of international organizations that have been highly successful at devising solutions to each of these challenges. The case studies gave the Masters Team an opportunity to better understand lantern distribution in action, and



likewise, they are useful tools for orienting readers of this report before they move on to the lantern project design presented in Chapter II.

### **Case Study #1. Greenlight Planet**

At 55% of the world's total, Asia has the largest off-grid population. This translates into 22% of the population in Asia, or 798 million people without access to electricity (IFC, 2012c). India faces the most acute challenge of electricity access in the world with 75 million of its 226 million households off the grid, the largest such demographic globally (IFC, 2012c). India therefore represents a vast BOP market that could potentially be supplied with solar technology. Greenlight Planet is an example of an organization that has been highly successful at tapping this vast off-grid market.

Greenlight Planet Inc. was founded by Patrick Walsh, an undergraduate student at the University of Illinois at Urbana-Champaign. Walsh gained experience with rural India while working for Engineers Without Borders. Launched in June 2009, Greenlight Planet manufactures and distributes photovoltaic lighting devices targeted at people without access to electricity. It began its operations in the northern part of India, primarily in the state of Bihar, and has since expanded to Orissa and Uttar Pradesh (Intellectap, 2012).

Greenlight's major product line is Sun King lamps. The company offers two types of solar lanterns: Sun King Solo and Sun King Pro priced at INR 900 (US\$ 17) and INR 1,600 (US\$ 31), respectively. Cheap solar lamps, often made in China, are available in shops in rural Bihar but they are unreliable and of poor quality. India has a large rural population that uses cellular phones, and people want to be able to charge their phones. People spend a significant amount of money and time on charging their phones. One study found that in rural areas of eastern India, people spent a larger part of their income on charging their phones than actual talk time (Hartnell, 2011). At a one-time price of US \$17 or \$31, the Sun King lantern is less expensive, and considerably brighter than a kerosene lamp. It also incorporates cell phone charging capabilities, and is offered with a one-year warranty from Greenlight (Intellectap, 2012).

Greenlight's customer base is primarily constituted of farmers (58%) and small business owners (23%), with approximately half of its customers earning below INR 3,000 (US\$ 57) per month. Thanks to a unique distribution network, Greenlight Planet has been able to achieve significant market penetration in rural India. Distribution remains one of the most significant market barriers in the solar lantern ecosystem (IFC, 2012b). The distribution network at the grassroots level consists of village-level direct sellers, called Sun King *saathis* (the word means "friend" in Hindi), each of whom is responsible for a group of villages that comprises roughly 2,000 households. *Saathis* are village-level entrepreneurs – they can be farmers, teachers, or housewives, and generally sell the lanterns as an additional source of income. They work for additional hours each evening after their day jobs. These additional hours generally double household income. Since

*saathis* are from the local community, they are known and respected by the villagers. This implies that they have a strong connection with their target customer base, and they can leverage this connection to achieve high market penetration levels. *Saathis* sit down with families, show them the lanterns and the amount of light they give, and help them manage their current expenditures on light and payback period for the lanterns. Apart from the *saathis*, there are also team leaders, district sales managers and regional sales managers that form the higher layers of the distribution network. Full-time team leaders find, train and support the *saathis*. All *saathis* receive training before they set out to sell the lanterns. Four hundred *saathis* now cover 10 per cent of Bihar. When a lot of homes have a Sun King light, the *saathi* becomes so trusted and credible in that village that he is in a good position to sell additional products like water filters or clean cookstoves alongside the lanterns to offer a complete product portfolio that raises the standard of living of the consumers (Hartnell, 2011).

Consistent with other studies, consumer awareness was found to be critical to the success of Greenlight lanterns. Market testing was carried out in a few very poor villages in a van with some prototype lights. Initially, villagers were not very welcoming, and the lanterns were having trouble selling. However, when an NGO field worker was included as a part of the sales team and sent to his own village to try to help the Greenlight team, a large number of lanterns were sold. This exhibited the importance of having locals within the sales and distribution network (Hartnell, 2011).

Greenlight is targeting INR 87.4 crores (US\$ 16.7 million) in revenues in 2013-14 – an exponential growth projection compared to the INR 8.3 crores (US\$ 1.5 million) earned in 2011-12. It plans to consolidate existing operations and establish its presence across India with its sustainable delivery model. It also aims to release an upgraded product every 4-6 months, as well as expand to additional product lines. Greenlight plans to pursue a strategy of horizontal expansion by adding other products such as clean cookstoves to its product portfolio (Intellicap, 2012).

### **Case Study #2. SELCO India**

SELCO India is a Bangalore-based social enterprise that makes photovoltaic solar lighting accessible to BOP populations in India. SELCO's mission is based on a simple but powerful idea of improving the economic conditions of the poor by increasing their productivity (Mukherji, 2011). Over 400 million people in India still lack electricity and depend on polluting, unsafe, and expensive kerosene lanterns for lighting. These consumers spend more than INR 100 (US \$1.9) every month on kerosene for lanterns that provide dim, unsteady light, toxic smoke and a high risk of catastrophic fires (Intellicap, 2012). The core business of SELCO is the design and sale of PV solar-home-systems, principally to provide lighting, but also for devices such as radios, cassette players and fans.

SELCO Photovoltaic Electric Private Limited was founded by Dr. Harish Hande as a commercial enterprise that would sell solar lights in rural India. It began as a subsidiary of Solar Electric Light Fund (SELF) – the sponsor of this Masters Project – and was funded by a U.S. Rockefeller grant of \$40,000. Rural populations in India have average incomes of less than US \$50 per month, making upfront investment in solar lighting, which ranges from US \$200 to \$500, prohibitively expensive (Mukherji, 2011). SELCO recognized this gap in the market, and came up with an innovative business model that would allow villagers to install solar lighting in their homes. SELCO worked extensively with local state-owned financial institutions to ensure that each villager’s repayment pattern was tailored to his individual cash flows. Many poor households who can afford the monthly loan repayments still find it difficult to pay the upfront down-payment. As a pilot, SELCO used part of the 2005 Ashden Award prize money as a “down-payment guarantee”, so that banks were able to loan to customers who could not afford a down-payment. This model has proven to be very successful (Ashden, 2009).

SELCO early on realized the importance of having long term relationships with suppliers for their business. All the components of the PV systems are manufactured in India. PV modules and batteries are imported, but SELCO initially had problems with the quality of CFLs, and so set up a sister-business to manufacture both CFLs and charge controllers (Ashden, 2009). The solar panels are sourced from Tata BP Solar, a leading solar panel manufacturer in India. SELCO tried to diversify their supplier base, but this proved harmful in terms of reliability and quality of the product (Moorthy, 2013).

A typical sales cycle for SELCO starts with gaining an understanding of how much money a customer can pay in monthly loan installments. A SELCO technician discusses with the customer the various costs that he incurs for providing light in his home, both in terms of out of pocket expenses as well as foregone opportunities. SELCO technicians then complete the installation of the PV system per the needs of the customer. SELCO technicians check every solar installation twice a year to ensure that they are in proper working condition. Since the livelihoods of many customers are critically dependent on the solar lights supplied by SELCO, the technicians try to respond to every breakdown as fast as possible. Most of the installations are in remote areas, and this makes maintenance efforts particularly challenging. SELCO has set up a number of rural service centers as part of their sustainable rural delivery model to augment their maintenance efforts (Mukherji, 2011). As of today, SELCO is able to respond to more than half of all maintenance related calls within 24 hours and they are constantly working on ways to improve this number. PV modules supplied by SELCO come with a 10-year guarantee and batteries with a 3-year guarantee: any faults are reported to the SELCO head office, which keeps details of all systems, so that faulty systems can be traced back to the appropriate supplier (Ashden, 2009).

Besides solar home lighting systems, SELCO also manufactures solar lamps that can be used by street vendors to sell their wares at the market. Street vendors however usually do not need lamps for the entire day and therefore would not be keen on investing a large

part of their monthly income on lanterns. SELCO came up with an innovative way to circumvent this problem. SELCO identified entrepreneurs who were willing to buy the lanterns from SELCO. These entrepreneurs then rent the lanterns to vendors for a specific duration. This solar lantern rental system proved to be economical for vendors. The importance of the entrepreneurs is underscored here as well – without them, it would be nearly impossible for the vendors to afford such lanterns (Mukherji, 2011).

SELCO won two Ashden Awards, the first in 2005, and the second in 2007 – an “Outstanding Achievement Award” for its work in lighting the BOP. It was around this period that they decided to join hands with SEWA bank in Gujarat, which has 300,000 female customers. In the next two years, SELCO designed several solar products in consultation with SEWA. This included solar lanterns for the vegetable and fruit vendors who could use it for extending their working hours as well as using it at home, head lamps for midwives and flower pickers, solar caps for laborers and masons, and a smokeless stove for cooking. SELCO’s partnership with SEWA allowed them venture away from their primary product line to explore new lines, making them an all-round energy product company (Ashden, 2009).

More than 15 years after it was founded, SELCO has achieved its mission of being a sustainable energy provider to impoverished populations, increasing their productivity and improving their quality of life. In the future, the firm is focusing its strategy on replication of its proven model rather than expansion, although it is exploring an expansion into mini-grids. The management feels that a small business model is ideally suitable for the kind of work that SELCO does. Scaling up will imply standardization, which is against SELCO’s fundamental business tenet where solutions are customized keeping in mind the context and needs of the end customer (Moorthy, 2013).

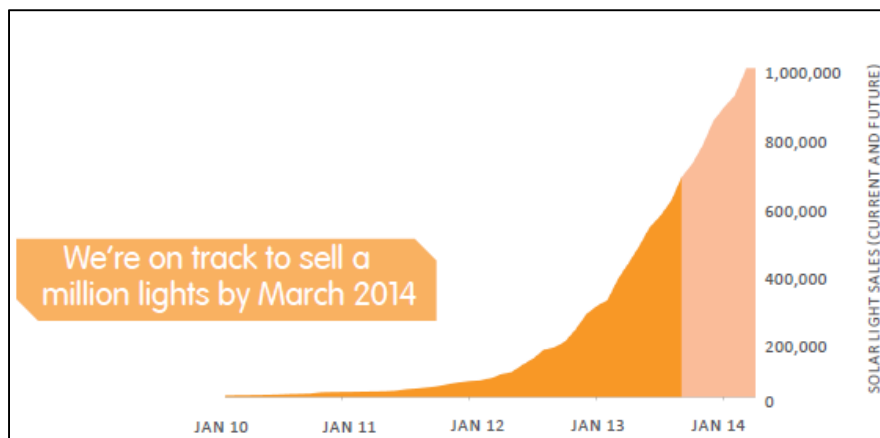
### ***Case Study #3. Sunny Money***

The electrification problem in sub-Saharan Africa is particularly grave, with 600 million people lacking electricity (91% of the rural population). As a result of the lack of electricity, 290 million people in Africa rely on kerosene to provide light for work, socializing, and studying in the evenings. According to SolarAid’s research, burning a single kerosene light in the home per day has a health impact equivalent to smoking 40 cigarettes for those who are subjected to the fumes (SolarAid, 2013a). This contributes to the 400,000 annual deaths attributed to indoor air pollution in sub-Saharan Africa. Kerosene also presents a financial challenge for BOP families, accounting for an average of 10-15% of annual household expenditures, which in the United States is equivalent to US\$ 5,000 to US\$ 8,000 for lighting services alone (SolarAid, 2013a).

Sunny Money was founded as a commercial arm of the U.K. non-profit SolarAid in 2010 to address the lack of electrification in Africa. SolarAid believed in the importance of philanthropy in opening up markets to new technologies and ideas, but recognized that a commercial approach could allow solar lantern distribution efforts to scale more quickly

(Ashden, 2013). The for-profit approach embraced by SolarAid through Sunny Money opened the door to new sources of funding from enthusiastic donors who were supportive of an innovative new approach to solving the electrification challenge. New contributions came from major companies, including Barclays Bank and the Man Group, as well as individual donors (SolarAid, 2013b). SolarAid launched Sunny Money specifically to help the non-profit achieve its goal of completely eradicating kerosene lamps from Africa by 2020. Four years after its launch, Sunny Money believes that it is on track to making this ambitious goal a reality.

Sunny Money stands out as a pioneer of solar lantern distribution. By the end of 2013, the company had sold almost 800,000 lights in Tanzania (57% of sales), Kenya (27%), Malawi, and Zambia (16% of sales between both countries). By the end of 2012, the exponential rate of sales achieved by Sunny Money put the company in the number one position for total lanterns distributed in Africa, edging out the previous title-holder, French oil company Total (Andrews, 2012). The extent of the company’s success is shown below in Figure 8.



**Figure 8. Sunny Money lantern sales (SolarAid, 2013a)**

Sunny Money owes its success in part to the power of its “Student Lights” campaign. In late 2010, shortly after its launch, Sunny Money launched a campaign focused on schools as sales hubs, teachers as marketing associates, and students as target customers. With approval from local educational authorities, the company organized meetings at centrally located schools, inviting head teachers from the surrounding region to attend. In these initial meetings teachers were educated on the health, financial, and other benefits of solar lanterns and encouraged to make sales pitches to their students. Within two weeks, Sunny Money contacted teachers to collect orders, which were shipped via public transportation to participating schools. Teachers were awarded free lanterns for orders of 40 lanterns or more (Ashden, 2013). This approach was so successful that following an expansion to Tanzania’s Arusha and Kilimanjaro regions in 2012, the Sunny Money operations director stated that: “Demand has far exceeded our ability to supply, and several times we have had to stop campaigning to wait for more lights to be imported. Even so sales have been

running at 150% of budget resulting in over 50,000 solar study lights benefiting students in these two regions alone” (Lighting Africa, 2012).

Sunny Money is careful to only offer products that have passed Lighting Africa quality certification testing. Their selective portfolio includes products from d.Light, Greenlight Planet, and Barefoot Power, ranging from US \$7 to \$40 retail price depending on the model. Most lanterns are equipped with cell phone charging capabilities. To ensure customer satisfaction and avoid market spoilage, every product comes with either a one or two-year manufacturer warranty, and a call center fields calls from customers who have experienced problems with their products. Overall, following a random phone survey of past customers, Sunny Money recorded a 93% satisfaction rate with 74% of customers reported as “very satisfied” (Ashden, 2013).

The company’s goal for 2014 is to sell over 1,000,000 lanterns in one year (SolarAid, 2013a). Currently all sales are cash in advance, but managing director John Keane is pursuing a variety of options for offering pay-as-you-go financing plans. As Sunny Money expands around Africa, new distribution models are also under development, including using a network of franchisees to sell products through local entrepreneurs (IFC, 2012a).

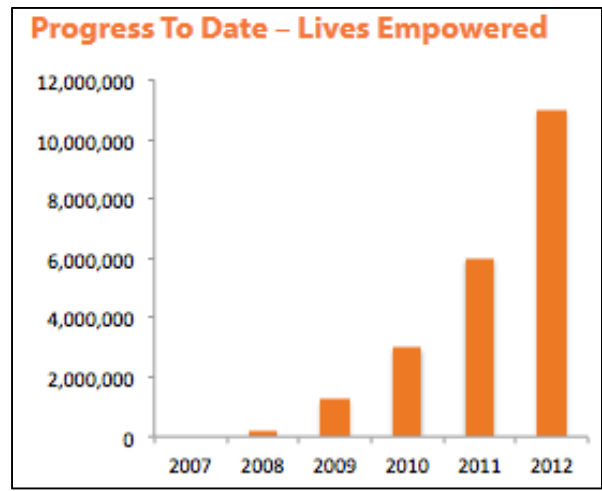
#### ***Case Study #4: d.Light***

d.Light Design is a prominent solar lantern manufacturer, founded in 2007 by Stanford Graduate School of Business students Sam Goldman and Ted Nozun. Because of its emergence from a leading business school, d.Light has pursued a Silicon Valley startup model of attracting top tier talent and venture capital. The company’s inexpensive and durable lanterns have helped open previously inaccessible markets to solar lanterns by making them affordable and suitable for BOP customers in remote regions of the developing world.

While on a Peace Corps mission in Benin, Africa, Goldman witnessed the severe burning of a neighbor’s child when a kerosene lantern overturned in their home. This experience prompted Goldman to enroll in an “Entrepreneurial Design for Extreme Affordability” course at Stanford, where he and co-founder Nozun came up with the design for d.Light’s first solar lantern product. In 2008, the pair managed to secure \$6 million in Series A venture capital funding from conventional and impact investors including Acumen Fund, Nexus Venture Partners, Gray Matters Capital, Draper Fisher Jurvetson and Garage Technology Ventures. As a result of the company’s early success in building a company that spanned manufacturing in China, design in San Francisco and Hong Kong, and offices in India and Kenya, a further \$5.5 million round of capital was raised in 2010 (d.light, 2010). Only five years into its operations, d.Light now has a management team that includes a legion of top executives, including CEO Donn Tice, U-M Ross School of Business graduate with 30 years of experience in global management roles; CFO Al Wood who has led the

successful IPOs of multiple tech companies; and VPs with decades of experience in product distribution, microfinance, and management of Fortune 500 companies (d.light, 2013).

Building on its sturdy financial backing and experienced leadership, d.Light has managed to expand its operations to over forty countries and sell over 12,000,000 lanterns (Figure 9). The company now has 10,000 retail outlets, ten field offices, four regional hubs, and dozens of partnerships with major companies to distribute its products. A partnership with Total, the French oil company, that began in 2013 allowed d.Light to expand its operations exponentially. Total agreed to distribute over 500,000 lanterns per month in Africa as part of its “Access to Energy Program” (Zweynert, 2013). The partnership with Total and other major customers has convinced d.Light that it should dream big: the CEO has announced a goal of providing 50 million people with clean energy from their products by 2015 and 100 million by 2020.



**Figure 9. D.Light’s Phenomenal Growth Rate (d.light, 2013)**

The core innovations that have made d.Light’s products successful from the beginning are their low price point, durable design, manufacturer warranty, and constant innovation using cutting edge technology. For example, d.Light’s latest products retail for between \$8 and \$40 depending on the model; can be rained on, covered with dirt, stepped on, or even run over by a car; come with a two-year warranty; and employ state-of-the-art lithium-ion batteries that last for 10 years and LEDs that are 20% more efficient than those used in earlier products (d.Light, 2013). As an example of how important durability is for product uptake at the BOP, one d.Light entrepreneur explained a recent experience with a lantern:

A group of students traveling back from Gulu to Kitgum [Kenya] (...) had a flat tyre [sic] on the road. It was after 7 p.m. and one of them had the d.Light S1 reader which he placed on top of the car to give them light as they changed tyres. (...) They forgot the light on top of the car and [it] toppled down and was run over. (...) The stand was completely flattened; the light had dust particles pressed into it, but (...) it didn’t break and it was still lighting (...). Needless to say all other occupants of the car ordered for their own immediately. They are spreading the news (d.light, 2012).

In addition to relying on a durable and inexpensive design, d.Light employs a thoughtful and varied approach to product distribution. Partnerships like the one with Total comprise an important source of orders, but d.Light also distributes products through proprietary outlets, retail chains, and franchises that employ micro-entrepreneurs

(IFC, 2012b). The company learned early on that selling lanterns through retailers that offered wide arrays of other lighting products was not necessarily beneficial: they did not have the time to educate consumers about the unique benefits of the new design. Moving to more selective retailers, proprietary outlets, and company-trained entrepreneur networks allowed the company to take off in Africa, India, and Southeast Asia (Shah, 2013).

### **Solar Lantern Projects in Haiti**

A number of organizations and programs are already working to address the Haitian energy access problem by selling or distributing solar lanterns. Through researching the nature and outcomes of these solar lantern programs, the Masters Team hoped to identify potential partners for the SELF lantern project and to gain familiarity with the existing lantern distribution landscape. The following profiles briefly discuss ongoing efforts in Haiti. The past distribution efforts of Micama Soley, the organization with which the Masters Team ultimately developed the distribution project, are not featured in this section as they are discussed at length in Chapter II.

#### ***Project #1. Global Sustainable Electricity Partnership***

Global Sustainable Electricity Partnership is a non-profit organization that promotes sustainable energy development through electricity sector projects and human capacity building activities in developing and emerging nations worldwide (GSEP, 2013a). Since its inception in 1992, it has worked in collaboration with United Nation agencies, key international organizations and numerous local partners to enhance clean energy access and reduction of fossil fuels consumption by the poorest populations of the world without pursuing commercial gain. During the United Nations Rio +20 conference in 2012, Global Sustainable Electricity Partnership partnered with the Global BrightLight Foundation to provide 50,000 portable solar lanterns to off-grid households in developing world, including Haiti, that have no electricity access. Out of the 50,000 lamps, 10,000 will be distributed in rural Haiti to off-grid families through a close partnership with EarthSpark and its local subsidiary Enèji Pwòp (Haitian creole for “clean energy”) (GSEP, 2013b).

The lantern model chosen by Global BrightLight Foundation and Global Sustainable Electricity Partnership was the Greenlight Planet Sun King Pro solar-powered lantern (Figure 10) due to the model’s reliability and convenience (Global BrightLight Foundation, 2013). Sun King Pro is able to charge cell phones the simultaneously when providing illumination for the users. Three different light modes allow users to adjust brightness accordingly from twenty lumens to ten lumens (Greenlight Planet, 2014). The photovoltaic charging panel of Sun King Pro is about the size of a tablet and stores electricity in a lithium-ion battery pack that can be fully charged in about four to six hours of daylight. This solar lantern model can provide stable lighting with its light emitting diode (LED) illumination that is at least twice as bright as a typical kerosene-fueled lantern. The lantern can provide up to sixteen hours of light with a full charge, depending on use (Global





**Figure 10. Greenlight Planet Sun King Lantern Model**

BrightLight Foundation, 2013). With a water-sealed cover, Sun King Pro can be used safely indoor and outdoor under various weather conditions. The expected lifetime for this solar lantern model is relatively long, with a battery life of five years, LED life of ten years, and a two year warranty for the complete product (Greenlight Planet, 2014).

Instead of distributing the lanterns to rural families for free, lanterns were sold for a reasonable price to ensure that people would take ownership and responsibility for the lanterns, and use them with care. Global Sustainable Electricity Partnership and Global BrightLight Foundation have been working closely with local partners ever since the launch of the project. They get to the field to select

locations suitable for the project, connect with local partners in order to provide better services to users regarding sustainability aspects such as repair and replacement. Locations selected for this project are areas with very slim probability of installing distribution wires or even a micro-grid. Lanterns are distributed by selling through the Haitian brand Enèji Pwòp. Local entrepreneurs supported by Global Sustainable Electricity Partnership and Global BrightLight Foundation are involved in the lantern distribution process. Through distributing affordable solar lanterns, local entrepreneurs are able to earn more income for their family than was previously possible. Families that purchase lantern from these local entrepreneurs are also benefit economically and socially. Before owning solar lanterns, most families need to collect wood or purchase kerosene to burn for light. Solar lanterns are able to provide these families with reliable light whenever they need it. Also, children will have a healthier indoor environment for living without all the toxic emissions from wood and kerosene burning (GSEP, 2013c).

### ***Project #2. WakaWaka***

WakaWaka (“Shine Bright” in Swahili) develops, manufactures, and markets high-tech, low-cost solar powered lamps and charges in both developing developed world. The patented solar technology developed by WakaWaka and its partner Intivation have resulted in the development of two different models: WakaWaka Light and WakaWaka Power (WakaWaka, 2014). This Netherlands-based solar company aims to deliver 50,000 renewable energy lamps to light up the lives of more than 250,000 people currently without access to electricity around the globe (TheGrio, 2013). In Haiti alone, around 12,000 lamps have been distributed to date (WakaWaka, 2013a). The project was initially

piloted at a partner school in Kenya and Haiti was the second location chosen for the pilot distribution program (Gestel, 2013).

The model distributed in this project is the WakaWaka Light solar lantern (Figure 11). The WakaWaka Light model has a very light body weight of approximately 200 grams. With a 0.5W, 120 lumen/watt LED light, the model is able to provide 8 hours of light at the brightest setting after a full charge (WakaWaka, 2013b). Each lamp is equipped with three different light intensity modes and is fully recharged when placed beneath the sun for a few hours (WakaWaka, 2013b). WakaWaka Light is supported by 800 mAh NiMh AAA-size batteries, which can last for at least three years, the solar cell installed is 0.75W monocrystalline that can last for ten years. The model also include extra functions, such as an SOS emergency signal, auto energy saving setting, and 200% torch mode which switches back to 100% brightness after 30 seconds. WakaWaka provides a one year warranty for the model, and with a water-resistant cover, WakaWaka Light is designed to provide safe solar power through the entire night.



**Figure 11. WakaWaka Light model in different configurations**

WakaWaka employs a buy-one-donate-one model that has been successfully implemented by other brands such as the shoe company TOMS (Park & Marquis, 2014). WakaWaka sells its solar lantern models in developed economies at a competitive price, the purchase of each lantern will subsidize another lantern to be given to the UN Refugee Agency (UNHCR) and other organizations for distribution to areas in the world without electricity access (TheGrio, 2013). WakaWaka believes that the combination of business and aid is the best way to generate positive impact. Part of the revenue WakaWaka gains from selling lanterns in wealthier countries is used to make their products available to off-grid communities around the world at an affordable price (WakaWaka, 2014). As the company's business model matures, WakaWaka is trying to expand the buy-one-donate-one campaign to a buy-one-donate-two model in the future. The rationale behind the use of partner organizations is that lanterns can be distributed to the people in with the greatest level of need. In the future, the WakaWaka company plans to build an assembly plant in

Haiti to manufacture these lights so that it can supply the American market, with an estimated 100 jobs created once the plant is at full production capacity (TheGrio, 2013).

WakaWaka is doing beyond just simply provide aid to the poor. The buy one, get one free campaign provides people in the developed world an easy and effective opportunity to help people struggling without electricity. This business model creates a bridge between rich and poor, and relieves some financial burden from WakaWaka by letting wealthier buyers subsidize the poor. Furthermore, this arrangement helps make consumers in wealthy countries aware of extreme poverty. If successful, the plan of opening a manufacturing plant in Haiti could be a win-win for both WakaWaka and Haitian communities. Having an in-country manufacturing plant will save WakaWaka future transportation cost for lanterns to get to Haiti. Along with the construction of plant local people will get more familiar with their solar lantern products, learn more about the benefits, and in turn will be more willingly to own the product in the future. For the community, having a manufacturing plant that provides job opportunities will allow locals to earn a stable income in a new way. Trainings are expected to provide with new jobs, giving local employees a chance to build up new skills and gain experience with advanced solar technology.

### ***Project #3. Let's Share the Sun & Phocos North America***

Let's Share the Sun Foundation (LSTS) was formed in 1985 by two University of Notre Dame graduates Nancy Brennan-Jordan and William Jordan. LSTS aims to facilitate the use of solar energy in poor communities around the world since the technological innovation made solar panels more efficient, smaller, and less expensive consequently improving the lives of the poor and underserved (LSTS, 2011). The Foundation helps install solar power in poor regions of the world that are rich in solar resources but lacking in electricity infrastructure.

Following the 2010 earthquake in Haiti, LSTS set out to provide Haitian schools with an affordable, high-quality, durable lighting solution. After meeting with representatives from Phocos North America in 2012 and learning more about their products, LSTS found the ideal solution: the Phocos Pico Lamp (Figure 12). The Pico Lamp is a lighting device specially designed to meet the needs of rural households. The model has three lighting level settings allowing users to adjust lightness accordingly, and it is also equipped with a function that automatically reduces brightness when batteries are low to conserve energy



**Figure 12. Phocos Pico Lamp**

(Phocos, 2014). With four 2,100 mAh AA-size NiMH batteries that can endure more than 500 charging cycles, the Pico Lamp is able to provide light for up to 55 hours after a full charge. With a 7V to 25V solar module, the lamp can be fully charged in three to five hours depending on the solar radiation received. This model also provide users with an option to charge their cell phones with solar energy, normally a cell phone can be fully charged in approximately two hours.

In 2012, LSTS began by donating 35 Pico Lamps to families of students of the George Washington Carver Academy in Leogane, Haiti. After this donation, LSTS expected to start a large campaign distributing solar lanterns with phone charging capabilities to schools in the poorest regions of Haiti. According to Brennan-Jordan, LSTS co-founder, the purpose of distributing these lanterns was not only providing light for individual families, but also encouraging students to stay in school. In addition to having access to a clean source of lighting, lantern owners can also generate revenue by offering phone charging services for a small fee (Phocos News, 2013).

Phocos, headquartered in Germany, is one of the world's leading manufacturers of solar charge controllers and components for autonomous power supply. Phocos is active worldwide and provides a wide range of products in developing countries including charge controllers for solar street lights and rural home support in India, Bangladesh, and Nepal. They also supply the Pico lantern systems that LSTS is distributing in Haiti. The Pico Lamp is equipped with a high-efficiency power LED and a USB charger (for cell phones, MP3 players, and others). In 2013, Phocos and LSTS supplied 138 Pico Systems for lighting schools in mountainous areas of Haiti (Phocos, 2013). LSTS depends on campaign funding to support all the lanterns, and thus the growth of solar lantern distribution is limited and depends on the campaign outcome. LSTS is actively developing campaign plans to raise more funding for the project, and is expecting to expand its operations to serve more Haitians in the near future.

### **Haiti: Looking to the future**

As a country with more than half of its population lacking reliable electricity access, Haiti needs as much assistance as it can get to meet its basic resource needs. Due to its relatively small population and isolation from larger at-risk populations in Africa and Asia, Haiti has received insufficient attention from large NGOs that are working to address energy access issues. Solar lantern distribution projects in Haiti thus far have been limited in scale compared to projects elsewhere in the world. Luckily, non-profits like Global Sustainable Electricity Partnership, WakaWaka, and Let's Share the Sun Foundation are helping to draw the world's attention to Haiti. So far, Haiti has received some attention, but not enough. Larger projects are still necessary to help Haiti seriously address its lack of access to electricity and the services that it provides.

The solar lantern project initiated by SELF in partnership with this Masters Project will be one positive step toward addressing Haiti's energy needs. Besides providing the off-grid community with affordable lanterns, SELF's project also comes with financial aid plan and a sustainable business model. Looking to the future, SELF's solar lantern project is expected to serve particularly impoverished rural areas in central Haiti and achieve a self-sustaining distribution network that should allow it to remain independent of philanthropic donations from outside the country.

## **CHAPTER II. The Solar Lantern Project in Haiti – Strategy in Action**

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### **Introduction**

Chapter I of this document presented the results of the exhaustive research – primary and secondary – that were performed over the course of the Masters Project. It sought to orient both the team and the project advisors to the challenges posed by a lack of electricity at the BOP and the array of technological solutions available for addressing those issues. It presented self-sustaining business models as an effective approach to lantern distribution, outlined the major challenges often encountered when trying to serve BOP markets, and presented four case studies of internationally renowned lantern distributors and three studies of local operations in Haiti. As a result of our extensive research, the Team is now extremely well versed in the nuances of the solar lantern industry, as well as the challenges faced by practitioners on the ground in Haiti.

Against this research backdrop, the Masters Team has been working steadily since late 2013 to find a suitable solution to our project client’s dilemma: how to build a sustainable distribution network for solar lanterns in Haiti that conforms to the guidelines established by the IDB – the agency funding the project. Over the past few months, we have worked with SELF and an important partner, Micama Soley, to draft a distribution plan that promises to help SELF to meet its grant obligations to IDB, satisfy Micama’s financial imperatives, facilitate the immediate distribution of roughly 5,000 solar lanterns in rural Haiti, and lay the foundation for a program that can be sustained indefinitely. This is a tall challenge, but thanks to the concerted efforts of all involved partners, the Masters Team believes that the chances for success are high.

Chapter II provides a detailed analysis of the project that has emerged from planning sessions with all involved partners. Our assessment of the benefits and drawbacks of the program will be left for Chapter III, while Chapter IV will address the risks and recommendations that should allow for successful project development. The goal of this document is not only to satisfy an important requirement of our Masters Project, but to outline to the best of our abilities the steps that SELF and their partners in Haiti must take to move the project from concept to reality. The actual development of this project will depend on the continued efforts of SELF and their partners to put this plan into action and overcome the many challenges that will inevitably arise from the intrinsic difficulties of the project or from misaligned interests between the numerous project partners.

The structure of Chapter II is as follows: we first provide an overview of the lantern distribution project (“project”), followed by sections that take deep dives into important topics, including the specific products that were chosen for the project, the financing mechanisms that enable the business model, the training program for entrepreneurs, the distribution network, and how the challenges of consumer awareness and maintenance will be addressed.

## SECTION 1. Project Design

### Overview of the Project Design

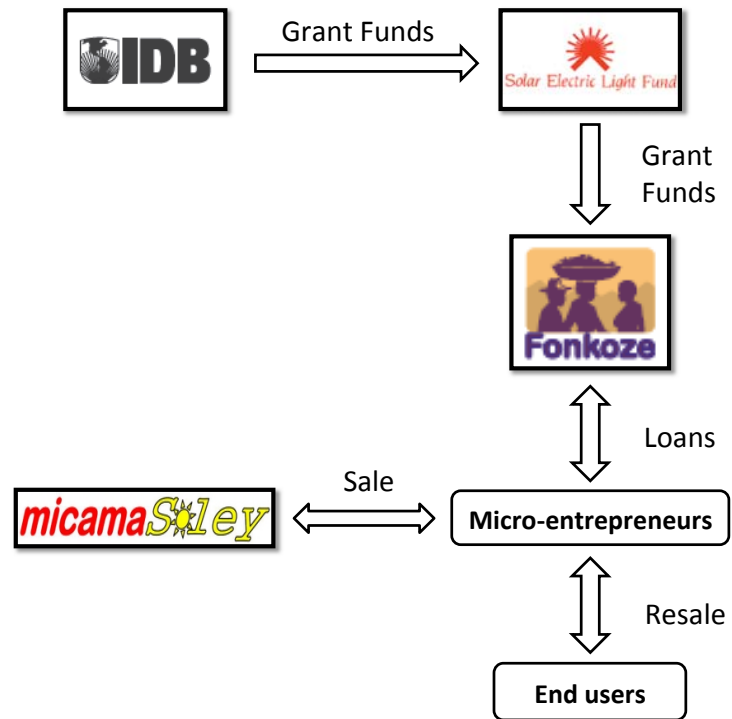
Prior to beginning their collaboration with this Masters Team, SELF received a grant from the IDB with roughly \$150,000 earmarked for a lantern distribution project in Haiti. A portion of the grant was dedicated to administration and training, while the remainder was reserved for the purchase of lanterns. By the time import tariffs have been paid to the Haitian government, roughly 5,000 lanterns will be available for purchase and distribution. An important goal for the Masters Team was not simply to build a network that would allow SELF to distribute the relatively small number of lanterns and move on, but to build a model that could be sustained indefinitely into the future. To accomplish such a lofty goal, it was necessary for us to pursue an explicitly for-profit model that could be financially self-sufficient and explore private enterprises as potential on-the-ground partners.

Although SELF has extensive experience working on renewable-powered electrification projects in rural Haiti, the organization's primary area of expertise is not lantern distribution. Consequently, SELF's management was very receptive to the possibility of the Masters Team spearheading the distribution plan for the solar lantern portion of the IDB grant. With the objective of presenting SELF with the best distribution plan possible for the project, the team has spent the past year engaging with practitioners in Haiti and abroad. The result of these efforts has been the Masters Team-driven formation of a partnership between SELF and Micama Soley, a Haitian company established with the explicitly "social" goal of helping Haitians improve their lives through appropriate technology (Micama, 2014). The backbone of the project is the SELF-Micama partnership, but it will also involve a major Haitian microfinance institution, an international sustainable energy developer, and an industry-leading solar lantern manufacturer. Each of those partners and their roles will be explored in detail in this document with a flow diagram represented in Figure 13.

Despite only having been in existence since 2009, through its own direct retail network and strategic partnerships, Micama Soley has surpassed the 100,000 unit mark in Haiti for solar lanterns distributed to the Haitian BOP. Part of the reason for this rapid success is due to Micama Soley's origins as an offshoot of SAFICO, a major mattress manufacturer and distributor in Haiti for the past 60 years. Tom Adamson is a transplanted Canadian who oversees the operations of both SAFICO and Micama Soley as President and CEO. Under Adamson's leadership, Micama Soley has built a strong network of partnerships with microfinance institutions, international aid organizations, solar lantern manufacturers, and providers of village-level entrepreneur training.

Micama's expertise in rural lantern distribution is unparalleled in Haiti, as the 100,000 distributed lanterns demonstrate. Other efforts have had limited success, but as was outlined in the case study section in Chapter I, none have attained a similar scale of

distribution. Not all of Micama’s lanterns have been distributed directly by the company. In fact, for the vast majority of its lantern sales, Micama has leverage existing networks, including that of SAFICO, to reach “last-mile” customers as efficiently as possible. Micama’s existing network in Haiti, its expertise in lantern distribution, and its history of successful partnership have led the Masters Team to the conclusion that they are an ideal partner for SELF in implementing the solar lantern project. The Masters Team was introduced to Tom Adamson through a mutual connection in the solar lantern industry, and since that point all efforts have been dedicated to facilitating a partnership between Micama and SELF, as well as designing the specifics of the project’s structure.



**Figure 13. Project Design Flow Diagram**

Under the current project design, rather than directly purchasing lanterns with grant funding, SELF will partner with Fonkoze, a prominent Haitian microfinance institution, to establish revolving loan funds for micro-entrepreneurs. Per the SELF-Micama agreement, Micama will purchase a quantity of lanterns exactly equivalent to those that SELF would have purchased under the original provisions of the grant. The revolving grant programs at the MFI will make funds available to a network of micro-entrepreneurs who will use the dedicated loan program to purchase lanterns from Micama. Although lantern distribution will ultimately depend on the network of entrepreneurs, they will receive extensive sales training from Micama based on its already proven model, and coaching from the MFIs to help them manage their finances. The partnership hopes to bring 200-300 new entrepreneurs into the existing Micama network, greatly expanding its current sales capacity. Adamson estimates that such a network could successfully distribute all 5,000 lanterns in less than twelve months.

The remainder of this chapter examines the most crucial aspects of the project in detail: the distribution plan, program financing, marketing and consumer awareness, product selection, and product maintenance.



## Distribution Plan

Secondary research for this project shows that distribution challenges can pose a major impediment to establishing a successful solar lantern distribution business. In most cases, solar lantern users in the BOP are located in remote rural areas that are accessible only by dirt roads or sometimes disconnected entirely from national road systems. Similarly, there are very seldom reliable third party logistics companies (3PLs) with regular distribution routes whose services can be purchased to help move goods to remote areas. Most lantern distributors are required to build their own networks from the ground up, making all capital investments and providing all personnel training themselves. Access challenges increase costs, as does the lack of established partners to help transport products from distribution centers to end-markets. Underlining the importance of building an effective network, David Small, managing director of d.Light Africa, recently stated that “product is king, but distribution is God” (Adamson, 2014).

These challenges can make a solar lantern project unviable unless it is able to manage the cost of its operations and establish a system of reaching last-mile customers. For the SELF project, it was important to minimize the impact of distribution on the organization’s limited resources in Haiti. Purchasing vehicles and hiring a lantern sales team was not an option. Luckily, Micama has over 60 years of experience distributing products in Haiti through its affiliated mattress business. The distribution portion of the project will be entirely handled by Micama and their partners, relieving the need for SELF to build its own network.

To minimize its own costs, rather than transporting goods from its warehouse to remote villages, Micama leverages its partnership with micro-entrepreneurs around the country to reach last-mile customers. When distributing lanterns in the past, Micama sells them to micro-entrepreneurs who make the ultimate delivery of the product to BOP consumers. Micama has a series of routes that it operates with a truck stocked according to orders they have received from their entrepreneur partners since the last delivery. The country is divided into nine such routes that connect Micama’s central operations in Port-au-Prince with major cities around the country. Micro-entrepreneurs place orders with Micama via mobile phone, and arrange to meet with the company truck as it passes near the area that they serve. Micama typically stocks its trucks with a surplus, knowing that impromptu sales will occur over the course of the distribution trip. For their own transportation, entrepreneurs usually purchase small enough quantities of lanterns to put them on the back of motorcycles, or other modes of transportation commonly available in remote areas.

This system allows the costs and logistics of bringing products to market to be distributed between two key partners – Micama and the network of micro-entrepreneurs. Each entity manages their own costs and accounts for them in the prices that they charge the next link in the supply chain. The role of the micro-entrepreneurs in this system is

crucial. This is a key value of Micama – not only do they already have an established network of entrepreneur partners, but they have direct connections to many more through their engagements with Fonkoze and CARE International – another non-profit operating nationally in Haiti.

For this system to function, other components are necessary. In particular, financing allows entrepreneurs to purchase quantities of lanterns that would otherwise be impossible, and training provided by Micama ensures that they will be able to clearly communicate the benefits of solar lanterns to the end-users.

### **Program Financing**

Program financing for the SELF-Micama Soley solar lantern project is a crucial piece for the success of the program, both in the short term and in the long term. There are three major partners in the program: Fonkoze, Micama, and SELF. Fonkoze is the largest MFI in Haiti, with branch offices all over the country. Due to its size, it is able to reach the country's poorest and most remote regions and serve more than 200,000 BOP clients with a full range of financial services. In addition, it provides over 60,000 women with microloans, business training, education, and health care services (Fonkoze, 2012). Fonkoze has collaborated with Tom Adamson and Micama Soley on prior projects, and they have established a solid working relationship. This also makes Fonkoze an ideal partner for the microfinance aspect of the project.

The SELF-IDB grant awards a total amount of \$ 150,728 towards the solar lantern project, out of which approximately \$100,000 is allocated towards purchase, shipping, customs and storage of lanterns. A further \$30,000 is allocated to implementation and distribution and \$13,000 are allocated to monitoring and evaluation of the program. The Masters Team and Tom Adamson jointly came up with a unique financing plan to make use of the budgeted funds in the most efficient and convenient manner. Details of that plan are outlined below.

The total landed value of the lanterns must be \$100,000 to comply with the grant. That budgeted amount must cover the product order, shipping, handling, and Haitian customs fees. Rather than purchasing the lantern equipment, SELF will transfer the \$100,000 to Fonkoze to set up a revolving loan fund for the last mile micro-entrepreneurs. Micama Soley will then purchase lanterns worth \$100,000 and sell them to the micro-entrepreneurs, who will use the small scale loans from Fonkoze to make their purchases. The micro-entrepreneurs will pay back the loans in monthly installments of around six to twelve months, at a pre-determined interest rate. Micama Soley will recover its investment in the lanterns from sales to the entrepreneurs. Fonkoze will recover all the money from the monthly loan repayments made by entrepreneurs, plus an additional interest premium. Thus, assuming this system works, each partner in the network not only covers the costs associated with their involvement, but is even able to earn a small profit. Once they have

purchased anywhere from one to twenty or more lanterns, the micro-entrepreneurs will then travel to rural villages in the Central Plateau and resell them to the end-users, recovering their investment and ensuring their ability to satisfy the requirements of their loan. The end-users buy the lanterns from the micro-entrepreneurs through a one-time upfront payment.

As other sections of this report have pointed out, the US \$15-\$25 that an end-user might pay for a lantern is sometimes too much for poor BOP families to manage. Because of this, the feasibility of end-user financing and a temporary lantern consignment model were also investigated. Based on prior experience with lantern distribution in Haiti, Micama Soley determined that the costs of administering an end-user finance scheme currently make such an arrangement impossible. The microscopic size of the loans, the challenges of communicating with rural populations, and the lack of creditworthiness of most rural families all drive up the costs of end-user financing programs. In other countries, such as Kenya and Tanzania, mobile payment technology has enabled an expansion of end-user financing. To be successful, however, those networks require thousands of “registered agents” who can use their phone to make payments on behalf of small-scale debtors. In Haiti, there are only a few such agents, and almost all of them are located in Port-au-Prince, far from where they would be needed in the Central Plateau.

Another strategy that was explored to try to lower the cost barrier of the lanterns is to give the lanterns on credit to the end-users for around two weeks, after which the end-users decides whether he wants to purchase the lantern or not. This allows families to understand the significant positive impact that lanterns will have on their lives before they are required to commit to a purchase. Once they see that they will break even with the purchase of a lantern within a few short months thanks to lower expenditures on kerosene, candles, and batteries, oftentimes no further marketing is necessary. As Chapter I showed, many families already spend significant portions of their income on energy services, and although a lantern is a sizable investment, the biggest challenge solar lantern entrepreneurs face is communicating lantern benefits – not the fact that families are completely unable to afford them. The temporary consignment strategy is particularly helpful in areas where lanterns were previously unknown and therefore have no local champions to communicate their benefits to their peers. Micama has already tested this strategy with great success and will encourage all entrepreneurs to follow this approach during their Micama-sponsored training sessions.

Micama Soley’s previous projects have had a gross profit margin of 32%. Assuming a wholesale lantern price of US \$10, the sale price per unit to the resellers will be \$14.70. It is estimated that micro-entrepreneurs charge a 15% premium for final sale to the end-user, implying a final price of about \$18 per lantern. It is important to recognize the existence of two separate profit margins in the sale of the lanterns – one at the bulk level and one at the

retail level. Although the existence of two premiums increases the final price to end-users, prior Micama projects in Haiti have demonstrated that this is not an impediment to trade.

### **Marketing, Consumer Awareness, and Entrepreneur Training**

The marketing and consumer awareness aspect of the project will be managed through a partnership established between Micama and Fonkoze, and supported by Global Partnerships (GP). GP is a nonprofit impact investor that invests in solutions that alleviate poverty and economically empowers underprivileged communities in countries in the Latin American and Caribbean region (Global Partnership, 2014). GP has invested in Fonkoze's operations in health, micro-entrepreneurship and more recently in green technology, through which the solar lantern access has been made possible. Fonkoze's micro-entrepreneurs receive training through Micama's established training process whereby Fonkoze's borrowing group "chiefs", become retailers of solar lights. This gives participants access to a supplementary source of income (Global Partnership, 2014). In the partnership between SELF, Fonkoze, and Micama, the support that GP provided will come from a share of the IDB grant directly to Micama which will then train micro-entrepreneurs. Micama estimates that between 200 and 300 micro-entrepreneurs could be trained with the portion of grant money allotted for training – far more than the minimum necessary to distribute the full amount of lanterns.


The methodology behind the training has been adapted from a Barefoot Power "training for trainers" course given to Micama employees. In the training program, future entrepreneurs take turns role playing, with the seller highlighting potential buyers' current energy expenditures. They encourage lantern customers to compare their current costs with the savings and non-financial benefits that they will receive with the purchase of a solar lantern. This process is demonstrated with the help of a sell sheet, displayed in Figure 14, that walks each buyer and seller through a set of questions that assess the buyers' current expenses and needs. Additionally, the sellers highlight the losses that a potential buyer might have without a lantern: for example, for a small-scale agricultural trader, not having his/her phone charged could mean missed business opportunities. The risk that kerosene lamps pose to the buyers' families' health due to indoor pollution or burns is also highlighted by the seller. In order to better communicate with its audience in Haiti the original pamphlet from Barefoot has been translated to creole (Adamson, 2014) (Figure 14).

Ki pwoblem ou panse ki pi inpotan pou rezoud?

Konbyen chanm kay ou ta renmen klere an minm tan?

Eske ou ta renmen jwenn limyè ou da deplase avel oubyen lumyè ki ret ifkse yon kote?

... ou... (ofri 2 solusyon)



Pwodwi sa gen 1 an garanti

**Fe ekonomi pandan wap sevi ak pwodwi solè**


Nan 3 zan wap depanse pou lanp ak telefon

Nouvo lanp Barefoot wap achete pou


**Lajan wap ekonomize pandan 3 zan =**

**Kisa ou pral fe ak lajan sa ou akonomize a?**

Kijan ou fé pou klere lakay ou?      Kijan ou fé pou chaje telefon ou?



Kijan de pwoblèm ou konn rankontre?



Konbyen kob sa koutew pou 1 semenn?

Pou telefon ou?

Pou lanp ou?

Pou lot bagay ou?

Total Semenn  x 52 semaines =  Total 1 Lane

Figure 14. Barefoot Training Sheet Adapted to Micama

Another awareness strategy that Micama has implemented, with the support of Fonkoze and GP, was the purchase of a sound truck that helps increase penetration in areas with very little awareness of solar lanterns. These promotion campaigns expose customers to affordable solutions in the same way that successful cases in Africa have done. The idea of the truck was to increase the number of sales per region, supporting the sale process of solar retailers in rural areas considered most important by them. In these areas, where Micama has established distribution routes, the vehicle has been used to provide a platform for the products to be displayed and a means of soliciting participation from local populations. The sales team tries leaves contact information that allows local entrepreneurs to follow up with interested customers later. In practice, however, after a seven month trial period the truck's impact on sales was revealed to have had a negligible impact on sales (Adamson, 2014). Currently, Fonkoze and Micama are evaluating their programs impact and strengths through interviews with thirty of the resellers trained by the partnership.

## **Lantern Product selection**

### ***Lantern Quantity***

Originally, the \$100,000 in grant funding was intended to be spent on purchasing lantern equipment. Through the revised engagement, SELF will spend the funds to establish a revolving loan fund through Fonkoze, while Micama will handle the purchasing necessary to make lanterns available to the soon-to-be-trained entrepreneurs. For the sake of cooperating with the original design of the project, Micama has agreed to purchase the exact dollar value's worth of lanterns as was originally intended according to the IDB grant, although these new lanterns will contribute to and be combined with its existing lantern inventory.

To understand how many lanterns will be made available with a \$100,000 expenditure, shipping and customs must be considered. The total amount must be divided by 1.22, where customs is 22% of the landed value. Therefore, if the landed value is declared to be \$100,000, the actual amount to purchase from d.Light will be around \$83K, amounting to roughly 5,000 lanterns after the bulk discount. The exact number of lanterns to be purchased is neither entirely clear at the point of compiling this report, neither is it highly relevant. It would be much more so if the project intended to hand the lanterns out for free, but because of the nature of the project's design, once the initial order is exhausted, Micama will simply order more lanterns. Beginning with an initial order comparable to that stipulated in the original formulation of the grant agreement merely provides assurance to the project SELF that Micama will have a strong incentive to ensure the success of the distribution and training program. Until the lanterns are sold, \$100,000 of capital will be locked up in solar lantern inventory.

### ***Solar Lanterns - Products and Manufacturers***

Selecting the right product(s) for the project is a key factor in the model's eventual success. For risk-averse individuals at the BOP, high demands are placed on both performance and price. In the solar lantern market, there are numerous brands available to choose from, making it challenging to select the best suited brand and model.

In order to narrow down the wide variety of choices to a select few particularly well-suited to the needs of the project, the team established a set of criteria. We assessed the number of different models each brand offered; whether the focus of their product development was specifically the BOP; and if organizations currently used their products. With these initial screens, some small companies that manufactured only one or two products were not considered. The logic behind this decision was that larger manufacturers could offer better prices due to economies of scale and could leverage their existing logistical capacities to efficiently deliver products to Haiti. The majority of these small manufacturers were local Asian and African companies that supplied local organizations with their products.

To screen the remaining options, the team made use of the valuable research completed by Lighting Africa. Lighting Africa is a program jointly funded by the International Finance Corporation and the World Bank that researches solutions to improving access to lighting solutions in unelectrified regions of Africa (UNDP, 2012). The program's website provides information on several organizations that work in the lighting space, as well as a comprehensive analysis of lantern products currently available in the market. Lighting Africa is committed to reducing market spoilage that results from the distribution of poor quality products (IFC, 2012b). From the remaining manufacturers, other products were added to the list that had not yet passed Lighting Africa's quality testing program (see Appendix I for a list of considered products). The assumption behind this decision was that if a particular manufacturer had more than two products that already complied with the quality standards from Lighting Africa, then whether or not their other products had been tested yet, they would also be of similar or higher quality.

The bulk of the Masters Team's screening work occurred before the partnership with Micama had been identified. Once it was clear that Micama was SELF's best option for an on-the-ground partners, we cross-checked our list with the products that Micama had previously distributed in Haiti. Not surprisingly, three of our top choices were in fact the three products that Micama stocks and currently sells. The company also holds Lighting Africa in high esteem, only purchasing products that have passed their quality testing program. For the project in Haiti, because Micama will be the entity making the direct purchase from the lantern manufacturer, and because the brands currently sold by Micama match the team's quality criteria, we recommend leveraging the relationships that Micama already has in place with lantern manufacturers. Those brands are: Barefoot Power, Marathoner Power, and d.Light Design.

To minimize lantern purchasing costs and thereby maximize the number of lanterns that would be made available to the entrepreneur network, Micama suggested that the \$100,000 be spent on only one brand, with sales of the other two brands being fulfilled from existing inventory. A mix of lanterns manufactured by d.Light Design was selected for that purpose. Micama already has a strong relationship with the manufacturer, and placing only one order will significantly reduce shipping costs, as all lanterns will ship in one container from Shenzhen, China, to Port-au-Prince, Haiti. Furthermore, because the volume purchased from the manufacturer is greater than it would be if models were selected from multiple companies, the discount will also be higher, allowing for more lanterns to be purchased for the same cost. The three brands that Micama and SELF will eventually work with in Haiti – Barefoot Power, Marathoner Power, and d.Light Design – are explored in greater depth below.

## Barefoot Power

Barefoot Power is a business that has manufactured affordable portable solar solutions for the BOP in an effort to increase energy access and alleviate poverty since 2005. Barefoot has focused on solar solutions that provide lighting and phone charging capabilities in order to fulfill basic lighting needs from low-income populations in developing nations. In their mission, Barefoot states that providing lighting as a first step to break the dependence on inefficient and harmful lighting sources. In addition to manufacturing these products, Barefoot is involved in several projects that distribute these low cost lighting sources to low income populations. Currently Barefoot offers products ranging from solar home systems solutions, such as the Barefoot Connect, to solar lanterns like the Firefly and Barefoot Go.

The Firefly series offers portable solutions with five different products including the Firefly Mini, the Firefly Mobile Lamp, the Firefly Family, the Firefly Mobile Ultra Torch and the Firefly Fast Phone Charge. This series is complete with phone charging capabilities and lighting, with the exception of the Firefly Fast Phone Charge that exclusively charges phones. These products are equipped with warranties varying from 12 to 24 months.

Barefoot currently has four products certified by Lighting Africa, which include the Firefly Mini and the Firefly Mobile Lamp, represented respectively in Figure 15 and Figure 16. These models differ on the availability of different settings as well as on their mobile phone charging capabilities. The Firefly Mini is a simpler model, with only one brightness setting that provides four hours of light at an intensity of 36 lumens. The Firefly Mini has a twelve month warranty, but does not offer the possibility of mobile phone charging. The Firefly Mobile Lamp, on the other hand, is a more sophisticated solar lantern providing two different brightness settings as well as mobile phone charging.



Figure 15. Barefoot Firefly



Figure 16. Barefoot Mobile Lamp



## Marathoner Power

Marathoner Clean & Lean Power designs all their products for off-grid use and built in power-usage monitoring capabilities (Marathoner, 2012). They understand the unique and important requirements of their customers and partnering organizations, and produce high quality products at reasonable cost. Marathoner produces four different types of solar lanterns. All lantern packages come with crystalline PV panels and built-in batteries: the MB2-090 (Figure 17) provides lighting only; the MB2-200 provides lighting and mobile phone charge through a standard USB plug; the MB2-290 and MB2-380 (Figure 18) provide both lighting and mobile phone charge with a single crystalline PV panel and multiple lanterns included in the kit (Marathoner, 2012).

The MB2-090 and MB2-380 models are 2012 Global Lighting Outstanding Product Award winners. Marathoner Lanterns can usually be full charged in six hours in a normal day. Different models provide different amount of lighting ranging from 92 lumens to 200 lumens at the highest setting. For the lantern models with a mobile phone charging function, charging cables with multiple mobile phone charge adaptor ends also come within the lantern package. All Marathoner Beacon™ solar lantern models are equipped with super-efficient LED bulbs and powerful lithium batteries. The micro-processor control technology equipped with all lantern models ensures the highest energy efficiency and a longer battery life. Waterproof body design ensures the performance of Marathoner lantern models in rainy and humid environments. All lantern models come with a two year warranty provided by Marathoner for the whole package.

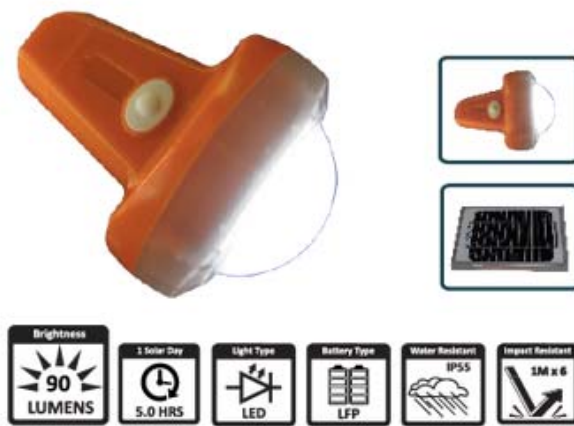


Figure 17. Marathoner MB2-090 Solar Lantern Model

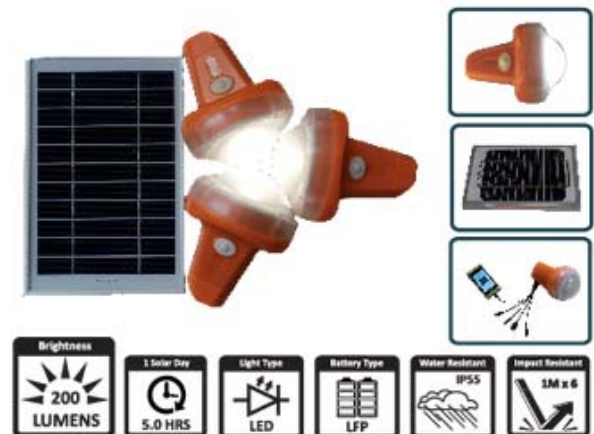


Figure 18. Marathoner MB2-380 Solar Lantern Model

### d.Light Design

d.Light Design is a for-profit social enterprise with the purpose of creating solution for customers without reliable access to power. d.Light designs small-scale, distributed renewable energy solutions for households and small businesses to provide the access and

pay for power for those 2.6 billion people globally without access to reliable electricity. d.Light offers four products, including the S2 (Figure 19), S20 (Figure 20), S300 (Figure 21), and D20. Each product comes with a two-year free replacement and maintenance warranty (d.light, 2014). The Central Plateau project will not make use of the D20 model, as it is a solar home system designed for larger power needs and wealthier customers. All three remaining models – the S2, S20, and S300 – are built with efficient LEDs, and equipped with multiple brightness settings that offer from four to sixteen hours of light depending on the setting. The S300 has an additional nightlight setting that can operate for up to one hundred hours after a full charge. Both S2 and S20 come with an adjustable handle, making them easy to carry for outdoor use or to be hung for indoor lighting. Although S300 does not have an adjustable handle, the design of a curved lighting surface provides light at a wide angle. The top strap allows it to be hung to illuminate an entire room or outdoor area as well. The S300 comes with a portable solar panel, which is convenient for charging. In addition to the conventional lighting function, the S300 also provides a mobile phone charging option. A built-in battery indicator on the S300 displays the lantern’s level of charge. All three models are built to last for at least five years.



**Figure 19. D.Light S2 Model**



**Figure 20. D.Light S20 Model**



**Figure 21. D.Light S300 Model**

The final brand that was chosen in this project is d.Light because d.Light not only fulfills all the selecting criteria that had mentioned in the first part in this section and also d.Light is excelling other options. This is also what the brand that Micama has the most inventory, meaning that the selection process that used in this project can effectively find the most appropriate and fitted product for BOP.

### **After-Sales Service and Product Maintenance**

In order to effectively monitor the last-mile selling process and create an up-to-date information flow, Micama intends to build a text message-based system using software that

has been proven to work in African solar lantern distribution programs. After every successful sale, Micama will require the entrepreneurs to send them a text message with the entrepreneur's name and number, the buyer's name and number, as well as the product serial number to keep track of the selling process. With this information flow, Micama will be know how entrepreneurs' businesses are faring, which model is more popular, how soon will the stock need to be refilled, and if the entrepreneurs need any selling assistance.

The d.Light lantern models come with a two year free replacement warranty, and this warranty program is usually fulfilled by the organization distributing the lanterns. During previous programs, Barefoot Power had tried to fix damaged lanterns at the end-user's house. This approach had generated a number of problems such as the availability of maintenance technicians. Now d.Light and Barefoot have replaced their maintenance programs with a trade-in system for defective lanterns, provided that the lantern is still within warranty. For the end-users on the Central Plateau, Micama will fulfill the lantern warranty program. Broken lanterns will be collected and checked by local entrepreneurs, and as long as the lantern is not visually damaged, a replacement will be provided free of charge immediately thereafter. End-users are encouraged to open and check the lantern immediately following their purchase to make sure that the lantern hasn't been tampered with, or damaged in shipping.

## **SECTION 2. Future Steps**

For this project, the design phase is largely complete, and has been outlined in the preceding chapter. Micama and Fonkoze are ready to begin building the new programs that will be necessary to carry the project forward. Based on their prior experience in the solar lantern field in Haiti, Micama predicts that the distribution of 5,000 lanterns should not last more than twelve months from the initiation of the project.

As we have sought to emphasize throughout this report, the project's design is intended to carry it forward indefinitely into the future, positively impacting the lives of rural Haitians for years to come. If the model works, the project can be scaled up to benefit other parts of the country, region, or even world. For this potential to be realized, it is crucial first-and-foremost that the project be implemented more-or-less according to the plan that the Masters Team has built with SELF, Micama, and Fonkoze. This will require an ongoing dialog between all partners and cooperation to overcome the inevitable challenges associated with operationalizing such a complex program. Once the program is in place, in order to sustain the revolving loan model and entrepreneurship network, it will be very extremely important to track performance metrics. This will help inform whether or not adjustments are needed before issues become entrenched. The following chapter takes a step back to critically assess the program that the team has built with SELF and Micama. Specifically, it evaluates the potential social impacts of the project and analyzes the strengths and weaknesses of the business model.

## CHAPTER III. A Critical Assessment of the Project

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### Introduction

In the previous chapter, the various aspects of the project were discussed separately. While assessing them individually allows for a better understanding of their key elements, extra analysis of how the model works as whole is also needed. Chapter III presents a critical analysis of the strengths and weaknesses of the current project design using analytical tools acquired over the course of the School of Natural Resources and Environment masters program at the University of Michigan. Firstly, it identifies the various impacts that the program could have on the lives of lantern end-users and micro-entrepreneurs. Secondly, it examines the business model, highlighting strengths and weaknesses of which project partners should be aware.

The analysis of the social impact and business model were conducted using two frameworks developed by Professor Ted London of the Ross School of Business at the University of Michigan to analyze operations at the BOP that offered services or products to the underprivileged populations. The first framework looks at three categories of well-being in order to determine how a project increases or decreases social welfare. Because of the team's familiarity with Fe-Yo Bien, the Central Plateau community visited in October, 2013, the social impact assessment focuses on that town as a proxy for other areas that will be affected by the project in the future.

The second framework, as its name suggests, assesses the business model using three different categories: resources, structure, and metrics. Each category relates to a different aspect of the business model in isolation, but the framework assess the overall robustness of the business plan at the same time, allowing for an early-stage assessment of how well a project is setting itself up for success. Both frameworks allow for the identification of possible weaknesses that are later addressed in Chapter IV.

## **SECTION 1. Social Impact Assessment**

### **Economic Well-Being**

Most residents of Fe-Yo Bien depend heavily on agricultural activities to support their families. Agricultural harvests are seasonal, can be easily impacted by extreme weather, and are usually low in volume. The entrepreneurs that will be involved in the solar lantern distribution program can expect to earn a supplemental income by selling lanterns. The program provides the entrepreneurs with a new access to financial credit and loans. Even with little or no credit history, motivated entrepreneurs can easily get loan from Fonkoze or ACME to purchase and sell lanterns, paying back their loans with their earnings. Through this process, the entrepreneurs are able to build up financial credit if they are able to pay back their loans and interests on time, meaning that they will have a better chance of getting higher loans in the future to expand their personal businesses. Income from selling lanterns is expected to be much more stable than traditional agricultural gains. As local people get a better sense of the benefits of using solar lanterns, demand for lanterns may increase. Therefore, as the project develops and awareness grows, entrepreneurs' sales volumes will grow as well, resulting in higher incomes.

Kerosene, candles, and battery-powered flashlights are the major lighting fuels in Fe-Yo Bien. Normally, people need to purchase kerosene regularly to burn for lighting. The estimated monthly expenditure on kerosene is roughly US \$10 per family. If the family owns a mobile phone, they will also need to travel to a charging station in Boucan Carre – one hour's walk from town – and pay for charging services. Basic solar lanterns without mobile phone charging capabilities retail for between US \$15 and \$20, while models with chargers sell for around \$40. For poor rural families, such a high expenditure could result in a temporary financial crisis immediately following their purchase.

In the long term, however, solar lanterns can create economic value for families by allowing them to save money that would have otherwise been spent on kerosene. Solar energy is a free-of-charge energy source, with lanterns providing lighting and possibly also mobile phone charging, families will not need further spending on energy. Moreover, with the convenient mobile phone charging provided by solar lanterns, individuals can use their phones more frequently and stay in touch with the outside world more easily. This in turn will be of great help to small business owners, traders, and also for people who wish to start their own business.

If we take a step back from looking into the individual economic benefit from solar lantern and look at the community as a whole, solar lanterns can be a great way to jumpstart economic growth in a community such as Fe-Yo Bien. As discussed earlier, solar lanterns not only bring in more income but also help with starting and expanding local business. Furthermore, as the solar lantern distribution program expands into larger areas, there will also be an opportunity for communities like Fe-Yo Bien to get connected with

other communities through the same program. Therefore, potential opportunities may be created for new businesses that span multiple communities. On the downside, people who get involved in the solar lantern distribution program as entrepreneurs may have larger economic gain than people who only purchase lantern for personal use. This situation may create a larger income gap between the entrepreneurs and other local residents.

### **Capability Well-Being**

Trainings regarding basic lantern functioning, technology, and benefits will be provided before entrepreneurs actually begin selling lanterns. Therefore, knowledge of advanced solar lantern technology that was previously inaccessible for people in rural communities will be made available to locals. The trainings will also prepare entrepreneurs with basic accounting and marketing skills. These trainings will provide knowledge and skills that will benefit the entrepreneurs for the rest of their lives, even when they no longer work with the program in the future. With the higher and more stable income gained from selling lanterns, local entrepreneurs will be able to afford a better quality of life, and provide their children with better education opportunities.

The greatest impact of burning kerosene for indoor lighting are the toxic fumes released in the combustion process and the high risk of fires if lamps are overturned. With solar lanterns providing lighting, all toxic fumes and indoor air pollution caused by kerosene will no longer be a threat to human health. People and their families who purchase solar lanterns can expect to be healthier and have a lower of respiratory diseases. Children can also study with safer solar lanterns at night. Aside from higher health expectations and the eliminating the risk of fires and burns, the high quality of solar lantern lighting can protect children's eyes when they study at night. They can also expect a longer and better education, since their parents can save money from kerosene purchasing and have a higher budget for education. Moreover, as the entrepreneurs advertise for the solar lanterns they are selling, buyers can also get exposed to the solar lantern technology knowledge, providing buyers a knowledge gain as well.

Introducing and distributing solar lanterns in Fe-Yo Bien will contribute to educating the community with the health risk brought by kerosene burning, new solar lantern technology, and the concept of sustainability. As people in the community can expect to receive better and longer education, the average education level of the community will rise as years pass. There would also be a higher prospect for the future of the community, due to the increasing income of its residents, longer life expectancy, higher education level, and easier access to outer world through using mobile phones.

### **Relationship Well-Being**

As local entrepreneurs start to sell solar lanterns and bring in more income for their households, it is possible that we will see a change in roles in these households. A family

member involved in the solar lantern business may gain more power and respect in the household since he/she will provide money for the family. If this person happens to be at a previously lower position within the household, serving as an entrepreneur may gain him/her a higher social standing position. This change in the household power structure may cause family conflict as members previously at higher positions feel threatened. If this person happens to be at a higher power position in the family (such as a household head), there is also the possibility that this person will gain more power over the whole family and become an overbearing leader. Besides the possible shift in household roles, entrepreneurs are expected to gain more respect from their communities. Other local residents will see the entrepreneurs as possessing specialized knowledge of solar lanterns, able to access financial credit, and able to give their families a better life.

For the individuals that plan to purchase solar lanterns with mobile phone charging capabilities, they will have a better access to people outside Fe-Yo Bien, and will be able to charge their phones whenever they want. It will be easier to stay in touch with people living in other areas, and reach out to new network connections. Since solar lanterns are expected to save family members time from collecting traditional fuels and travel to phone charging centers, the family will have more time to dedicate to other activities. They may have time to chat with each other and create better relationships among family members as well as with their neighbors and people in the community.

According to the field survey we conducted in Fe-Yo Bien, the primary income source for most families is from the sale of agricultural products. With some people acting as entrepreneurs to serve the solar lantern project, uneven income changes both among all residents in Fe-Yo Bien and among entrepreneurs is possible. People gaining more money by selling lanterns will improve their social position, and this is a great opportunity for people at the bottom of the society to make changes for themselves. Fe-Yo Bien is still a very traditional and undeveloped area; the change in people's economic and social position may bring uneasy feelings for those not able to participate as entrepreneurs and those earning less than fellow entrepreneurs. Thus, there is a slight potential of social conflict arising in the community as time goes on.

Lighting at night is also believed to be lower crime rates. With more people owning solar lanterns and be able to light their way when walking outside at night, the whole community will be safer, especially for women and children. Furthermore, the distribution of solar lanterns will also give the village of Fe-Yo Bien a "green" start to its economic development. The whole community will not only have a clean and safe source of energy, but will also create a friendly relationship with its surrounding environment by using a renewable energy source.



## **SECTION 2. Assessment of the Business Model**

The partnership between SELF, Fonkoze, and Micama in Haiti seeks to provide a large number of last-mile consumers with low cost solar lantern solutions. This partnership builds off an existing partnership between Fonkoze and Micama with the objective of vastly expanding the number of micro-entrepreneurs already involved in the partnership. The addition of a revolving loan-fund to provide support to future micro-entrepreneurs adds complexity the current operation, resulting in a model that has not been fully tested before. The foundation for the new partnership, however, is a successful program that has allowed Micama to pass the 100,000 lanterns sold mark. For that reason, SELF enters the picture leveraging its partner's prior experience. With the initial grant money, Micama has estimated that a number between 200 - 300 micro-entrepreneurs can receive training. The lanterns will be sold initially to micro-entrepreneurs from Fonkoze's branches on the Central Plateau, totaling nine routes that are served by Micama. The number of solar lanterns sold is then recorded by Micama and will later help SELF and Fonkoze determine the effectiveness of their strategy.

### **Resources**

In terms of resources, SELF will utilize the IDB grant to set up a revolving loan fund at Fonkoze that will support the entrepreneurship network. The pre-existing partnership between Micama and Fonkoze allow for the grant to effectively impact those that can benefit the most by the adoption of environmentally safe lighting options. Micama offers this partnership its supply of varied types of lanterns and its successful training program that enables micro-entrepreneurs. Micama has set up nine different distribution routes that serve some of Fonkoze's branches in Haiti. Fonkoze's loan support and the low-cost training program provided by Micama are sources of competitive advantage for micro-entrepreneurs. By participating in the project, micro-entrepreneurs will have access to resources unavailable to the vast majority of Haiti's population.

Conversely, business success for entrepreneurs is threatened by dependence on the partnership with Fonkoze and the lack of end-user financing for those purchasing the lanterns from them. They will depend on their own acquired marketing abilities and the financial means of their customers to drive the business model, as no aspect of the project will make additional financial resources available to the end-users.

### **Metrics**

In terms of metrics, through their roles in the project, Micama and Fonkoze are directly connected to the micro-entrepreneurs' sales on the ground. Micama currently measures its sales numbers with the use of Quickbooks, an accounting and financial software, that allows for the provision of monthly reports on the progress of sales. More recently, however, Micama is in the process of adopting software that uses text messages to

keep track of entrepreneurs' sales almost instantly. The system, developed by an American organization working in Africa, allows for the seller to register the buyer's name and product number in each text referring to a sale. This process taps into the existing mobile phone network in Haiti. These metrics allow for a better estimation of the areas that need more sellers, as well as giving a broad perspective on the progress of the program.

## **Structures**

The project leverages the existing networks of Micama and Fonkoze to provide financing for entrepreneurs who will buy and resell lanterns. This can both benefit the microfinance bank by offering a new revolving loan fund and sustaining their business, while simultaneously creating opportunities for local entrepreneurs. The lantern market in Haiti can also be expanded since those entrepreneurs can potentially attract Haitians' broader interest in solar lantern technology. For SELF, by partnering with established organizations in Haiti, the risk of failure can be significantly reduced. Micama will provide training for the entrepreneurs built on a previous successful program from Barefoot that will educate micro-entrepreneurs in marketing strategies. Given the previous experience of selling lanterns in Haiti, this can be seen as a sign that this project can succeed. Furthermore, the free two year replacement warranty that comes with the d.Light lanterns can cover the risk of product failure and lessen the burden of responsibility for micro-entrepreneurs, who will be the direct point of contact for end-users.

However, the lack of a system for controlling the ultimate retail price of lanterns is a risk that could cause challenges for the business model. In addition, the import tariff of 22% for lanterns is high and represents a barrier to selling lanterns at a lower cost. This could be a weakness for a long-term operation due to the rigid financial constraints of the BOP lantern customers. Because the business model will not be subsidized in the future, any costs will be passed on down the value chain to the end-consumer. Furthermore, after the expiration of the one year warranty period, maintenance issues could become challenging.

## **CHAPTER IV. Outlook for the future: Risk and Recommendations**

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The SELF-Micama project has the potential to lay the foundation for a successful long term partnership to deliver solar lantern solutions for rural Haitian populations. However, there are a number of risks that must be seriously considered. The Masters Team also has synthesized a short list of recommendations for SELF that we feel will augment the relevance and impact of the SELF-Micama project, and lay the foundation for any future project SELF chooses to undertake in this area. The sections below describe in detail potential risks associated with the project, possible solutions to mitigate them, and general recommendations for the future.

### **Risk and solutions**

The financing mechanism for the lanterns involves multiple layers and flows. The sale of lanterns is a two-step process, with the sale to the micro-entrepreneurs being one step, and the resale of those lanterns by the micro-entrepreneurs to the end-users being the second. This two part process implies the existence of two different price points and premiums – one at the entrepreneur level and one at the final end-user level. Therefore, project managers may have limited control over the price that the end-user pays. There are two possible ways to mitigate this. At the entrepreneur level, SELF can contract an agreement with Micama that sets an upper bound margin for the sale price of the lanterns, ensuring any premiums that Micama charges are reasonable. At the end-user level, SELF can set up a reporting system and feedback channel between the last-mile entrepreneurs and Micama to regulate final retail prices being charged to end-users.

SELF is a fairly large non-profit with a diverse portfolio of energy access projects across various countries including Benin, Colombia, Haiti, and more. Their core strength is not in the solar lantern space – this is new territory for them. Their lack of experience with solar lanterns and the extent of their other commitments pose a risk of not enough involvement from SELF's end to maintain key relationships with on-the-ground partners. The Masters Team proposes that SELF focus on prioritizing regular communication and strong relationships with Micama and Fonkoze, because constructing a distribution network from scratch will be much more time consuming than working with current partners. SELF also does not necessarily have a clear vision for what will happen to the lantern project after the initial stages. A possible solution to this may be to work with Micama and Fonkoze to ensure the maintenance of lantern inventories and revolving loan funds. The details of the post-grant lantern program must be charted out clearly to benefit all parties involved, especially the entrepreneurs, the last-mile customers, and their families.

The final risk that we see with the project is the distinct lack of an end-user financing program. In the literature, end-user financing has been identified as an essential

piece to solving the energy access challenge for the BOP. SELF and its on-the-ground partners must work together to leverage existing expertise and experiences to forge an end-user financing scheme once the pilot model has been proven as successful.

## **Recommendations**

According to Micama, the basic lantern models will be sold to local entrepreneurs for around US \$15 with a gross margin of 32%. This price setting will result in the end-users paying an estimated \$17 to \$18 for the most basic lantern. For most families in the Central Plateau, this is a significant sum to pay for a lantern all at once. SELF's partnership with Micama has brought an MFI into the business, but hasn't yet connected with the Haitian government. The import tariff for solar lanterns in Haiti is 22%, which adds extra cost to the ultimate retail price of the lanterns. Considering the fact this SELF-Micama solar lantern distribution program is not solely a profit-aimed business, but the primary goal is to help rural Haitians obtain better access to clean energy, it would be worth the effort to negotiate with the government to lower or even eliminate the 22% import tariff for lanterns. If such negotiations succeed, the lantern price for the end-users may be 2-3 USD less – a significant amount for BOP consumers. There is precedent for this type of negotiation: non-profits and business have succeeded in communicating the importance of eliminating taxes on clean energy products in multiple African nations.

Another strategy worth trying to make the lanterns more affordable for end-users would be to set up an end-user financing program. As one of the options, mobile lending could give end-users more flexibility with the amount of credit they purchase each time, giving them the option of paying for lantern use whenever they can afford. In this way, even the poorest family may be able to purchase solar lanterns. Creating a daily rental plan for lanterns could be another solution. By setting a low price for daily rental, the poorest families could still rent lanterns for a day or two when they need them the most.

The warranty program for solar lanterns lasts only for two years, but the lanterns are designed to last for at least five to ten years. End-users will still need maintenance and repair services after the end of the warranty period. Depending on the amount of solar lanterns sold in the first two years of the program, Micama should consider setting up a third-party repair network for the products no longer covered by warranty, and facilitate the training of repair technicians by lantern manufacturers. Standard repair fees should also be established to void over-charging. This approach could not only solve the problem of lacking repair and maintenance services, but also create more job opportunities and income for local people. The d.Light S2, the solar lantern with only basic lighting function, is expected to comprise the majority of all lanterns sold. This is not a complicated model and will be relatively easy to repair if it experiences a malfunction. Along with the training provided for entrepreneurs for solar lantern distribution, entrepreneurs could also get trained of basic repair for solar lanterns. This approach may be easier to implement and

more feasible than have professional maintenance personnel on the ground if the amount of lanterns sold is smaller, but the repair and maintenance quality may be limited to a more basic level.

The solar lantern distribution program hasn't yet established a concrete marketing plan. Even though most Fe-Yo Bien families who participated in our field survey expressed an interest in owning a solar lantern, their actual willingness to pay for a single lantern remains unclear. Some families may back out from purchasing lanterns if they find the price higher than they expected or doubt the effectiveness of the lanterns. Marketing strategies will be needed to drive sales. Demonstrations could help people understand the benefit lanterns can bring more visually. Elephant Energy, an organization distributing solar lanterns in Africa, performs demonstrations at night to convince potential buyers by showing them the effectiveness of solar lanterns. They have seen an increased interest in the product after the night demonstrations. Having a "trial period" or "full refunding period" for lanterns may also help increase sales volumes for entrepreneurs. Giving the lantern to local families free for a few days to try, or give them the choice of returning the lantern with full refund within the first few days of purchase, as Micama already does and plans to do for this project is a good start. It gives people time to experience the benefits they will receive from owning a lantern before making the final purchasing decision. People who remain unconvinced by the effectiveness of solar lanterns can have an opportunity to try them for themselves and decide if it is something that will improve their quality of life.

Another factor that must be taken into consideration is the timing for marketing and advertising. Since most of the families in the Central Plateau earn their income from agricultural activities, there is seasonal variation in their household wealth. The harvest season may be a better time for marketing and encouraging lantern purchases versus other times of the year.

## Conclusion

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At the conclusion of this Masters Project, the need for electrification in the developing world is just as pressing as it was when we began our work eighteen months ago. Lack of lighting for homes and businesses, indoor air pollution, and financial hardship from kerosene use are still major problems endured by roughly 20% of the world's population.

Despite how entrenched the energy access problem continues to be, forward progress is being made. For example, Panasonic recently announced plans to distribute 100,000 lanterns to the regions of the world in the greatest need of electricity by the company's hundredth anniversary in 2018 (Panasonic, 2014). This type of high-publicity campaign not only immediately improves the lives of individuals living without electricity, but it draws attention to the severity of the problem, which in turn facilitates the work of organizations like the Solar Electric Light Fund or Micama Soley.

Our project seeks to establish a self-sustaining solar lantern distribution network in Haiti – the least developed country in the Americas and one of the world's most impoverished countries. If successful, the project will make 5,000 high-performance lanterns immediately available to some of Haiti's poorest citizens, the residents of the Central Plateau. Moving forward, the income generated from the sale of the lanterns will support a network of hundreds of micro-entrepreneurs, and fund the continuation of the program.

Working with SELF and Micama Soley, we have completed an important phase of this project: planning and project design. The much greater task of implementing the project, overcoming the inevitable hurdles, and monitoring its evolution over time will be left on the shoulders of the on-the-ground partners. It is this team's sincere hope that the thoughts and recommendations that we have outlined in this document will contribute to the success of that colossal task.

## Appendix I. Selected Solar Lantern Models

Brand / Manufacturer	Model	Phone Charging
<b>Barefoot Power Ltd.</b>	Barefoot PowaPack 5W (Gen. 2.5)	YES
	Barefoot Power Firefly Mini (Gen. 2.5)	YES
	Barefoot Firefly Mobile Lamp (Gen. 2.5)	YES
	Barefoot PowaPack Junior Matrix (Gen. 2.5)	YES
<b>d.Light</b>	d.Light S2	NO
	d.Light S20	NO
	d.Light S300	YES
<b>Fosera Group</b>	Fosera Pico Solar Home System 7000	YES
	Fosera SCANDLE 200	YES
	Fosera BOP	YES
<b>Greenlight Planet</b>	Sun King Eco	NO
	Sun King Pro	YES
	Sun King Solo	NO
<b>Prakruthi Power</b>	1Watt LED Arundhati Solar Lantern	YES
	2Watt LED Arundhati Solar Lantern	YES
	3Watt 3 Step Solar Ceiling Lantern	YES
<b>Marathoner CLP (Africa); Toomeen Solar Co., Ltd. (Asia)</b>	Marathoner Beacon MB2-090 (Africa) / SooLED B1 (Asia)	NO
	Marathoner Beacon MB2-200	NO
	Marathoner Beacon MB2-380 (Africa) / SooLED B3 (Asia)	NO
<b>Niwa</b>	Niwa Uno 50	NO
	Niwa Multi 100	NO
	Niwa Multi 300 (Standard)	YES
<b>Nokero</b>	Crestone Solar Light Bulb (N200)	NO
	Crestone Pro Solar Light Bulb (N210C)	NO
	Shavano Solar Light Bulb (N220)	NO
	Shavano Pro Solar Light Bulb (N220C)	NO
<b>Schneider Electric</b>	Schneider Electric In-Diya 2: LED Solar Home Lighting System (2.5W)	NO
	Schneider LED Solar Home Lighting System Mains Input	YES
	Schneider Electric LED Home Lighting System 2.5W	YES
	Schneider Electric LED Home Lighting System 5W	YES
<b>Nuru Energy</b>	Nuru Light + PV (Solar Nuru Light Star)	YES
	Solar Nuru Light Smart	YES
	NURU LIGHT (NL1)	YES
<b>SOLUX Service GmbH</b>	Solux LED-105	YES
	Solux LED-50	YES
	Solux LED-100	YES
<b>SUNLITE</b>	Sunlite Solar Light G3	YES
	Sunlite 1	YES
	Sunlite 2	YES
	Sunlite 4	YES

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