

# SUSTAINABLE PRODUCT UPTAKE AT THE BASE OF THE PYRAMID

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## LIST OF FIGURES

Figure 1: General Model Overview .....	3
Figure 2: Images of Community Life in Haiti .....	10
Figure 3: Images of Community Life in Haiti .....	10
Figure 4: Case One Social Impact and Need Comparison .....	12
Figure 5: Case Two Social Impact and Need Comparison .....	14





TABLE OF CONTENTS

CONTENTS

List of Figures.....i

Table of contents.....ii

Executive Summary .....iv

Introduction.....1

Client Background.....1

Problem Statement .....1

    The Importance of Measuring Impact.....1

    Approaching the Client.....2

    Shaping the Project .....2

Energy Project Impact Model .....2

Model Architecture .....4

    Social Impact .....4

    Community Need .....5

        Quantitative Measures .....5

        Qualitative Measures.....6

Product Impact.....6

    Devices.....6

Environmental Impact.....7

Financial Performance.....8

Case Studies.....8

    The Solar Electric Light Fund and the Fe-Yo Bien, Haiti Case Study .....8

    Fe-Yo Bien Needs Assessment.....9

    Modeling Two Energy Project Scenarios in Fe-Yo Bien .....11





Scenario I: Solar Lanterns.....11

Scenario II: Micro-Grid.....13

Conclusion .....14

Future Work / Future Studies.....15

References.....16

Appendix A – Survey Results .....17

Appendix B – Case Study One Rankings .....32

Appendix B – Case Study Two Rankings .....37



## EXECUTIVE SUMMARY

Thanks to the Dow Sustainability Fellowship, the six of us, graduate students from across the University of Michigan, formed a team in order to investigate sustainable energy solutions at the base of the economic pyramid (BoP). Together we created the Energy Project Impact Model. The Energy Project Impact Model assists impact investing funds, like the Acumen Fund, in assessing the social, environmental, and financial impact of a given BoP energy solution. Impact investing funds can use our model as one tool in their search for the best energy solution for a given community.

Acumen Fund worked with us throughout our creation of the Energy Project Impact Model. Acumen Fund was a natural fit for our work and boasts an investment portfolio of some of the most innovative social enterprises in the world. Our team worked with Tom Adams, Acumen's Head of Impact, to build a model that would relate to Acumen's energy portfolio. Our goal was to create a model that would allow competing energy projects to be evaluated against a consistent set of criteria. In the world of impact investing, investors must work with investees to measure aspects of their operations that resist easy quantification: social impact, environmental impact, female empowerment, and more. Our goal was to create a tool that could assist Acumen, and other impact investing funds, in measuring these difficult impact measurements.

The Energy Project Impact Model measures the social, environmental, and financial impact of possible investments. Calculating the social, environmental, and financial impact are three very different metrics. Therefore, we measured each impact separately before forming one holistic impact score.

The social impact score of the Energy Project Impact Model requires two sides of information: a measurement of a particular community's needs and a product impact score for a particular product. The needs and product impact sides were broken down into the same five subgroups: 1) health and safety 2) education 3) water and agriculture 4) enterprise and economic development and 5) community and household. The needs and product impact sides of the social impact score asks unique questions related to these five categories. The needs side of the social impact score uses quantitative and qualitative information to learn more about a particular community and its needs. For instance: the population size of a community, the education attainment in the community, the community's access to water, and more. The product impact side of the social impact score asks the user to rate the impact the product will have on various aspects of rural living on a scale of 0 to 5, with 0 being no impact and 5 being high impact. For instance: impact on household lighting, impact on electrification to health clinics, impact on street lighting. The goal is to then match up both sides of the model. For example, a product that scores highly on the product impact side for the health and safety category will receive a high social impact score in a community that also had a high need for improved health and safety. A higher social impact score indicates the product would make a positive social impact on the community.

The environmental score of the Energy Project Impact Model assesses the environmental performance of a product using four categories: the embodied energy of the infrastructure, the impact of installation, fuel type and usage, and the project lifespan. Embodied energy of the infrastructure looks at the amount of energy required to manufacture the project infrastructure. The installation impact component measures the amount of ecosystem that will be cleared for the project. The fuel component assesses the relative proportion of renewable and conventional fuels. Finally, the product lifespan looks at the useful life of a product and accounts for potential installation of additional infrastructure as a product ages. A higher environmental score indicates that the product



makes a positive environmental impact.

The financial impact score of the Energy Project Impact Model uses a variety of metrics to determine the financial feasibility of a certain product and the financial burden it may place on a community. In order to assess the financial performance of the product or service a baseline of community electricity and lighting use and consumption were established. Then, key financial information was captured regarding the product. For instance: the price of the purchase, ongoing fuel expenses, the product's useful light. A higher financial impact score indicates that the product will be less of a long-term financial burden on a community.

After calculating the social, environmental, and financial impact we then formed one holistic impact score. Each individual impact score is normalized so that the output is on a 100 point scale, then the three scores are averaged to determine the Overall Project Score. The higher the Overall Project Score the more positive the impact a certain product has on a community.

## INTRODUCTION

Thanks to the Dow Sustainability Fellowship, the six of us, graduate students from across the University of Michigan, formed a team in order to investigate sustainable energy solutions at the base of the economic pyramid (BoP). Together we created the Energy Project Impact Model. The Energy Project Impact Model assists impact investing funds, like the Acumen Fund, in assessing the social, environmental, and financial impact of a given BoP energy solution. Impact investing funds can use our model as one tool in their search for the best energy solution for a given community.

## CLIENT BACKGROUND

Acumen Fund is a global non-profit at the forefront of the impact investment industry. It was founded in 2001 by Jacqueline Novogratz, an alumna of the Stanford Graduate School of Business who began her career as an investment banker on Wall Street before transitioning into impact investing. Twelve years after its establishment, Acumen Fund boasts an investment portfolio of some of the most innovative social enterprises in the world, an illustrious board of directors that includes Nobel Prize winner Joseph Stiglitz, and a track record that claiming to have positively impacted over 100 million people at the base of the economic pyramid (BoP).

Each of Acumen's investments fall into one of six portfolios: agriculture, education, energy, health, water, and housing. Within each of those sectors, Acumen Fund invests in companies that operate with a triple bottom line, that is, they pursue profits while respecting or even enhancing the natural environment and the lives of the world's poor. Most of Acumen's portfolio companies were founded specifically for the purpose of alleviating poverty with innovative solutions to problems faced in the developing world.

In the economic development community, impact investing is considered a form of subsidized investment (London, 2010). According to the impact model, value-driven organizations provide debt or equity capital to companies at sub-market rates – the subsidy being the difference between the market rate and the one the investee receives. Until impact investing began to emerge as an industry over the past two decades, it was extremely difficult for socially responsible startups operating in emerging markets to obtain capital. Acumen refers to their investments as "patient capital" – capital that is willing to accept unusually long waits for returns that are often smaller than the risks should merit.

## PROBLEM STATEMENT

### THE IMPORTANCE OF MEASURING IMPACT

In the world of finance, metrics have been finely tuned to assess the performance of a company relative to expectations. These tools allow venture capitalists and investment banks to track the performance of their investments against initial expectations. In the world of impact investing, however, investors must work with investees to measure aspects of their operations that resist easy quantification: social impact, environmental performance, female empowerment, and other equally nebulous concepts. Because of its role in measuring non-financial success, impact measurement is a cornerstone of impact investing. Organizations like Acumen Fund are constantly seeking to improve the tools they use to measure and evaluate their metrics.

## APPROACHING THE CLIENT

The Dow Sustainability team approached Acumen Fund to help explore the possibility of working on project related to their clean energy portfolio, which focuses on finding energy solutions for communities living in the BoP. Our team was put in touch with Tom Adams, Acumen's recently appointed Head of Impact. Mr. Adams consulted with his colleagues and concluded that our efforts would be most welcomed by the Energy Portfolio managers, who were trying to build a more effective system for evaluating new investments.

## SHAPING THE PROJECT

At Acumen, prospective investees are vetted on a case-by-case basis, rather than in a systematic way. This is not due to a lack of diligence on Acumen's part, but to the inherent challenges of assessing the future social and environmental impact of a socially responsible company's operations. Measuring the impact of ongoing operations is already a major challenge for impact investors, but the problem is compounded when companies are still in the pilot phase.

When presenting their socially responsible startups to investors, founders may have one specific community need in mind that they hope to address without taking into account many other more important needs. Furthermore, a while a project may effectively respond to the needs of a poor community, its services may be priced far above local purchasing power, rendering it ineffective. Finally, projects may have drastically different environmental impacts. Founders typically focus on the aspects of their companies that have the greatest positive impact and may either be unaware or intentionally obfuscate its shortcomings. These biases make it difficult for impact investors to select winning formulas from amongst a large pool of applicants.

To help overcome these challenges, Acumen's Energy Portfolio asked the Dow Sustainability team to explore the possibility of building a model that would allow competing energy projects to be evaluated against a consistent set of criteria. In particular, they were interested in better understanding the role of grid extensions in providing power to rural communities. Previously, Acumen had adopted a policy against funding projects that proposed new solutions for extending the national power grid because they felt that companies installing renewable-powered micro-grids or selling solar lanterns could have a greater social and environmental impact. Acumen's Energy Portfolio managers wanted to revisit this policy with the help of a tool that could help them compare different projects in a more systematic way. Our discussions with Acumen lead to the conceptualization of the Energy Project Impact Model that was the focus of our efforts for the duration of the fellowship.

## ENERGY PROJECT IMPACT MODEL

Our discussions with Acumen lead to the conceptualization of the Energy Project Impact Model that was the focus of our efforts for the duration of the fellowship. We decided to build a model that would account for the particular needs of a community, and measure a project's social impact against those specific needs. The selected community would be representative of the area where a startup was seeking to expand. The "impact" of a project would be its performance in an established set of categories identified by our team: Health and Safety, Education, Water and Agriculture, Enterprise and Economic Development, and Community and Household. In addition, we believed that a project needed to be evaluated according to its financial and environmental sustainability. The result was a model that produced an overall project score that was composed of three parts: a social impact score,



a financial impact score and an environmental impact score.

## Understand Needs



## Classifying Products



## Methodology

Figure 1: General Model Overview

To determine the needs within a community, we first have to understand the general characteristics that surround a given community. What are the aspects of a village or a region that define the village or region? What are the crucial distinguishing features that give an accurate picture of a community?

To answer these questions, it is essential to first break down the structure of a community. A community can be separated out into Education, Water and Agriculture, Enterprise and Economic Development, Community and Household, and Health and Safety. Each of these areas covers a distinctly different part of the community that can be measured. Measurement could be in the form of the number of paved roads or the number of cell phone subscriptions in a given area. These statistics can be used to develop a model that is able to accurately depict the community in an objective manner. The statistics can then be compared to neighboring communities to determine whether one community is operating at a different level than the current one. However, on relative terms, these comparisons may be very similar to each other. Extending this, an entire region could be mapped to understand the communities which have more or less development than the next which could result in more substantial comparisons. Expanding the coverage area to a global scale, the comparison will give a sense as to where the community falls compared to developments in many continents, from the extremely wealthy neighborhoods to poverty stricken areas. This global comparison may be the most relevant to the study as it will give the extremes of what a community could have and what it does not have. It will also give a relative basis as to how much improvement the community may need to be on par with the rest of the world.

On the other hand, the products also need to be categorized. Certain products will have more impact in certain areas than others. For instance, a street light is going to have more impact in an area that has a lot of night activities and is currently sparsely lit. Similarly, a cell charging station will have a big impact in an area where there are many cell phone users but very few charging stations.

Each product has a different impact on the five areas above (Education, Water and Agriculture, Enterprise and Economic Development, Community and Household, and Health and Safety). Many products have varying degrees of impact within these sectors as well. Accurately depicting each of these products with respect to the amount of impact they provide in all of the sectors is essential. A given product may have a specific purpose that targets a specific sector, but it may also provide indirect impacts to other sectors as well. For instance, a solar lantern

designed to provide light at night to help students read and study may be used to light a community area to have nighttime events. These lanterns may also be used by the medical staff to see patients in the evening where they wouldn't be able to otherwise. These examples represent possible additional improvements in both the Community and Household and Health and Safety sectors on top of the original intent of helping the Education sector.

Once both community needs and product impacts have been established, these statistics can then be combined to determine the products impacts on the most pressing needs of the community. Naturally, if a community has sufficient access to health clinics, and thus scores well in the Health and Safety sector, a product that has a large impact in this sector will not be an ideal fit for the community. Alternatively, if a community has been doing very poorly in Education, a product that has a big impact on Education will be a great fit.

Each product will need to be taken on a case by case basis and applied to each community separately to ensure that the appropriate impact is applied to the right need. Aggregating products can be done, however the exact impact of the individual products may not be able to be determined if they are combined with others.

This analysis is also just one of many aspects that will need to be assessed before investing in a particular product. Several other important factors play into the probability of a products market and impact succes. Two key factors are its financial and environmental impact. If the services that product provides are not affordable for the intended consumers, it will not be a sustainable project in the long term. If the product destroys forests or primary water sources needed for survival, then the product may actually cause more harm than good. Taking each of these factors into account is necessary when analyzing whether or not to invest in a given product.

## MODEL ARCHITECTURE

The Energy Project Impact Model is designed to examine the impact an energy product or service will have in a given community in order to help Acumen Fund make informed investment decisions. Products are scored based on their performance in the following three categories: social impact, financial performance, and environmental impact, where each category is weighted equally in determining the final project score.

## SOCIAL IMPACT

Determining the social impact of a given product or service was key to the success of this model. Two separate detailed surveys were developed to 1) determine the impact of the product or service, and 2) determine the actual social needs of the community or region. These survey questionnaires are listed in the "Product Questions" and "Community Questions" tabs of the model. The goal was to determine how well the product or service performs at improving the most pressing needs of the community.

Both surveys were then broken out into five different subgroups: 1) Health and Safety, 2) Education, 3) Water and Agriculture, 4) Enterprise and Economic Development, and 5) Community and Household. These subgroups were

chosen to match the subgroups that the Solar Electric Light Fund (SELF) laid out in their Whole Village Development Model<sup>1</sup>.

The product survey asks the user to rate the impact the product will have on various different aspects of rural living on a scale from 0 to 5, with 0 being no impact and 5 being high impact. The answers are then averaged to give a product impact score within each subgroup, again from 0 to 5. These surveys have been designed to be dynamic, that is Acumen can add or change the questions as they see fit.

The community survey, on the other hand, asks more census type questions regarding the community, again broken out into the five subgroups. These answers are then compared to global statistics, provided by the World Bank. A needs score is then developed assuming a normal distribution from the World Bank data. This score is again on a scale from 0 to 5 to match the product score, with 0 being low level of need and 5 being high level of need.

These two surveys are combined by multiplying the product scores of each individual subgroup with the needs score from its associated subgroup to obtain a final product impact score for each subgroup. Thus a high score in a subgroup represents a high level of need and a high product impact to that particular need. In the “Results Page” tab of the model, these results are presented. Radar plots are given to visually show the relation between the level of need and the product impact. For example, a product may have a high impact in a certain subgroup but the community may have a low level of need there, or vice versa. The goal is to match up products with high impact with those specific areas with the highest need. These subgroup scores are then added together and normalized to a 100 point scale to determine the final social impact score.

## COMMUNITY NEED

In order to choose the best product for a community, an investor will want to start by researching what a community is like and what it needs. Once an investor knows what a community currently lacks it may begin an investigation of products that best suit and may solve those needs. To build the community needs side of the model, we researched various metrics that could be used in order to compare and learn more about individual communities. We wanted our metrics to be as useful and specific as possible so that investors could determine targeted solutions for each community’s needs. At the same time, we understood that too broad a survey of community needs might be costly and time consuming. Therefore, we sought to provide a broad range of quantitative and qualitative questions, but limited ourselves to only a few questions on each topic.

## QUANTITATIVE MEASURES

Certain questions from a community may be quantifiable, and possibly, even readily available. Such questions include: population size, geographical area, school enrollment, and more. These questions impact what a community needs. For instance, a wildly dispersed low population community may need a different product than a densely populated high population community. Such quantitative information is much more useful if it is measured

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<sup>1</sup> Solar Electric Light Fund. (2012). *Solar Electric Light Fund Annual Report*.

against something. Taking world statistics enables the community to be compared to all development in the world, from the poorest to the richest countries.

We chose to use available data from the World Bank to provide comparative global data. This data is not perfect and it has a few limitations that should be noted. First, not all countries are represented in each statistic we used. Some statistics only have a few countries, and this limits a truly global comparison. Second, distributions of the statistics have an effect as well. If a factor is not normally distributed across all countries, the ranking of the factor within the community has to be determined a different way. Third, some data distributions spread into figures that weren't possible for the indicator. Elimination of outliers could help get the spread of data within reasonable limits.

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## QUALITATIVE MEASURES

Although quantitative questions provide useful and readily comparable information, some information from BoP communities is more difficult to directly quantify. These measures are no less important, though, and can greatly impact a community's true needs. We sought to include qualitative measures in the model in a slightly different way than the quantitative measures. The qualitative questions ask for community opinions on the community's needs and are even more community specific. These questions will require more in-depth discussions with a variety of community members in order to discover answers. We formulated the questions as a ranking 1-5 system to facilitate community surveys and discussions.

## PRODUCT IMPACT

To build the social impact side of the model, we had to research the various technologies that could provide power to unelectrified communities at the BoP. This part of our research helped us better understand the types of benefits different energy systems could provide, and build a tool for comparing them to each other on the same scale. Our research revealed that there are four main categories of energy systems that can be installed to provide electricity services in rural communities: devices (solar lanterns, clean cookstoves), home energy systems (small, household-scale systems), micro-grids (community-scale utilities), and grid extensions (service extended from the national power grid).

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## DEVICES

The global energy device industry is largely divided between cooking devices and lighting devices. Based on the design of our project with the Acumen Energy Portfolio, we focused exclusively on lighting devices. Over the past decade, numerous companies have arisen to market solar powered lanterns to communities at the base of the economic pyramid. Companies typically combine cutting-edge design with mainstream business acumen and non-profit distribution expertise to profitably market inexpensive products to the world's poor.

An exemplary lantern company is d.Light, founded in 2007 by Stanford Graduate School of Business MBA Sam Goldman. Goldman's company was formed around a concept he and an engineer partner designed while still enrolled at Stanford. Using the most inexpensive materials and Chinese manufacturing, Goldman and his partners succeeded in producing a solar lantern that combined an efficient poly-crystalline silicon solar panel, LED lights,

and a high-performance lithium-ion battery that retails for less than US\$ 15 (d.Light, 2013).

## HOME ENERGY SYSTEMS

Another common energy solution for base of the pyramid consumers are home energy systems, which usually rely on solar energy to provide electricity for lighting, phone charging, radios, and other basic services. These systems demand a higher upfront investment, and therefore are often paired with end-user financing solutions. Grameen Shakti in Bangladesh is the most successful solar home system (SHS) company in the world, installing thousands of systems per month. Grameen's success is due to its ability to pair its systems with in-house financing with repayment rates exceeding 99% (Grameen, 2013).

## MICRO-GRIDS

In regions where local economic conditions permit, renewable resources are sufficient, and the cost of grid extension is prohibitive, micro-grids can be installed to provide electricity to one or more rural communities. Capital costs for micro-grids are extremely high compared to devices and home energy systems, and therefore require infrastructure financing and complex payment systems from end-users to insure that debt servicing, and operation and maintenance costs are adequately covered (IFC, 2012). Micro-grid operation costs are minimized when conventional fuel is displaced by solar, wind, or hydro power. Typically, micro-grids integrate one or more sources of renewable energy with a diesel generator, batteries, power management systems (inverters, controllers, battery chargers, and monitoring systems), and local distribution lines.

## GRID EXTENSION

The most logical first option for a rural community seeking electrical services is the national grid. Relative to devices, home systems, and micro-grids, grid extension provides many advantages. Because of the scale of its services, prices are almost always lower for consumers. Also, it can deliver virtually unlimited power for any type of end-use, from household lighting to heavy industry.

Unfortunately, for many communities grid extension is not an option. Many communities are too far from the grid to justify expensive extensions, and even if extension were possible, rural customers are too poor to shoulder interconnection fees and local distribution. For grid projects to be viable, a minimal level of demand is necessary, but often communities with no prior experience with electricity have not yet attained a level of development that can support the associated costs. In some cases, even when grid-extension would be financially viable, national generation and distribution infrastructure is insufficient to support increased demand (IFC, 2012). Finally, from an environmental perspective, many national grids in developing countries are powered by coal plants with minimal environmental standards. Despite its drawbacks, thanks to economics of scale grid extension is generally the first option considered for rural electrification.

## ENVIRONMENTAL IMPACT

The environmental impact section of the model was constructed by assessing project performance in four categories: the embodied energy of the infrastructure, the impact of installation, fuel type and usage, and the project lifespan. This choice of architecture was developed in consultation with University of Michigan professor

Gregory Keoleian, who specializes in life-cycle assessment at the School of Natural Resources and Environment.

The embodied energy component of the environmental model assesses the energy required to manufacture the project infrastructure. Because the range of products to be assessed is too great to allow for a comprehensive life-cycle assessment of all components, this part of the model is designed to be more generic, evaluating embodied energy from a qualitative perspective. The installation impact component measures the amount of ecosystem that will be cleared for the project, including power line corridors (for grid extensions) and land cleared for community-based infrastructure. The fuel component of the environmental impact section is weighted more heavily than other components to reflect the importance of the use phase of energy equipment. The model assesses the relative proportion of renewable and conventional fuels, and assesses other aspects including consistency of supply (for renewables), and travel distance (for conventional fuels). Finally, the product lifespan component incorporates the concept of maintenance and product replacement to account for additional infrastructure installation at the end of a product's useful life.

## FINANCIAL PERFORMANCE

In order to assess the financial performance of the product or service, a baseline of community electricity and lighting access and consumption was first established. Then, key information about the product or service was captured, including the ability to deliver electricity or lighting, the price of purchase and ongoing fuel expenses, and the length of the product's useful life. Most of these data points are captured in the "Product Questions" and "Community Questions" surveys in Appendix B.

From these inputs, key metrics are calculated to determine financial impact. These include savings relative to current lighting and electricity solutions, the amount of time required to payback the initial investment for the new product or service, and the time required to install or implement for the new solution. These metrics are then assigned a ranking from 0 to 5, from which an average is calculated to assign an overall weighting for Financial Impact for the technology in the community. The Financial Impact value is incorporated into the "Results Page" in a manner similar to the Social Impact score, by normalizing the output to a 100 point scale that is averaged with the Social and Environmental scores to determine the Overall Project Score.

## CASE STUDIES

### THE SOLAR ELECTRIC LIGHT FUND AND THE FE-YO BIEN, HAITI CASE STUDY

Early on in the project, the Dow Sustainability team realized that a case study for the model would be an essential component of assessing the success of the project. Before the summer, no suitable destination had presented itself, and in any case, the model was not yet ready to be tested. By the time the team reconvened at the University of Michigan in August, we needed to immediately identify a potential case study, or we knew that coordinating travel would be impossible. Through his connection to the Solar Electric Light Fund (SELF) through another project, Lukas Strickland coordinated a visit to Haiti to evaluate the team's model in one of SELF's partner communities. SELF is an international non-profit headquartered in Washington D.C. that specializes in installing renewable energy based electrification projects. For their operations in Haiti, they have received funding from the Clinton Foundation, the Inter-American Development Bank, the Haitian government, and many other public and

private organizations.

Our team coordinated with SELF to explore Fe-Yo Bien, a rural non-electrified community in which SELF had plans to install a solar powered micro-grid. Concurrently with the micro-grid project, SELF was also exploring the possibility of facilitating the sale of solar lanterns in the region around the community. The fact that the community was currently non-electrified and extremely impoverished combined with SELF's ongoing assessment of two energy projects made the community a perfect candidate for testing our model.

With the help of funding from the Dow Fellowship, team members Lukas Strickland and Wesley Allred coordinated a six day trip to Fe-Yo Bien in late October, 2013. While on the ground, an extensive survey was conducted to assess the socio-economic status of local residents, as well as their potential to benefit from energy projects.

## FE-YO BIEN NEEDS ASSESSMENT

An on-site survey of Fe-Yo Bien was completed in order to establish a baseline level of development and to better understand the needs of the community. This survey included 13 households and roughly 90 individuals. The results of the survey were input into the "Community Questions" section of the model and the results are given below in Table 1. As can be seen, the two most pressing needs are for improved health and safety and general community and household daily living.

Table 1: Case One Social Impact Scores

Social category	Level of Need (0-5)
Health and Safety	4.5
Education	3.9
Water and Agriculture	3.6
Enterprise and Economic Development	4.2
Community and Household	4.4

Most of the needs in the community arise from the lack of infrastructure of two basic services: transportation and electricity. Fe-Yo Bien currently has no connection to grid electricity or generators, with most locals using gas lanterns and candles to fulfill their lighting needs. With regard to transportation, there is a single dirt road leading to the village that can only be navigated by foot, motorcycle, or horseback. The frequency of floods during the rainy season often makes travel nearly impossible to nearby Boucan Carre - the nearest town with access to basic services.

Aside from the direct impacts that result from lack of electricity and lighting, numerous indirect issues arise as well. Some of these issues include: the difficulty children have studying at night without sufficient lighting, the hour long walk many locals must make to charge their mobile phones, the lack of ability to pump water for irrigation, and the

inability to store medicines or vaccines in refrigerated containers.



Figure 2: Images of Community Life in Haiti

One of the major impacts of this lack of electricity and power is its effect on the health of people in the community, as can be seen by the results of the model. The local population must travel nearly an hour to reach the nearest health clinic, almost exclusively by foot as there are few motorized options. It is also common for people in the community to carry the sick the entire distance when they are in need of care. In addition, the community also lacks access to clean water, giving rise to high levels of cholera and diarrhea. While this is a common occurrence, medicines and treatment are not available locally due to lack of services, which could easily be improved with greater access of electricity and power.

Access to good education is also a pressing need in the community, as there is only a single elementary school in Fe-Yo Bien, with multiple grades studying together in a single concrete building. Due to the lack of electricity, students have difficulty studying in the evenings. On top of this, older students must walk each day to Boucan Carre for their lessons and often do not return late into the evening. These older students are frequently forced to stay in Boucan Carre late into the evening to study with the few available lights before returning home.



Figure 3: Images of Community Life in Haiti



Based on this assessment of Fe-Yo Bien's needs, it is clear that providing access to electricity and transportation would improve many aspects of the community. Specifically, more educational opportunities, higher economic development, and improved community health would all result from improved access to these basic services.

## MODELING TWO ENERGY PROJECT SCENARIOS IN FE-YO BIEN

### SCENARIO I: SOLAR LANTERNS

Based on the needs assessment described above, the Dow Sustainability team used our model to assess the potential impact of two separate projects on community well-being. The first scenario assesses the impact that solar lanterns would have if they were sold to a majority of the community's residents. The inputs for project impact were derived both from our experience on the ground in Fe-Yo Bien, as well as our interactions with Solar Electric Light Fund personnel. The project scores are displayed in Table 2 below.

Table 2: Case One Overall Score

<b>Overall Project Score</b>	<b>58</b>
Social Impact Score	27.8
Financial Score	65.3
Environmental Score	81.8

The project scores best in the environmental impact category, scores moderately well in the financial performance category, and poorly in social impact.

#### ENVIRONMENTAL IMPACT

The high environmental score is derived from the fact that solar lanterns have a low infrastructure impact, are completely solar-powered, and require no land to be cleared for installation. The greatest detractor from the environmental score is the short lifespan of average solar lanterns, which is estimated at five years.

#### FINANCIAL PERFORMANCE

The financial score of 65.3 is decent considering that under modeled conditions the product would require no subsidization. The scenario assumes that lanterns are distributed by the Solar Electric Light Fund to local micro-entrepreneurs, who would sell lanterns at a profit to villagers, thereby generating income for themselves, and furthering Solar Electric Light Fund's mission to reduce kerosene consumption. The current scenario assumes that no financing is available to consumers, meaning that the \$15 cost for a lantern must be paid up front. Due to the low (\$4.00) monthly energy expenditure of the average family in Fe-Yo Bien, the high upfront cost results in a lower financial score than would otherwise be possible with microfinancing.

#### SOCIAL IMPACT

The performance of the project in responding to the needs of the community is presented below (Figure 4). The green pentagon reflects the level of need in each category, while the red shape reflects lantern impact in each category.

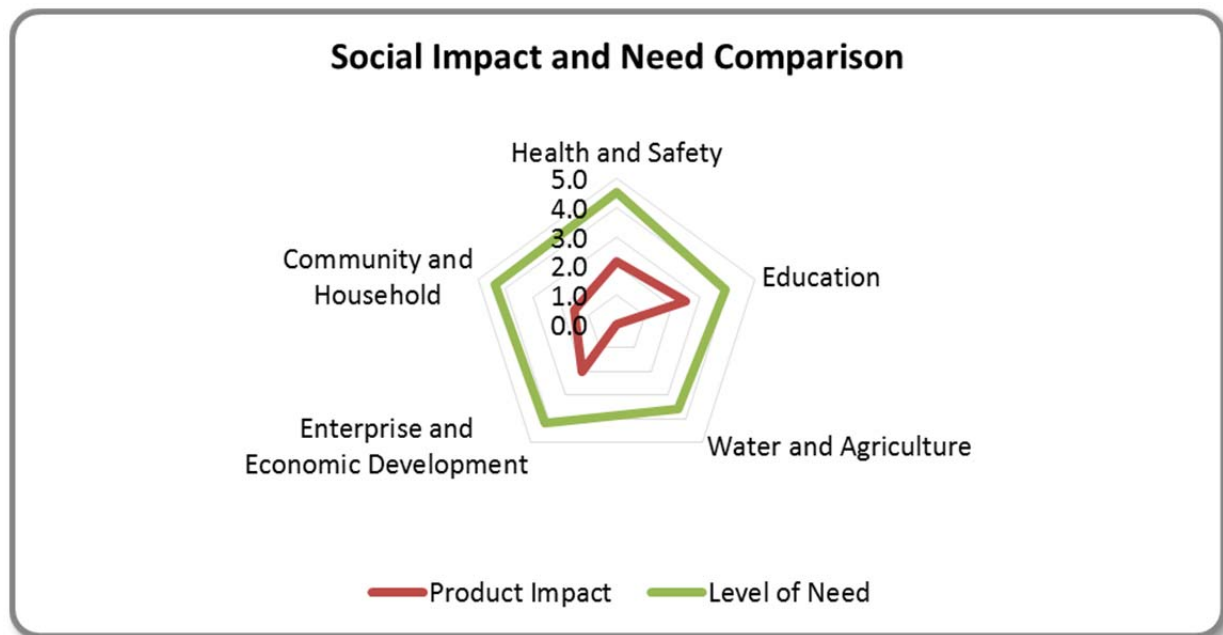


Figure 4: Case One Social Impact and Need Comparison

Lanterns perform best in education, economic development, and health/safety, slightly less well in community/household and worst in water and agriculture. The benefits lanterns would have a community like Fe-Yo Bien are providing light, savings on energy expenditures, a reduction of kerosene and candle burning in the home, and job creation for the micro-entrepreneurs selling the lanterns. As noted in most development literature, the benefits of lighting have impacts across many categories. Light improved education at school and in the home, provides a means of socializing in public places and homes, illuminates clinics for improved health services, and help business to improve sales after dark.

Despite all of these positive impacts, the social impact score for solar lanterns remains low. This is due to a variety of reasons, none of which mean that lanterns would not be beneficial to the community. To understand the results, it is important to understand how the model scores impact. For example, in the water and agriculture category, products that provide pumping services to farmers, or replace manual labor with electric tools would earn high scores. In healthcare, energy services that would power vaccine refrigerators or diagnostic labs would also perform well. These services are important to the overall well-being of the community, but cannot be provided by lanterns, no matter how well designed. Characteristics of the community also impact a product's score. For example, there is no clinic in Fe-Yo Bien, meaning that despite the healthcare needs of the community, no level of electrical service could provide better clinical service.

Ultimately, what a low social impact score means is that not all needs of a community can be met by an electricity project. In addition, other infrastructure investments are needed to maximize the benefits of electricity. The value of the score is greatest not as an absolute evaluation of a project, but as a benchmark for evaluating it against

competing solutions.

## SCENARIO II: MICRO-GRID

The second scenario assesses the impact that a solar-powered micro-grid project would have if it was installed in Fe-Yo Bien. The inputs for project impact were derived both from our experience on the ground in Fe-Yo Bien, as well as our interactions with Solar Electric Light Fund personnel. The project scores are displayed in Table 3 below.

Table 3: Case Two Overall Score

<b>Overall Project Score</b>	<b>61</b>
Social Impact Score	37.1
Financial Score	54.2
Environmental Score	91.8

The overall project score is comparable but slightly higher than the solar lantern score, while the individual category scores differ more significantly. The solar micro-grid scores even higher than lanterns in the environmental impact category, lower in financial performance, and higher in social impact.

### ENVIRONMENTAL IMPACT

Like the lanterns, the modeled micro-grid is entirely powered by solar electricity. Due to its small size <10kW, it has a minimal infrastructure and installation impact, and requires minimal distribution lines within the community. It scores higher than solar lanterns primarily because of its longevity: typical micro-grid projects last 25 years.

### FINANCIAL PERFORMANCE

The micro-grid financial performance is dramatically skewed upward by the assumption that the grid infrastructure and installation costs would be funded by a philanthropic entity. The remaining cost burden is solely to pay for operation and maintenance costs. Typically, unless they are built under very unique circumstances, micro-grid installation and infrastructure must be funded by a third party to be affordable for local consumers.

### SOCIAL IMPACT

The performance of the project in responding to the needs of the community is presented below (Figure 5).

Social impact is greatest in the enterprise and economic development category, as well as education. The micro-grid also scores moderately in community and household, but poorly in health and safety and water and agriculture.

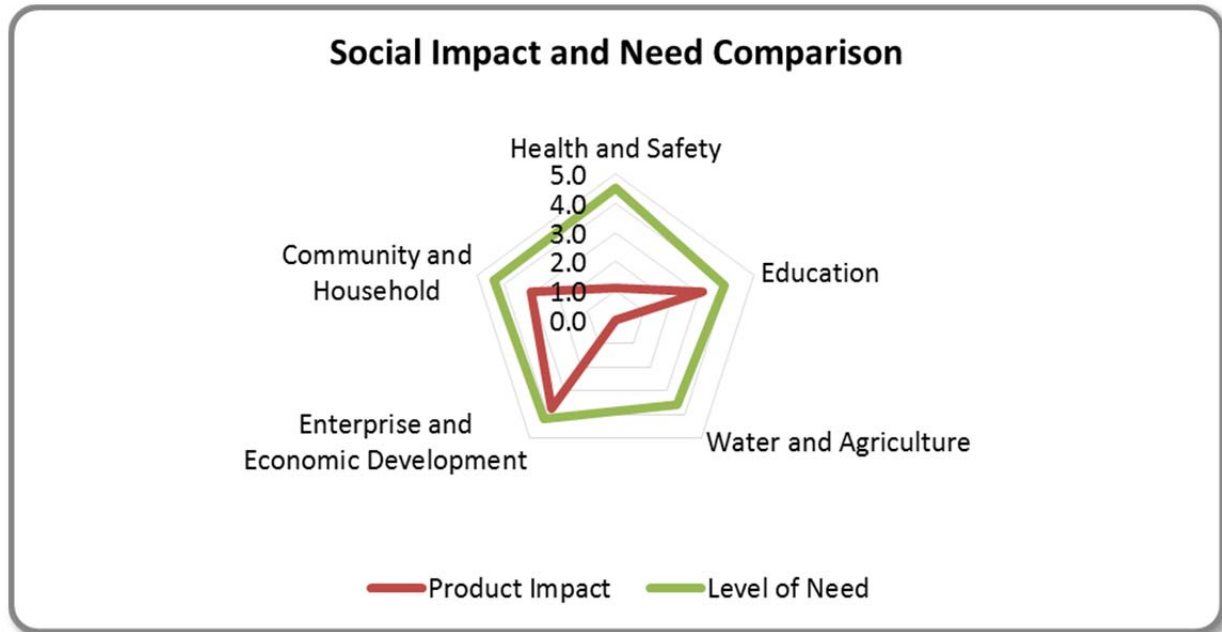


Figure 5: Case Two Social Impact and Need Comparison

The poor performance in water and agriculture is due to the same factors that impact solar lantern performance: power will be provided directly to homes and will therefore not affect irrigation or crop processing. Like lanterns, the micro-grid project will primarily power lights in homes, with the added possibility of powering radios, televisions, and other household equipment. The high performance in economic development is due to the fact that jobs will be created in the community to maintain and operate the system, and more importantly, because the current system design will power a “business center” where local entrepreneurs will use electricity to power a variety of revenue-generating equipment.

Overall the score remains low because the project will not affect the entire community (power will only be available to a fraction of the residents), it has no impact on local healthcare due to the lack of healthcare facilities, and it provides no benefits to local agriculture.

## CONCLUSION

This model was created to aid the Acumen Fund in finding the most impactful investments in the energy space. As a thought leader in impact investing, it is critical that they continue innovating about how to best assess investments, and make investments that maximize positive social impact globally.

As mentioned, the social, environmental, and financial impact scores of this model are combined to form one holistic impact score, which shows how much impact that venture will have in the target community. We hope that Acumen will use these scores to identify the best investments amongst a range of options. However, it's worth noting that this score is also the be-all end-all of a venture. There are numerous factors that it does not include, including the strength of the entrepreneur, future plans for scale, and network effects of this type of service that are critical to identifying investable ventures. However, this model should give a baseline that is comparable across

all products, and shows whether the product or services is effectively meeting a true need in the community.

## FUTURE WORK / FUTURE STUDIES

As a thought leader in impact investing, we hope that Acumen will use this model as a jumping off point, both to improve it and expand the logic into other impact assessment products. One current limitation is the reliance on outside data for the inputs. For the product side of the model, Acumen is dependent on the entrepreneur giving accurate and truthful information about the capabilities and limitations of the project, which can often be a conflict of interest. In the future, it would be ideal if this side of the model could be built out such that the characteristics of each product (kWh produced, battery life, etc) were inputted in a way that automatically interprets its capabilities, without interference from the entrepreneur. On the other side, it would be useful if community data were drawn from pre-existing surveys, rather than new data collected. This would save time for Acumen and the entrepreneur in establishing need in the target communities.

Lastly, there are other elements of impact that were not built into this model, that could be considered and incorporated through future studies. For example, many products create employment, empower women, or have other ancillary effects through innovative distribution (often microentrepreneurship) systems. In an effort to measure and communicate impact clearly, these were left out of the model here. However, it would be useful to include them in order to gain a more holistic measure of impact in the future.



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## APPENDIX A – SURVEY RESULTS

GENERAL SURVEY INFORMATION							
Section	Question #	Question	Duration of survey	Respondent Name (First, Last)	Male (M) or Female (F)	Relationship to head of household, head name if not respondent (First, Last)	General notes/observations on interview
	Survey #1		1:45	Christiane Lucien	F	Daughter, Serieuse Vercil (mother)	Resp was bored with the interview process after first hour.
	Survey #2		1:00	Toniel Pierre	M	Head	The flood destroyed some of their fields. The road to BC is bad. Not enough water for people to grow rice. Kerosene lamps are for outside, candles for indoors.
	Survey #3		0:50	Christophe Dessallines	M	Head	The flood made life worse for their family.
	Survey #4		0:50	Fleurina Fleurissant	M	Head	"If we don't grow it, we don't eat."
	Survey #5		0:50	Balaguette Pierre (M) and Desir Silvenie (F)	M and F	Head and his wife (head responded to all questions)	The flood made life harder.
	Survey #6		0:40	Sainphanie Pierre	F	Head	Road is a major problem for commerce. Interested in distributing goods in the community, e.g. solar lanterns.
	Survey #7		0:50	Virgemaine Mergenor	F	Wife of voodoo priest, Jean Robert Pierre	Flood took all their crops; they purchase all food. Voodoo activities support everything. Interview degenerated because of unruly relative. "We never would have even given our names if we knew you would ask these types of questions."
	Survey #8		0:50	Jourdinel Pierre	M	Head, pastor of FVB	"Why are you asking people all these questions?" "Kerosene lamp light destroys kids eyes."
	Survey #9		0:40	Sainrelia Jean-Baptiste	M	Head	
	Survey #10		0:40	Monel Toussaint	M	Son of head, Morales Toussaint	
	Survey #11		0:55	Molere Pierre	M	Head	"I'd buy 3-4 solar lanterns, definitely."
	Survey #12		0:35	Margarette Darelus	F	Daughter of head, Saint Louis Dorelus	
	Survey #13		0:40	Daniel Pierre	M	Head	Reluctant respondent. Home/property far from village - will not be on electricity line. "Why all these questions?" "Candles, light - that's women's stuff."



Section		HOUSEHOLD INFORMATION	
Question #	A1	A1b	TABLE A1
Question	How big is your household?	How many buildings or structures are there in your household?	See second tab of file for all tables.
Survey #1	9	1	
Survey #2	4	1	
Survey #3	10	5	
Survey #4	9	3	
Survey #5	4	3	
Survey #6	4	2	
Survey #7	9	5	
Survey #8	8	3	
Survey #9	8	2	
Survey #10	5	3	
Survey #11	9	7	
Survey #12	7	2	
Survey #13	5	4	





Health and Safety - 1							
Section	B1	B2	B3	B4	B4b	B5	B6
Question #	Who is principally responsible for health decisions in your household?	Who is principally responsible for healthcare and prevention costs in your hh?	If a member of your hh is sick, who provides first aid/care?	In the last year, have members of your hh suffered from malaria?	In the last year, have members of your hh suffered from cholera?	Do you think your hh suffered more from malaria or cholera over the past year or the year before?	How many members of your hh sleep under a mosquito net?
Survey #1	Head	Head	Hospital in Boucan Carre	None	2 out of 9	Same	None
Survey #2	Head	Head	Hospital in Boucan Carre	None	None	Better	Some
Survey #3	Head	Head	Hospital in Boucan Carre	None	None	Same	4 out of 10
Survey #4	Head	Head	Hospital in Boucan Carre	None	1 out of 9	No sickness for that period	Some (1 net for whole family)
Survey #5	Head	Head	Hospital in Boucan Carre	None	None	Same	All
Survey #6	Head, helped by older brother	Head	Hospital in Boucan Carre	None	None	Same	None
Survey #7	Head and wife	Head	Hospital in Boucan Carre	None	None	Same	None
Survey #8	Head	Head	Hospital in Boucan Carre	Some	None	Last year was worse.	2 out of 8
Survey #9	Head	Head	Hospital in Boucan Carre	Not sure of malaria vs other sickness.	Some	Same	Some
Survey #10	Mother	Head	Hospital in Boucan Carre	None	Some	No malaria, some cholera.	Some
Survey #11	Head	Head	Hospital in Boucan Carre	None	None	Same - none.	All
Survey #12	Head	Head	Hospital in Boucan Carre	None	None	Same	2 out of 7
Survey #13	Head	Head	Hospital in Boucan Carre	None	Some	1 person had cholera in prev. yr	All



Health and Safety 2														
Section	B7	B8	B9	B9b	B9c	B10	B11							
Question #	Question	B8	B9	B9b	B9c	B10	B11							
Survey #1	In the past month, did members of your hh suffer from diarrhea?	1 out of 9	Same	Currently, is it difficult for your hh to buy medication or take someone to a clinic in case of illness?	No	Boucan Carre	How far away is the nearest clinic?	Boucan Carre	Do you ever use medicinal plants remedies to replace medication?	Sometimes	On average, how many different meals are prepared in your hh every day?	1 to 2	How many times per month does your family eat meat, egg, fish or cheese?	Every couple days
Survey #2		Some	Better		Sometimes. The road can be bad.	Boucan Carre		Boucan Carre		Yes		1		Very infrequently. Maybe every 2 weeks.
Survey #3		Some	Same		Very difficult.	Boucan Carre		Boucan Carre		Yes		1 to 3		Sometimes, rarely.
Survey #4		Some	Some		Very difficult.	Boucan Carre		Boucan Carre		Yes		1		Sometimes, rarely.
Survey #5		None	Same - none.		Very difficult, esp. in rainy season.	Boucan Carre		Boucan Carre		Yes		1 to 3		Once in a while.
Survey #6		Some	Same		Transportation is a problem.	Boucan Carre		Boucan Carre		Yes		2 to 3		Once in a while.
Survey #7		None	Same - none.		Always difficult	Boucan Carre		Boucan Carre		Yes		1		Very rarely.
Survey #8		None	Same - none.		Always difficult	Boucan Carre		Boucan Carre		Yes, esp. when river floods		1 to 2		Not easy to get meat. No fish.
Survey #9		None	Better - less.		Sometimes a problem.	Boucan Carre		Boucan Carre		Yes		2		Once in a while.
Survey #10		None	Same - none.		Very difficult, esp. in rainy season.	Boucan Carre		Boucan Carre		Yes		1 to 2		Once in a while.
Survey #11		2 out of 9	Worse - more than before.		Very difficult - because of road.	Boucan Carre		Boucan Carre		Yes		1		Once per week (Sundays).
Survey #12		None	Same		Always difficult	Boucan Carre		Boucan Carre		Yes		2		Sometimes, rarely.
Survey #13		None	Same		Difficult. Depends on road.	Boucan Carre		Boucan Carre		Yes		Yes		Rarely



Health and Safety 4									
Section	B15	B17	B18	B18a	B20	B20a	B20b		
Question #	How many times per month do you eat vegetables or fruit	Is it currently difficult for the hh to buy or obtain enough food per day?	How do you perceive your household's current food security compared to the previous 5 years?	If it is worse now, what is the most important reason?	For the following products, has their price in local markets increased or decreased over the past 5 years?	Cereals	Tubers		
Survey #1	Almost every day	Sometimes	Respondent didn't live at this location	x		+	+		
Survey #2	Very infrequently. Maybe every 2 weeks.	Very difficult. Must wait for crops to grow.	Since 2010, much worse than before.	Question was added later		=	+		
Survey #3	Vegetables rarely, fruit more often.	Not easy.	More difficult.	The road.		+	+		
Survey #4	Not often.	Yes, sometimes 2-3 days with almost no food.	Same	x		=	+		
Survey #5	Vegetables more often, fruit rarely.	Sometimes difficult, sometimes easier.	Worse	The flood		+	=		
Survey #6	Vegetables fairly often, same for fruit	Not difficult.	Not sure	x		-	+		
Survey #7	Very rarely	Very difficult.	More difficult.	The flood		+	+		
Survey #8	They produce veggies and fruit, so they eat	Difficult. Cannot produce enough, so must buy.	Worse	Problem is national.		+	+		
Survey #9	Veg. and fruit: eat what they produce	Not easy, but they do their best.	Worse	The flood		+	=		
Survey #10	Once in a while.	Difficult.	Worse	The flood		+	?		
Survey #11	Once per week (Sundays).	Very difficult. "Miserable."	Much worse	The flood		+	+		
Survey #12	Sometimes	Yes, difficult.	More difficult.	Father runs around with other women.		-	-		
Survey #13	Only what they grow. Rarely.	Yes, difficult.	Comparable now.	x		x	x		



Health and Safety 5					
Section	B20c	B20e	B20f	B20g	TABLE B1
Question #	Vegetables	Fruits	Meat	Dairy products	See second tab of file for all tables.
Survey #1	=	=	+	powdered milk +, all else about =	
Survey #2	=	=	+	+	
Survey #3	+	=	=	=	
Survey #4	+	+	+	+	
Survey #5	=	+	+	+	
Survey #6	X	X	+	+	
Survey #7	+	+	+	+	
Survey #8	=	+	+	+	
Survey #9	+	=	+	+	
Survey #10	?	?	+	+	
Survey #11	=	+	+	+	
Survey #12	=	=	+	+	
Survey #13	X	X	+	+	



GENERAL SERVICES 1								
Section	C1	C2	C3	C4	C7	C8	C9	
Question #	What is the principal water source for your hh?	How far from your house is your principal source of water?	Who is in charge of fetching the water?	How much time do members of your household spend each day fetching water?	How often does your primary water source dry up?	How do you treat drinking water taken from your primary sources?	Do your hh have access to a toilet or latrine?	
Survey #1	Spring dug in river bed (river water)	100m	Everyone	15 min.	Never	Always by adding chemical treatment	N	
Survey #2	Spring dug in river bed (river water)	100m	Wife, everyone.	15 min.	Never	Sometimes with chemicals	N	
Survey #3	Spring dug in river bed (river water)	100m	Everyone	15 min.	Never	Sometimes with chemicals	Y	
Survey #4	Spring dug in river bed (river water)	100m	Wife and kids.	15 min.	Never	Sometimes with chemicals	N	
Survey #5	Spring dug in river bed (river water)	100m	Everyone	15 min.	Never	Sometimes with chemicals	Y	
Survey #6	Spring dug in river bed (river water)	100m	Everyone	15 min.	River can dry up, but can dig and make spring	Sometimes with chemicals	Y	
Survey #7	Spring dug in river bed (river water)	100m	Everyone	15 min.	Never	Never	N	
Survey #8	Spring dug in river bed (river water)	100m	Wife	5 min.	Never	Sometimes with chemicals	Y	
Survey #9	Spring dug in river bed (river water)	100m	Children	15 min.	Never	Sometimes with chemicals	Y	
Survey #10	Spring dug in river bed (river water)	100m	Everyone	15 min.	Never	Sometimes using lemons	Currently building one	
Survey #11	Spring dug in river bed (river water)	100m	Women	15 min.	Never	Sometimes with chemicals	Y	
Survey #12	Spring dug in river bed (river water)	100m	Everyone	20 min.	Sometimes low, never dry	Sometimes with chemicals	Y	
Survey #13	Spring dug in river bed (river water)	400m	Everyone	1 hour	Never	Sometimes with chemicals	N	



General Services 2									
Section	C9a	C10	C12	C11	C13a	C13b	C13c		
Question #	How many years have you had access to it?	What is the primary source of light in your hh?	For how many hours does your household keep a light on in the evening?	For how many hours do the children of the hh study in the house in the evening?	Have you heard of solar lanterns?	Are you interested in this type of technology?	How much would you be willing to pay each month? (in Haitian \$)		
Survey #1	x	Kerosene lamp	2 to 3 hours	They study under solar street lamp	N	Very interested	Unclear		
Survey #2	x	Kerosene (more), candles	6 hours	2 hours	Y	Interested	Unclear		
Survey #3	17 years	Kerosene, candles, flashlight	5 hours	3 hours by candle light	Y	Interested	\$3		
Survey #4	x	Kerosene, candles, flashlight	1 hour	kids only study during day	Y	Interested	Unclear		
Survey #5	Just finished building.	Candles (most), kerosene, some flashlight	1 to 2 hours	1 hour	N	Interested	\$50-100		
Survey #6	3 years	Kerosene, candles	2 hours	2 hours	Y	Very interested	Willing, amount unclear		
Survey #7	x	Kerosene, candles	5 hours	kids only study during day	N	Interested	Unclear. Question caused huge debate.		
Survey #8	15 years	Kerosene, candles, rarely have \$ for batteries	4 hours	3 hours	Y	Very interested	\$50		
Survey #9	<1 year	Kerosene (most), candles	5-6 hours	2 hours	Y	Interested	\$10		
Survey #10	Now	Kerosene, candles, flashlight	1 hour	0	N	Interested	\$20		
Survey #11	4 years	Kerosene, candles, flashlight	1 hour	1 hour	Y	Interested	"\$30/mo would be a gift"		
Survey #12	several years	Kerosene	3 hours	0	N	Interested	Willing, amount unclear		
Survey #13	x	Kerosene, candles	2 hours	2 hours	N	Interested	Willing, amount unclear		



Section Question #	General Services 3									
	C15a How many cell phones does your hh have?	C15b How much do you pay per week for phone credit? (In Haitian \$)	C15c How do you charge your phone?	C15d How often do you charge your phone/week?	C15e How much do you spend per week on charging? (In Haitian \$)	C16 Do you listen to the news on the radio?	C17a Is your oven indoors or outdoors?			
Survey #1	1	?	In Boucan Carre	2 to 3 times	\$34	Not at home	Outdoors			
Survey #2	0	x	x	x	x	N	Outdoors			
Survey #3	5	\$40	In Boucan Carre. Someone collects them	?	\$5	Y	Outdoors			
Survey #4	1	Very little. Rarely buys.	In Boucan Carre	x	Free	N	Outdoors			
Survey #5	1	\$40-90	In Boucan Carre	?	\$5	Y, when can afford batteries	Outdoors			
Survey #6	0	x	x	x	x	N	Indoors			
Survey #7	2	?	Solar charger.	x	Free	N	Indoors			
Survey #8	1	\$84	In Boucan Carre	2 times	\$6	Y, when can afford batteries	Outdoors			
Survey #9	0	x	x	x	x	Y	Indoors			
Survey #10	0	x	x	x	x	Y	Indoors			
Survey #11	1	\$60	In Boucan Carre	5 times	\$25	Y	Indoors			
Survey #12	1	?	In Boucan Carre	?	Free	N	Outdoors			
Survey #13	0	x	x	x	x	N	Outdoors			

General Services 4					
Section	C17b	C17a	C17b	C17d	C17e
Question #	What type of oven do you typically use for cooking?	What is your primary source of energy for preparing meals in your hh?	Who is in charge for fetching wood?	How many times per week do they fetch wood?	How long does it take you to collect wood?
Survey #1	Stones	Wood and some charcoal	All	Every day	1 hour
Survey #2	Stones	Wood only	Head	Every day	1 hour
Survey #3	Stones	Wood and some charcoal	Everyone	Every day	20-25 minutes
Survey #4	Stones	Wood only	Head	Once every 5 days	3 hours
Survey #5	Stones	Wood and some charcoal	Head	Once every 4 days	1 hour
Survey #6	Stones	Wood and some charcoal	Husband	Once per week	Very long
Survey #7	Stones	Wood and some charcoal	Everyone	?	?
Survey #8	Stones	Wood and some charcoal	Everyone	Every day	2 hours
Survey #9	Stones	Wood and some charcoal	Father and oldest son	Twice per week	1 hour
Survey #10	Stones	Wood and some charcoal	Everyone	Every day	30 minutes
Survey #11	Stones	Wood and some charcoal	Head	4 times per week	1.5 hours
Survey #12	Stones	Wood, rarely charcoal	Everyone	Every day	1 hour
Survey #13	Stones	Wood, rarely charcoal	Everyone	?	?





AGRICULTURE							
Section	D1a	D1b	D1c	D1d	D1e	D1f	D2b
Question #	How many plots does your hh cultivate?	For each plot, what is the rough size in acres or the dimensions?	Do your plots belong to you or do you rent them?	For the plot(s) that you rent, how much do you pay per month?	List what you grow from the most to the least in all of your plots?	For each of the crops mentioned above, do you consume them, sell them, or both?	How do you irrigate your plots?
Survey #1	5	Resp not sure	Own 2, rent 3	Resp. not sure	Corn, millet, plantain, beans	Both sell and consume	Rain only
Survey #2	2	5x100m, 2x100m	Own 1, rent 1	?	Millet, potato, plantain, banana	Consume only	Rain only
Survey #3	3	3 acres total	Own 1, rent 2	?	Millet, corn, beans, rice, potato	Consume all, sell millet only.	Rain, and irrigation ditches to divert river
Survey #4	1	"very small" - est. 5x5m	Own 1	x	Corn, plantains	Consume only	Rain only
Survey #5	3	1.75 acres total	Own 3	x	Corn, millet, rice, beans	Sell some, consume some	Rain only
Survey #6	1	20x50m	Own 1	x	Corn, millet, sweet potatoes	Sell some, mostly consume	Rain only
Survey #7	Flood destroyed fields.	x	0	x	x	x	x
Survey #8	3	1.5 acres total	Owens 1 acre, rents 0.5	?	Beans, corn, millet, vegetables	Mostly sell, consume some	Rain, irrigation ditches, and a co-owned pump
Survey #9	1	0.25 acres	Owens 1	x	Corn, millet	Consume only	Rain only
Survey #10	2	Total 30x100m	Owens 2	x	Potato, corn, beans	Sell some, consume some	Rain, and irrigation ditches to divert river
Survey #11	3	~0.75 acres	Owens 0.5 acre, rent 0.25	\$3000/yr	Corn, millet, potato	Sell some, consume some	Rain only
Survey #12	2	Resp. not sure	Owens 1, rent 1	Resp. not sure	Millet, corn, potato	Mostly eat, sell some	Rain only
Survey #13	2	25x25m total	Own 1, rent 1	?	Corn, millet, rice	Mostly to eat	Rain only



AGRICULTURE 2									
Section	D3	D5	D5a	D6	D6a	D7	D8a	D8b	
Question #	Does your hh have fruit trees at home?	Does a member of your hh belong to an agricultural coop?	What does the coop do?	Does your hh own other plots that are rented?	How much do you make from this rental?	When do you usually harvest your crops?	When do you sell them?	Do you ever hold crops until prices are better so you can sell them for a higher profit?	
Survey #1	Y	No	x	N	x	Corn, October; Millet, January; Beans, March	Depends on the crop.	Yes. The family can hold grain over time	
Survey #2	Y	No	x	N	x	Once per year, January.	Only consume.	x	
Survey #3	Y	No	x	N	x	January, March, October	At harvest	N	
Survey #4	Y	No	x	N	x	Mango, May; Plantain, October	Only consume.	x	
Survey #5	Y	No	x	N	x	Corn, May; millet, June; sweet potato, may, rice, June	Keep to let dry.	Not clear. Probably some for grains.	
Survey #6	Y	No	x	N	x	Corn, October; millet, January; potato, December	After harvest	N	
Survey #7	Y	No	x	N	x	x	x	x	
Survey #8	Y	No	x	Y	1/3 of the food produced by field	Corn, October; beans, March; millet, January			
Survey #9	Y	No	x	N	x	Corn, October; millet, January	x	x	
Survey #10	Y	No	x	N	x	Potatoes; October; corn, August	Sell immediately.	N	
Survey #11	Y, coconut, lime, fruit	No	x	N	x	x	Consume some, hold some over.	Yes, keep some to wait for market.	
Survey #12	N	No	x	N	x	x	Mostly eat, sell some immediately.	N	
Survey #13	Y	No	x	N	x	x	Some barter, mostly eat.	N	



ECONOMICS 1									
Section Question #	E1a	E1b	E1c	E2	E2b	E3	E5	E5	E5
	What are your walls made of primarily?	What is your roof made of primarily?	What is the floor in your room made of primarily?	Does this house belong to the hh?	What is the monthly cost for this house if rented? (In Haitian \$)	Are you owner of another house that you rent out?	Do you save money in a financial institution?		
Survey #1	Stone, mud, wood frame	Tin	Concrete	Y	x	N			N
Survey #2	Concrete	Tin	Concrete	Y	x	N			N
Survey #3	Concrete	Tin	Concrete	Y	x	N			N
Survey #4	Concrete	Tin	Concrete	Rent	\$1000/yr	N			N
Survey #5	Rock	Tin	Dirt	Y	x	N			N
Survey #6	Concrete	Tin	Concrete	Y	x	N			N
Survey #7	Concrete	Tin	Dirt	Y	x	N			N
Survey #8	Concrete	Tin	Concrete	Y	x	N			N
Survey #9	Concrete	Tin	Concrete	Y	x	N			N
Survey #10	Concrete	Tin	Concrete	Y	x	N			N
Survey #11	Concrete, exposed rock	Tin	Concrete	Y	x	N			N
Survey #12	Concrete	Tin	Concrete	Y	x	N			N
Survey #13	Rock	Tin	Concrete	Y	x	N			N



ECONOMICS 2						
Section	E6	E7	E7a	E7b	E9	E8a
Question #	Does a member of your hh benefit from a credit with a credit institution?	Relative to the past year, how do you perceive your current financial situation?	Aside from selling crops, does anyone in your family do any other revenue generating activities?	How much do these non-agricultural activities earn per month? (In Haitian \$)	TABLE F1 and F2 See second tab of file for all tables.	If you had money to complete two purchases, what would they be?
Survey #1	N	Same. "There is no life."	No	0	Everything. In particular, access to capital and credit.	1. clothes, 2. a tub (for bathing)
Survey #2	N	Worse now.	No	0	The poor state of the road.	1. sewing machines, 2. china
Survey #3	N	Worse now because products are more \$\$.	Small commerce (selling lotto tickets), sewing, one family member is a driver, one is a chef	\$2,000	The road, especially during the rainy season.	1. food, 2. irrigation
Survey #4	N	Same	Resp makes charcoal.	\$600	Electricity	1. Refrigerator, 2. TV
Survey #5	N	Better	Small commerce	\$400-\$500	The bad road, electricity.	1. Refrigerator, 2. TV
Survey #6	N	Better	No	0	The bad road. Commercial challenges related to bad road.	1. Electricity, 2. a microenterprise (buy, sell)
Survey #7	N	Worse	Voodoo activities.	Delicate situation. Not possible to ask.	The road. Electricity.	1. Electricity
Survey #8	N	Much better now.	School related activities, church activities	\$800	The road. Electricity.	1. Food, 2. clothes
Survey #9	N	Worse now because of the flood.	No	0	The road. Electricity.	1. New roof, 2. bed
Survey #10	N	Worse because of country's economy.	No	0	The road. Electricity.	1. Food, 2. clothes
Survey #11	N	Worse now because of the flood.	Hosts parties under designated pavilion on property (has electric lights and decorations)	?	1. Road, 2. Electricity, 3. Water, 4. Health, 5. Education - 4&5 are too far	1. Elec., 2. food, 3. beds
Survey #12	N	Worse now because of absent father	No	0	The road. Water.	1. Refrigerator, 2. electric fan
Survey #13	N	Same	No	0	1. Road, 2. Electricity, 3. Hospital (too far)	1. Bed, 2. Table





APPENDIX B – CASE STUDY ONE RANKINGS

Community Needs		58	User Input
<b>General</b>			
How many people in the community?	7000	people	
How many children are in the community?		children	
How many roads are in the community?	1	number	
How many kilometers of road are in the community?	1	km	
What is the total land area of the community?		square kilometers	
How much does the national government spend on health related expenditures	58	dollars	
<b>Health and Safety</b>		<b>4.5</b>	
<b>Quantitative Measures</b>			
How long do local people typically live?	62	years	4.0
How often do babies die during birth? (e.g. number in 100 births or %)	5	% of birth	4.1
How much do people spend on health related expenses per year?		dollars	
(for rural communities) How many people have access to an improved water source (faucet, spigot, etc.)	10	% of people	5.0
(for urban communities) How many people have access to an improved water source (faucet, spigot, etc.)		% of people	
How many people have access to improved sanitation facilities? (e.g. number of people in 100)	10	% of people	4.9
How many children get immunization for diphtheria, pertussis (or whooping cough), and tetanus		% of children	
How many children get immunization for measles		% of children	
<b>Qualitative Measures (Rate each from 1 to 5, with 1 being excellent and 5 being poor)</b>			
Ease of access to health care facilities	5		5.0
Overall level of community health	4		4.0
<b>Education</b>		<b>3.9</b>	
<b>Quantitative Measures</b>			
What percentage of children between the ages of 5 and 10 are enrolled in school?	80	% of children	2.6
What percentage children between the ages of 10 and 18 are enrolled in school?	75	% of children	3.0
What percentage of people over the age of 18 are enrolled in school?		% of people	
How many people over the age of 15 can read?	50	% of people	4.9
<b>Qualitative Measures (Rate each from 1 to 5, with 1 being excellent and 5 being poor)</b>			
Access to light in the community for studying and education	5		5.0
Overall level of community education	4		4.0
<b>Water and Agriculture</b>		<b>3.6</b>	
<b>Quantitative Measures</b>			
How much of the town/city land is used for agriculture?		% of land	
How much income do farmers earn?	50	USD	3.5
What percentage of the agricultural land is irrigated?	5	% of land	3.2
(for rural communities) How many people have access to an improved water source (faucet, spigot, etc.)	0	% of people	5.0
(for urban communities) How many people have access to an improved water source (faucet, spigot, etc.)		% of people	
<b>Qualitative Measures (Rate each from 1 to 5, with 1 being excellent and 5 being poor)</b>			
Ease of access to water sources	2		2.0
Are the local water resources (rain, rivers, reservoir, etc.) sufficient for agricultural production?	3		3.0
Is the community able to produce enough food to meet its needs?	5		5.0
<b>Enterprise and Economic Development</b>		<b>4.2</b>	
<b>Quantitative Measures</b>			
What is the local income?		USD	
How much income do farmers earn?	50	USD	3.5
What percentage of people make less than 1.25 per day?		% of people	
How much power is currently consumed per person each month?		kWh	
How much gas is consumed per person each month?	0	liter	4.0
What percentage of people have mobile phones?	80	% of people	3.2
How much diesel fuel is currently consumed per person each month?	0	liter	3.7
What percentage of people use the internet regularly?	0	% of people	4.6
How many motor vehicles are in the community	5	number	4.5
How many roads are paved?	0	number	4.9
<b>Qualitative Measures (Rate each from 1 to 5, with 1 being excellent and 5 being poor)</b>			
Are there sufficient economic and job opportunities in the community	5		5.0
Are people able to earn enough income to meet their needs	4		4.0
Is the community able to produce enough food to meet its needs?	4		4.0
Are there sufficient roads and transportation options?	5		5.0
<b>Community and Household</b>		<b>4.4</b>	
<b>Quantitative Measures</b>			
What percentage of people have mobile phones?	80	% of people	3.2
What percentage of people use the internet regularly?	0	% of people	4.6
How many motor vehicles are in the community?		number	
How many roads are paved?	0	number	4.9
<b>Qualitative Measures (Rate each from 1 to 5, with 1 being excellent and 5 being poor)</b>			
Access to radio in the community	4		4.0
Access to television in the community	5		5.0
Are there sufficient lighting solutions in homes (especially at night)?	5		5.0







Product Impact		28	User Input
<i>For all questions assume 100% market penetration of your product or service (enter appropriate penetration in dedicated box).</i>			
<b>Health and Safety</b>		<b>Weight</b>	
Enter total market penetration percentage (100 = 100%)		100	
1) Will your product or service provide electrical power for a local health clinic? (yes/no)		No	
<i>If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)</i>			
What impact will your product or service have on providing light in the local clinic?		3	5
What impact will your product or service have on providing power to the diagnostic equipment in the labs?		5	4
What impact will your product or service have on providing power for refrigerators in the labs?		5	4
2) Will your product or service provide any health or safety benefits to households? (yes/no)		Yes	
<i>If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)</i>			
To what extent will your product or service displace kerosene usage in the home?		5	10
To what extent will your product or service displace candle usage in the home?		5	3
What impact will your product or service have on improving health/safety in the home by displacing manual labor with power tools?		0	1
What impact will your product or service have on reducing particulate matter in home from cooking or heating?		0	3
<b>Health Impact product or service Score</b>		<b>2.2</b>	
<b>Final Health product or service Impact Score (weighted by market penetration)</b>		<b>2.2</b>	
<b>Education</b>		<b>Weight</b>	
Enter total market penetration percentage (100 = 100%)		100	
1) Will your product or service provide electrical power for a school? (yes/no)		Yes	
<i>If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)</i>			
What impact will your product or service have on providing lighting for the school?		3	5
What impact will your product or service have on providing power for educational labs or devices?		0	1
What impact will your product or service have on providing air conditioning or heating to the schools?		0	1
What impact will your product or service have on providing the school with access to computers and/or internet service?		0	3
2) Will your product or service provide help provide power for at-home schooling? (yes/no)		Yes	
<i>If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)</i>			
What impact will your product or service have on providing light for at home reading or studying?		5	5
What impact will your product or service have on enabling electronic equipment usage in the home?		0	1
<b>Education Impact product or service Score</b>		<b>2.5</b>	
<b>Final Education product or service Impact Score (weighted by market penetration)</b>		<b>2.5</b>	
<b>Water and Agriculture</b>		<b>Weight</b>	
Enter total market penetration percentage (100 = 100%)		100	
1) Will your product or service be used to pump or purify drinking water or provide power for sanitation services? (yes/no)		No	
<i>If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)</i>			
What impact will your product or service have on pumping water for drinking?		3	5
What impact will your product or service have on purifying water for drinking?		3	3
What impact will your product or service have on pumping water for sanitation services?		3	2
2) Will your product or service help facilitate agriculture? (yes/no)		No	
<i>If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)</i>			
What impact will this product or service have on pumping water for irrigation systems?		2	5
What impact will your product or service have on powering farm equipment?		2	2
<b>Water and Agriculture Impact product or service Score</b>		<b>0.0</b>	
<b>Final Water and Agriculture product or service Impact Score (weighted by market penetration)</b>		<b>0.0</b>	
<b>Enterprise and Economic Development</b>		<b>Weight</b>	
Enter total market penetration percentage (100 = 100%)		100	
1) Will your product or service provide electrical power for businesses? (yes/no)		Yes	
<i>If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)</i>			
What impact will your product or service have on providing light to businesses?		5	5
What impact will your product or service have on providing power to refrigerators, printers or other electrical equipment?		0	4
What impact will your product or service have on providing power to manufacturing equipment or other revenue-generating tools?		0	4
What impact will your product or service have on providing businesses with access to computers and/or internet service?		0	2
2) Will your product or service provide employment opportunities or household savings? (yes/no)		Yes	
<i>If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)</i>			
What impact will your product or service have on direct job creation in the community (directly employed by project)?		0	5
What impact will your product or service have on the creation of peripheral businesses or micro-entrepreneurs in the community?		3	5
Will your product or service result in net savings on energy expenditures for households?		4	5
<b>Water and Agriculture Impact product or service Score</b>		<b>2.0</b>	
<b>Final Water and Agriculture product or service Impact Score (weighted by market penetration)</b>		<b>2.0</b>	
<b>Community and Household</b>		<b>Weight</b>	
Enter total market penetration percentage (100 = 100%)		100	
1) Will your product/service provide power for outdoor lighting, community centers, or entertainment? (yes/no)		No	
<i>If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)</i>			
What impact will your product or service have on providing light for outdoor areas (streets, soccer fields, court yards, etc.)?		5	5
What impact will your product or service have on new publicly available sources of entertainment for the community?		5	4
What impact will your product or service have on providing power to places of communal gathering (public building, church, other)?		5	4
For the above services, to what extent will they be provided free of charge? (no charge = 0, paid services only)		5	4
2) Will your product or service provide power for general household services? (yes/no)		Yes	
<i>If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)</i>			
What impact will your product or service have on household lighting?		5	5
What impact will your product or service have on cell phone charging?		5	4
What impact will your product or service have on household entertainment (radio, television, music)?		0	2
What impact will your product or service have on kitchen appliances?		0	1
<b>Community Impact product or service Score</b>		<b>1.6</b>	
<b>Final Community product or service Impact Score (weighted by market penetration)</b>		<b>1.6</b>	







Financial Impact Score (100 point scale)		65	User Input
<b>Current residential expenditures</b>			
<i>Do not double count expenditures (if household purchases electricity that is used for lighting, phone charging, and other purposes, only count under electricity line).</i>			
What does the average household spend per month on lighting (kerosene, candles, batteries)?	\$ 3.50	USD/month	
What does the average household spend per month on cell charging?	\$ 0.50	USD/month	
What does the average household spend per month on electricity (for any purpose)?	\$ -	USD/month	
What are all other electricity-related expenditures (batteries for radio, other charging, etc.)?	\$ -	USD/month	
<b>Total monthly electricity-related expenditures</b>	<b>\$ 4.00</b>		
<b>Residential expenditures with energy project</b>			
<b>1) Upfront costs (one-time fees, such as capital purchases or interconnection fees)</b>			
What upfront costs will the average household pay for new service?	\$ 15.00	USD	
What percent of upfront cost is financed (if applicable)?	0	%	
<b>Remaining total upfront cost</b>	<b>\$ 15.00</b>	USD	
<b>2) Recurring costs</b>			
What is the amount of the monthly loan repayment for the upfront cost?	\$ 1.00	USD	
What other monthly costs are necessary to meet current demand (fuel, maintenance, membership, \$/kWh fee)?	\$ -	USD	
<b>Total monthly expenditures for new energy service</b>	<b>\$ 1.00</b>	USD	
<b>Current commercial expenditures</b>			
<i>Commercial customers include businesses, or government and nonprofit organizations. If there are no established business yet, use residential data. Do not double count expenditures.</i>			
What is the average monthly commercial expenditure for lighting (kerosene, candles, batteries)?	\$ 3.50	USD/month	
What does the average household spend per month on charging?	\$ 0.50	USD/month	
What does the average household spend per month on electricity (for any purpose)?		USD/month	
What are all other electricity-related expenditures (generator fuel, batteries, other)?		USD/month	
<b>Total monthly electricity-related expenditures</b>	<b>\$ 4.00</b>		
<b>Commercial expenditures with energy project</b>			
<b>1) Upfront costs (one-time fees, such as capital purchases or interconnection fees)</b>			
What upfront costs will the average commercial customer pay for new service?	\$ 15.00	USD	
What percent of upfront cost is financed (if applicable)?	0	%	
<b>Remaining total upfront cost</b>	<b>\$ 15.00</b>	USD	
<b>2) Recurring costs</b>			
What is the amount of the monthly loan repayment for the upfront cost?	\$ -	USD	
What other monthly costs are necessary to meet current demand (fuel, maintenance, membership, \$/kWh fee)?	\$ -	USD	
<b>Total monthly expenditures for new energy service</b>	<b>\$ -</b>	USD	
<b>Financial Metrics</b>		<b>Value</b>	<b>Score</b>
<b>1) Residential financial impact</b>			
Impact of upfront cost (upfront cost/average monthly household energy expenditure):	3.8		1.3
Impact of total monthly expenditures (new expenditure/current expenditure):	0.3		4.4
Simple payback period in years (upfront cost/annual savings):	0.4		4.8
<b>2) Commercial financial impact</b>			
Impact of upfront cost (upfront cost/average monthly household energy expenditure):	3.8		3.1
Impact of total monthly expenditures (new expenditure/current expenditure):	0.0		5.0
Simple payback period in years (upfront cost/annual savings):	0.3		4.8
<b>3) Sustainability of service</b>			
What is the lifespan of product/project in years?	5		1.0
How long is the warranty period for the product in months?	0		0.0
Does your personnel or a third party conduct system/product repairs when necessary?	yes		5.0
<b>Financial Impact Score</b>		<b>3.3</b>	





Environmental Impact Score (100 point scale)		82		
<b>Embodied Energy of Infrastructure</b>				
Is your product made out of recycled materials?	No		0.0	1
Will your product be recycled at the end of its useful life?	Yes		5.0	1
Are most of the components of the system manufactured domestically?	No		0.0	1
Estimate the total mass of one unit of installed infrastructure (excluding transmission) for a complete energy system.	1	kg		
Estimate the number of units necessary to fully serve 100 households.	100	#	5.0	4
Estimate the length of all transmission lines bringing power to community from outside for the project.	0	km	5.0	4
Estimate the length of all distribution lines that will be installed to bring power to homes within the community.	0	km	5.0	2
For the transmission and distribution lines in the previous two questions, approximately how many households will be served?	0			
<b>Embodied energy impact on Environmental Score</b>			<b>4.2</b>	<b>2</b>
<b>Installation Impact</b>				
Will your product or service require the permanent installation of physical infrastructure?	No		5.0	1
Does the installation require disruption of cultivated land or a natural ecosystem?	No			
To serve 100 households, how much crop land or natural ecosystem will be disrupted in/near the community (excluding transmission lines)?	0	m <sup>2</sup>	5.0	2
Will your product or service require transmission lines to bring power to the community or distribute it locally?	Yes			
How long will the cleared corridor be for power lines associated with the project?	0	km	5.0	2
For the transmission lines in the previous question, approximately how many households will be served?	0			
<b>Installation impact on Environmental Score</b>			<b>5.0</b>	<b>1</b>
<b>Renewable or Conventional Fuel Use</b>				
<b>1) Renewable resources</b>				
What percentage of the energy output is derived from renewable sources (incl. grid power mix)?	100	%		
What percentage of the project's renewable energy source is solar?	100	%		
According to the best atmospheric data available, what is the annual average insolation?	6	kWh/m <sup>2</sup> /day	5.0	1
What percentage of the project's renewable energy source is wind?	0	%		
According to the best atmospheric data available, what is the annual average windspeed?	0	m/s	0.0	0
What percentage of the project's renewable energy source is hydro?	0	%		
For what percentage of the year will the hydro resource be sufficient to fully power the system?	0	%	0.0	0
What percentage of the project's renewable energy source is biomass?	0	%		
On a scale of 0 to 5, rate the sustainability of the biomass supply (0 = very unstable, 5 = excellent supply)	0		0.0	0
<b>Renewable resource impact</b>			<b>5.0</b>	<b>5.0</b>
<b>2) Non-renewable fuel sources</b>				
What percentage of the energy output is derived from non-renewable sources (incl. grid power mix)?	0	%		
What percentage of the project's non-renewable energy source is coal (100% means all non-renewable fuel)?	100	%	0.0	1
What percentage of the project's non-renewable energy source is diesel?	0	%	0.0	0
What percentage of the project's non-renewable energy source is gasoline?	0	%	0.0	0
What percentage of the project's non-renewable energy source is natural gas?	0	%	0.0	0
<b>Non-renewable fuel impact</b>			<b>0.0</b>	<b>0.0</b>
<b>Renewable and non-renewable fuel use impact on Environmental Score</b>			<b>5.0</b>	<b>5</b>
<b>Product Lifespan</b>				
How long does will this product last under typical usage conditions?	3	years	0.6	4
How long is the warranty period for the product?	0	months	0.0	1
Does your personnel or a third party conduct system/product repairs when necessary?	yes		5.0	1
<b>Product lifespan impact on Environmental Score</b>			<b>1.2</b>	<b>2</b>





APPENDIX B – CASE STUDY TWO RANKINGS

Community Needs		61	User Input
<b>General</b>			
How many people in the community?	7000	people	
How many children are in the community?		children	
How many roads are in the community?	1	number	
How many kilometers of road are in the community?	1	km	
What is the total land area of the community?		square kilometers	
How much does the national government spend on health related expenditures	58	dollars	
<b>Health and Safety 4.5</b>			
<b>Quantitative Measures</b>			
How long do local people typically live?	62	years	4.0
How often do babies die during birth? (e.g. number in 100 births or %)	5	% of birth	4.1
How much do people spend on health related expenses per year?		dollars	
(for rural communities) How many people have access to an improved water source (faucet, spigot, etc.)	10	% of people	5.0
(for urban communities) How many people have access to an improved water source (faucet, spigot, etc.)		% of people	
How many people have access to improved sanitation facilities? (e.g. number of people in 100)	10	% of people	4.9
How many children get immunization for diphtheria, pertussis (or whooping cough), and tetanus		% of children	
How many children get immunization for measles		% of children	
<b>Qualitative Measures (Rate each from 1 to 5, with 1 being excellent and 5 being poor)</b>			
Ease of access to health care facilities	5		5.0
Overall level of community health	4		4.0
<b>Education 3.9</b>			
<b>Quantitative Measures</b>			
What percentage of children between the ages of 5 and 10 are enrolled in school?	80	% of children	2.6
What percentage children between the ages of 10 and 18 are enrolled in school?	75	% of children	3.0
What percentage of people over the age of 18 are enrolled in school?		% of people	
How many people over the age of 15 can read?	50	% of people	4.9
<b>Qualitative Measures (Rate each from 1 to 5, with 1 being excellent and 5 being poor)</b>			
Access to light in the community for studying and education	5		5.0
Overall level of community education	4		4.0
<b>Water and Agriculture 3.6</b>			
<b>Quantitative Measures</b>			
How much of the town/city land is used for agriculture?		% of land	
How much income do farmers earn?	50	USD	3.5
What percentage of the agricultural land is irrigated?	5	% of land	3.2
(for rural communities) How many people have access to an improved water source (faucet, spigot, etc.)	0	% of people	5.0
(for urban communities) How many people have access to an improved water source (faucet, spigot, etc.)		% of people	
<b>Qualitative Measures (Rate each from 1 to 5, with 1 being excellent and 5 being poor)</b>			
Ease of access to water sources	2		2.0
Are the local water resources (rain, rivers, reservoir, etc.) sufficient for agricultural production?	3		3.0
Is the community able to produce enough food to meet its needs?	5		5.0
<b>Enterprise and Economic Development 4.2</b>			
<b>Quantitative Measures</b>			
What is the local income?		USD	
How much income do farmers earn?	50	USD	3.5
What percentage of people make less than 1.25 per day?		% of people	
How much power is currently consumed per person each month?		kWh	
How much gas is consumed per person each month?	0	liter	4.0
What percentage of people have mobile phones?	80	% of people	3.2
How much diesel fuel is currently consumed per person each month?	0	liter	3.7
What percentage of people use the internet regularly?	0	% of people	4.6
How many motor vehicles are in the community	5	number	4.5
How many roads are paved?	0	number	4.9
<b>Qualitative Measures (Rate each from 1 to 5, with 1 being excellent and 5 being poor)</b>			
Are there sufficient economic and job opportunities in the community	5		5.0
Are people able to earn enough income to meet their needs	4		4.0
Is the community able to produce enough food to meet its needs?	4		4.0
Are there sufficient roads and transportation options?	5		5.0
<b>Community and Household 4.4</b>			
<b>Quantitative Measures</b>			
What percentage of people have mobile phones?	80	% of people	3.2
What percentage of people use the internet regularly?	0	% of people	4.6
How many motor vehicles are in the community?		number	
How many roads are paved?	0	number	4.9
<b>Qualitative Measures (Rate each from 1 to 5, with 1 being excellent and 5 being poor)</b>			
Access to radio in the community	4		4.0
Access to television in the community	5		5.0
Are there sufficient lighting solutions in homes (especially at night)?	5		5.0





Social Impact Score (100 point scale)		37	User Input
<i>For all questions assume 100% market penetration of your product or service (enter appropriate penetration in dedicated box).</i>			
<b>Health and Safety</b>		<b>Weight</b>	
Enter total market penetration percentage (100 = 100%)		50	
1) Will your product or service provide electrical power for a local health clinic? (yes/no)		No	
If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)			
What impact will your product or service have on providing light to the local clinic?		3	5
What impact will your product or service have on providing power to the diagnostic equipment in the clinic?		5	4
What impact will your product or service have on providing power for refrigerators in the clinic?		5	4
2) Will your product or service provide any health or safety benefits to households? (yes/no)		Yes	
If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)			
To what extent will your product or service displace kerosene usage in the home?		5	10
To what extent will your product or service displace candle usage in the home?		5	3
What impact will your product or service have on improving health/safety in the home by displacing manual labor with power tools?		2	1
What impact will your product or service have on reducing particulate matter in home from cooking or heating?		0	3
<b>Health Impact product or service Score</b>		<b>2.2</b>	
<b>Final Health product or service Impact Score (weighted by market penetration)</b>		<b>1.1</b>	
<b>Education</b>		<b>Weight</b>	
Enter total market penetration percentage (100 = 100%)		100	
1) Will your product or service provide electrical power for a school? (yes/no)		Yes	
If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)			
What impact will your product or service have on providing lighting for the school?		5	5
What impact will your product or service have on providing power for educational labs or devices?		0	1
What impact will your product or service have on providing air-conditioning or heating to the schools?		0	1
What impact will your product or service have on providing the school with access to computers and/or internet service?		0	3
2) Will your product or service provide help provide power for at-home schooling? (yes/no)		Yes	
If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)			
What impact will your product or service have on providing light for at home reading or studying?		5	5
What impact will your product or service have on enabling electronic equipment usage in the home?		0	1
<b>Education Impact product or service Score</b>		<b>3.1</b>	
<b>Final Education product or service Impact Score (weighted by market penetration)</b>		<b>3.1</b>	
<b>Water and Agriculture</b>		<b>Weight</b>	
Enter total market penetration percentage (100 = 100%)		100	
1) Will your product or service be used to pump or purify drinking water or provide power for sanitation services? (yes/no)		No	
If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)			
What impact will your product or service have on pumping water for drinking?		3	5
What impact will your product or service have on purifying water for drinking?		3	3
What impact will your product or service have on pumping water for sanitation services?		3	2
2) Will your product or service help facilitate agriculture? (yes/no)		No	
If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)			
What impact will your product or service have on pumping water for irrigation systems?		2	5
		2	2
<b>Water and Agriculture Impact product or service Score</b>		<b>0.0</b>	
<b>Final Water and Agriculture product or service Impact Score (weighted by market penetration)</b>		<b>0.0</b>	
<b>Enterprise and Economic Development</b>		<b>Weight</b>	
Enter total market penetration percentage (100 = 100%)		100	
1) Will your product or service provide electrical power for businesses? (yes/no)		Yes	
If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)			
What impact will your product or service have on providing light to businesses?		5	5
What impact will your product or service have on providing power to refrigerators, printers or other electrical equipment?		4	4
What impact will your product or service have on providing power to manufacturing equipment or other revenue-generating tools?		4	4
What impact will your product or service have on providing businesses with access to computers and/or internet service?		0	2
2) Will your product or service provide employment opportunities or household savings? (yes/no)		Yes	
If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)			
What impact will your product or service have on direct job creation in the community (directly employed by project)?		2	5
What impact will your product or service have on the creation of peripheral businesses or micro-entrepreneurs in the community?		5	5
Will your product or service result in net savings on energy expenditures for households?		4	5
<b>Water and Agriculture Impact product or service Score</b>		<b>3.7</b>	
<b>Final Water and Agriculture product or service Impact Score (weighted by market penetration)</b>		<b>3.7</b>	
<b>Community and Household</b>		<b>Weight</b>	
Enter total market penetration percentage (100 = 100%)		75	
1) Will your product/service provide power for outdoor lighting, community centers, or entertainment? (yes/no)		Yes	
If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)			
What impact will your product or service have on providing light for outdoor areas (streets, soccer fields, courtyards, etc.)?		3	5
What impact will your product or service have on new publicly available sources of entertainment for the community?		3	4
What impact will your product or service have on providing power to places of communal gathering (public building, church, other)?		5	4
For the above services, to what extent will they be provided free of charge (5, no charge - 0, paid services only)?		5	4
2) Will your product or service provide power for general household services? (yes/no)		Yes	
If yes: Please rank the following from 0-5: (0 - no impact, 5 - high impact)			
What impact will your product or service have on household lighting?		5	5
What impact will your product or service have on cell phone charging?		5	4
What impact will your product or service have on household entertainment (radio, television, music)?		3	2
What impact will your product or service have on kitchen appliances?		0	1
<b>Community Impact product or service Score</b>		<b>4.1</b>	
<b>Final Community product or service Impact Score (weighted by market penetration)</b>		<b>3.1</b>	





Financial Impact Score (100 point scale)		54	User Input
<b>Current residential expenditures</b>			
<i>Do not double count expenditures (if household purchases electricity that is used for lighting, phone charging, and other purposes, only count under electricity line).</i>			
What does the average household spend per month on lighting (kerosene, candles, batteries)?	\$ 3.50	USD/month	
What does the average household spend per month on cell charging?	\$ 0.50	USD/month	
What does the average household spend per month on electricity (for any purpose)?	\$ -	USD/month	
What are all other electricity-related expenditures (batteries for radio, other charging, etc.)?	\$ -	USD/month	
<b>Total monthly electricity-related expenditures</b>	<b>\$ 4.00</b>		
<b>Residential expenditures with energy project</b>			
<b>1) Upfront costs (one-time fees, such as capital purchases or interconnection fees)</b>			
What upfront costs will the average household pay for new service?	\$ -	USD	
What percent of upfront cost is financed (if applicable)?	0	%	
<b>Remaining total upfront cost</b>	<b>\$ -</b>	USD	
<b>2) Recurring costs</b>			
What is the amount of the monthly loan repayment for the upfront cost?	\$ -	USD	
What other monthly costs are necessary to meet current demand (fuel, maintenance, membership, \$/kWh fee)?	\$ 5.00	USD	
<b>Total monthly expenditures for new energy service</b>	<b>\$ 5.00</b>	USD	
<b>Current commercial expenditures</b>			
<i>Commercial customers include businesses, or government and nonprofit organizations. If there are no established business yet, use residential data. Do not double count expenditures.</i>			
What is the average monthly commercial expenditure for lighting (kerosene, candles, batteries)?	\$ 3.50	USD/month	
What does the average household spend per month on charging?	\$ 0.50	USD/month	
What does the average household spend per month on electricity (for any purpose)?		USD/month	
What are all other electricity-related expenditures (generator fuel, batteries, other)?		USD/month	
<b>Total monthly electricity-related expenditures</b>	<b>\$ 4.00</b>		
<b>Commercial expenditures with energy project</b>			
<b>1) Upfront costs (one-time fees, such as capital purchases or interconnection fees)</b>			
What upfront costs will the average commercial customer pay for new service?	\$ 100.00	USD	
What percent of upfront cost is financed (if applicable)?	0	%	
<b>Remaining total upfront cost</b>	<b>\$ 100.00</b>	USD	
<b>2) Recurring costs</b>			
What is the amount of the monthly loan repayment for the upfront cost?	\$ -	USD	
What other monthly costs are necessary to meet current demand (fuel, maintenance, membership, \$/kWh fee)?	\$ 10.00	USD	
<b>Total monthly expenditures for new energy service</b>	<b>\$ 10.00</b>	USD	
<b>Financial Metrics</b>		<b>Value</b>	<b>Score</b>
<b>1) Residential financial impact</b>			
Impact of upfront cost (upfront cost/average monthly household energy expenditure):	0.0		5.0
Impact of total monthly expenditures (new expenditure/current expenditure):	1.3		1.9
Simple payback period in years (upfront cost/annual savings):	No payback		0.0
<b>2) Commercial financial impact</b>			
Impact of upfront cost (upfront cost/average monthly household energy expenditure):	25.0		0.0
Impact of total monthly expenditures (new expenditure/current expenditure):	2.5		2.5
Simple payback period in years (upfront cost/annual savings):	No payback		0.0
<b>3) Sustainability of service</b>			
What is the lifespan of product/project in years?	25		5.0
How long is the warranty period for the product in months?	24		5.0
Does your personnel or a third party conduct system/product repairs when necessary?	yes		5.0
<b>Financial Impact Score</b>		<b>2.7</b>	





Environmental Impact Score (100 point scale)		92		
<b>Embodied Energy of Infrastructure</b>				
Is your product made out of recycled materials?	No		0.0	1
Will your product be recycled at the end of its useful life?	No		0.0	1
Are most of the components of the system manufactured domestically?	No		0.0	1
Estimate the total mass of one unit of installed infrastructure (excluding transmission) for a complete energy system.	1500	kg		
Estimate the number of units necessary to fully serve 100 households.	1	#	4.3	4
Estimate the length of all transmission lines bringing power to community from outside for the project.	0	km	5.0	4
Estimate the length of all distribution lines that will be installed to bring power to homes within the community.	0.1	km	4.9	2
For the transmission and distribution lines in the previous two questions, approximately how many households will be served?	50			
<b>Embodied energy impact on Environmental Score</b>			<b>3.6</b>	<b>2</b>
<b>Installation Impact</b>				
Will your product or service require the permanent installation of physical infrastructure?	Yes		0.0	1
Does the installation require disruption of cultivated land or a natural ecosystem?	Yes			
To serve 100 households, how much crop land or natural ecosystem will be disrupted in/near the community (excluding transmission lines)?	25	m <sup>2</sup>	4.4	2
Will your product or service require transmission lines to bring power to the community or distribute it locally?	Yes			
How long will the cleared corridor be for power lines associated with the project?	0.1	km	4.9	2
For the transmission lines in the previous question, approximately how many households will be served?	50			
<b>Installation impact on Environmental Score</b>			<b>3.7</b>	<b>1</b>
<b>Renewable or Conventional Fuel Use</b>				
<b>1) Renewable resources</b>				
What percentage of the energy output is derived from renewable sources (incl. grid power mix)?	100	%		
What percentage of the project's renewable energy source is solar?	100	%		
According to the best atmospheric data available, what is the annual average insolation?	6	kWh/m <sup>2</sup> /day	5.0	1
What percentage of the project's renewable energy source is wind?	0	%		
According to the best atmospheric data available, what is the annual average windspeed?	0	m/s	0.0	0
What percentage of the project's renewable energy source is hydro?	0	%		
For what percentage of the year will the hydro resource be sufficient to fully power the system?	0	%	0.0	0
What percentage of the project's renewable energy source is biomass?	0	%		
On a scale of 0 to 5, rate the sustainability of the biomass supply (0 = very unstable, 5 = excellent supply)	0		0.0	0
<b>Renewable resource impact</b>			<b>5.0</b>	<b>5.0</b>
<b>2) Non-renewable fuel sources</b>				
What percentage of the energy output is derived from non-renewable sources (incl. grid power mix)?	0	%		
What percentage of the project's non-renewable energy source is coal (100% means all non-renewable fuel)?	100	%	0.0	1
What percentage of the project's non-renewable energy source is diesel?	0	%	0.0	0
What percentage of the project's non-renewable energy source is gasoline?	0	%	0.0	0
What percentage of the project's non-renewable energy source is natural gas?	0	%	0.0	0
<b>Non-renewable fuel impact</b>			<b>0.0</b>	<b>0.0</b>
<b>Renewable and non-renewable fuel use impact on Environmental Score</b>			<b>5.0</b>	<b>5</b>
<b>Product Lifespan</b>				
How long does will this product last under typical usage conditions?	25	years	5.0	4
How long is the warranty period for the product?	24	months	5.0	1
Does your personnel or a third party conduct system/product repairs when necessary?	yes		5.0	1
<b>Product lifespan impact on Environmental Score</b>			<b>5.0</b>	<b>2</b>

