Stanford University Social Entrepreneurship Startup

Business Plan and Recommendations

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Please Note: For Section 3.2 (the competitive analysis of LED lighting vs other forms of lighting), we have recently received much more detailed lighting statistics from Lawrence Berkeley Laboratories (LBL). These statistics are included in a separate report from LBL.

CONTENTS

<u>1</u>	EXECUTIVE SUMMARY	4
<u>2</u>	THE DESIRED SOCIAL IMPACT	5
<u>2.1</u>	Social Impact 1 Improving Quality of Life	. 5
<u>2.2</u> emi	Social Impact 2 Improve the global environment by conserving energy and lessening the impact of ssions	.6
<u>2.3</u>	Social Impact 3 Encouraging growth and innovation in emerging economies	.6
<u>2.4</u> <u>dev</u>	Social Impact 4 Acting as a case study for the effectiveness of a market approach to international elopment.	.7
<u>3</u>	THE THEORY OF CHANGE	8
<u>3.1</u>	Principle 1 Sustainable Change through market solutions	. 8
<u>3.2</u>	Principle 2 LEDs are the best technology for achieving desired impact	. 8
<u>3.3</u>	Principle 3 Philanthropic Investment needed to 'create market'	12
<u>4</u>	PRODUCT DESIGN AND DEVELOPMENT	3
<u>4.1</u>	Design process	13
<u>4.2</u>	Development status and next steps	14
<u>5</u>	STRATEGIC RECOMMENDATIONS FOR LUTW	5
<u>5.1</u>	LUTW Status	15
<u>5.2</u>	Vision for the Future	15
<u>5.3</u>	Core Competencies	16
<u>5.4</u>	Strategic Initiatives	19
<u>5.5</u>	Key Recommendations	21
<u>6</u>	THE ORGANIZATION	22
<u>6.1</u>	Organizational Structure	22
<u>6.2</u>	Key Management Roles	23

Sta	nford University Social Entrepreneurship Report	June 2003
<u>6.3</u>	Board of Directors	
<u>6.4</u>	Staffing	
<u>7</u>	FUNDRAISING	24
<u>7.1</u>	Sources of Funding	
<u>7.2</u>	Fundraising Strategy	
<u>8</u>	CRITICAL RISK FACTORS	
<u>8.1</u>	Identifiable Risks	
<u>9</u>	MANUFACTURING AND LOGISTICS	
<u>9.1</u>	Manufacturing Strategy	
<u>9.2</u>	Strategy Reasoning	
<u>9.3</u>	Services Outsourced	
<u>9.4</u>	Relationship	
<u>9.5</u>	Estimated Startup Costs for Manufacturing	
<u>AP</u>	PENDIX 1 FUNDING BENCHMARKS	

1 Executive Summary

An estimated 2 billion people do not have access to even the most inefficient electric lighting systems. The majority of these people are still using fuel-based lighting in the form of kerosene or propane lamps, candles, or wood. These fuel-based systems are over 500 time less energy efficient than emerging electrical lighting systems (based on useful light output per \$) and have a wide range of adverse social and environmental impacts ranging from cancer inducing smoke inhalation to deaths from accidental fires. Further research is needed to scope the annual global costs of kerosene use for lighting purposes but current estimates from Lawrence Berkeley National Laboratory place the value between \$15 and \$60 billion.

Traditional incandescent lighting systems have had limited success in replacing fuel-based lighting because of the lack of consistent access to the electrical grid, reliability issues and other factors. Current electrical lighting solutions therefore have relied on battery-powered systems that are much more expensive to purchase compared to fuel-based alternatives. Without an economic incentive for the end user to invest in electrical lighting, fuel based systems have continued to dominate the market place in the developing world.

However, recent advancements in lighting technology have opened up the opportunity of using market forces to bring low-cost, battery-powered electrical lighting to the developing world. In particular, there are two technologies, Compact Florescent Lamps (CFLs) and Light Emitting Diodes (LEDs), that offer efficient lighting at relatively low power, therefore reducing battery powered operating costs to a level that is competitive with current fuel based lighting. Of these two technologies, LED lighting has the greatest potential; it is fast becoming the most efficient lighting technology and can provide sufficient illumination for common tasks such as reading with less than 1 Watt of electrical power. By comparison, standard CFL devices typically require 5 Watts, and incandescent household light bulbs require 40 Watts or more.

This 'global' business plan primarily focuses on the opportunity presented by LED lighting and the role that Light up the World (LUTW) foundation and other entrepreneurs should play in making LED lighting a reality. Detailed strategies and implementation plans are presented in three individual, stand-alone business plans for China, India and Mexico. In this business plan, we first lay the foundation for our work by demonstrating the social impact of bringing more efficient lighting solutions to the developing world. We then describe why introducing LED lighting by creating sustainable markets will lead to this social impact (our theory of change) before outlining the recommended strategy for making this change happen. Finally, we explain the resources needed for our plans to be successful and outline ways in which we aim to measure how effective we have been in achieving our desired outcomes.

2 The Desired Social Impact

The exact number of people who lack direct access to electric lighting is unknown. In 1996 the World Bank placed this figure as just under 2 billion people and some estimates are as high as 2.2 billion. More recent estimates suggest that the number has fallen to 1.6 billion people following an aggressive rural electrification program in China. In fact, all of these figures are likely to underestimate the issue as, in reality, many of people classified as having access to electricity face forced outages for at least 6 hours per day. According to the International Energy Agency, the number of electrified households is growing in regions outside of East Asia. Whatever the actual figure, there is little doubt that the use of fuel-based lighting has a wide range of negative social impacts from environmental pollution to individual health problems. The high operating costs of inefficient fuel based lighting also often leads to a 'rationing' of light, often at the expense of non-essential activities such as reading, writing and general education.

This business plan addresses the social problems of fuel-based lighting by planning development and market introduction of more efficient electrical lighting systems to the developing world. By doing this our desired social outcomes are to:

- Improve the productivity and quality of life of people who use fuel-based lighting, or have no lighting access, by giving them access to safer, more efficient lighting systems
- Improve the global environment by lessening the impact of emissions from fuel-based lighting.
- Stimulate growth and innovation by introducing new technology, training and skills into the economy.

These objectives are described in more detail below and relate specifically to this project. However, there is also a third, more generic objective relating to the effective use of donor funds:

• To demonstrate the effectiveness of introducing solutions to the developing world through market, rather than charitable mechanisms, and improve the leverage resulting from international philanthropic investments.

2.1 Social Impact 1 Improving Quality of Life

Replacing fuel-based lighting with more efficient electrical lighting will improve the quality of life for the end-user in a number of different ways:

Health Benefits

Kerosene lamps cause local and indoor air pollution. According to the World Health Organization, kerosene smoke has a '*nasty mix of particulates, carbon monoxide and carcinogenic gases*'. This smoke is responsible for respiratory infections, lung and throat cancers, and serious eye infections as well as being associated with low birth weights. Acute respiratory infections like influenza and pneumonia kill nearly 2 million children in developing nations each year

The World Bank estimates that 780 million women and children breathing kerosene fumes inhale the equivalent of smoke from 2 packs of cigarettes a day. Two-thirds of adult female lung-cancer victims in developing nations are none-smokers (SELF Newsletter, 2002).

Productivity Benefits

Electrical lighting will allow the user to increase productivity for two primary reasons; electrical lighting has a lower operating costs and can therefore be used longer, and the quality of electrical lighting is higher so the user can perform more tasks or perform the same task more effectively.

Lower Operating Costs

Fuel-based lighting such as kerosene has low fixed costs (i.e. buying the lamp) but relatively high variable costs. These costs not only involve money, but also time. The burden of obtaining kerosene is often on women and can involve walking long distances or taking up time that could otherwise spent more

productively. This often leads to 'rationing' the use of the light to a certain number of hours per day. A similar behavior is also true for users who have temporary access to electrical lighting via the grid. Efficient electrical lighting has the opposite dynamic; relatively high fixed costs but low variable costs. These lower variable costs will open up new opportunities for the continued productive use of the light, such as producing goods after-dark.

Higher Quality Light and Income Generation

The higher quality output of electrical lighting versus fuel-based lighting will enable users to perform a wider variety of tasks or perform the same task more efficiently. For example, many current users of fuel-based light are involved in 'cottage industries' such as embroidery and needlework and for processing agricultural products or caring for animals. Better quality light to perform these tasks will lead to higher productivity and therefore higher earned income, as well as potential health benefits resulting from better illumination.

Education

At present, the 'rationing' of fuel-based lighting and the low quality of flame lighting is a key barrier for continued education after daylight hours. As children are often required to work during daylight hours, the evening becomes the only real opportunity for children to study. The lower operating costs of electrical lighting will make reading after-dark much more affordable, both in terms of the after school education of children in the home as well as formal evening and early morning education in schools.

2.2 Social Impact 2 Improve the global environment by conserving energy and lessening the impact of emissions

The inefficiency of fuel-based lighting relative to electrical lighting is staggering. For example, the operating cost per useful lighting energy services (\$ / foot candle-hour of light) for kerosene lighting is 100 times higher than that for incandescent lighting and 500-times higher than for compact-florescent lighting. (These are average values, many end-users face even worse inequities). This difference in efficiency leads to severe inequities in affordability and lighting services. Although roughly one in three people obtain light with kerosene and other fuels, representing about 40% of total worldwide household lighting costs, they receive less than 1% of the resulting lighting services (measured in lumen-hours).

Fuel based lighting also results in approximately 250 million metric tons of carbon dioxide emissions into the atmosphere each year. This is equivalent to roughly 60% of the CO_2 emissions associated with electrical household lighting of the 26 developed country members of the International Energy Association (IEA).

Replacing fuel based lighting with more efficient electrical solutions will clearly lead to significant improvement in the global environment, both in terms of reducing total energy costs as well as severely reducing carbon dioxide emissions. We also have anecdotal evidence of wider ranging environmental benefits such as deforestation. This deforestation can occur because of the need to use wood for lighting purposes, often triggered by a shortage or price hike of Kerosene.

2.3 Social Impact 3 Encouraging growth and innovation in emerging economies

Introducing new technology and employment into the local country infrastructure will also help to encourage growth and innovation within emerging economies. For example, the solar panels built into the lighting solution will probably be manufactured within the developing world, and the supply chain will also involve local businesses.

The large-scale introduction of LEDs will also have an impact at a national government level. Firstly, Kerosene is typically subsidized, often to a very high degree. Reducing dependence on these subsidies therefore frees up government funds for other purposes as well as reducing the social problems that are

often associated with the volatility of kerosene pricing (sudden and unpredictable price hikes in Kerosene often result in civil unrest).

Secondly, electricity theft is widespread in the developing world, with up to 40% of the power illegally diverted in some areas. While our primary target is fuel-based lighting, battery-powered LED systems in countries like Mexico will help to reduce the extent of electricity theft.

2.4 Social Impact 4 Acting as a case study for the effectiveness of a market approach to international development

During this project, we have spent considerable time talking to a wide variety of advisors, including the International Finance Corporation (IFC), Grameen Bank and International Development Enterprises (IDE). In looking at potential business models, we have decided to sell the lights through market mechanisms rather than offer an aid-based charity model. We believe embedding new technology in the market is the best way to lead to long-lasting social impact. Our understanding is that this product development, market based approach can have significant impact. For example, over the last 15 years IDE has introduced 1.3 million water 'treadle' pumps in Bangladesh by selling these products in the market. These pumps retail at between \$12 and \$35 and the market is essentially self-sustaining. Although donors funds have been used to 'kick-start' the market, when amortized across the total pumps sold, these funds translate to a per pump donation of just \$5, a small fraction of the total pump price.

We have by no means completed a thorough analysis of the effectiveness of different models of international development. However, from the advice we have received, we believe that a market based product development model has great potential. By using this model effectively, we believe the introduction of LED technology into the developing world through market mechanisms can act as a role model for other organizations and improve the 'bang per buck' of philanthropic dollars devoted to international development.

Accountability

Although all the social impacts are important, Light Up The World (LUTW), should focus on holding itself accountable for delivering the first social impact; improving the quality of life of people in the developing world through the introduction of improved lighting services. In the process of delivering the product, LUTW needs to clearly define the specific social impact within quality of life for each market segment and ensure it explicitly identifies measures against which to judge progress.

3 The Theory of Change

Our theory of change rests of three key principles:

- i) The best way of creating sustainable change in the developing world is to harness market forces
- ii) LED lighting is best technology for achieving our desired impact because:
 - LEDs have a competitive advantage over fuel-based lighting and will therefore sell successfully in the market without the need for ongoing subsidies.
 - LEDs are also a more effective solution than alternative electrical lighting such as Compact Fluorescents.
- *iii)* Although profitable on an ongoing basis, donor funds will be required to kick-start the market for LEDs and create the manufacturing, distribution and marketing infrastructure needed for sustainability.

3.1 Principle 1 Sustainable Change through market solutions

Our 'theory of change' is built upon the foundation of harnessing market forces in the developing world to create sustainable change. If a new product does not add enough value to customers to cover the cost of purchase then any long-term attempt to introduce the product will fail. To achieve lasting impact, we believe that our lighting product must be able to stand-alone in the market place and therefore compete with current solutions. We also believe that the value to cost equation must make sense not just for the end-user but also for the whole supply chain. If every element in the supply chain is profitable then the market will become self-sustaining.

Given this principle of harnessing market forces, the task of identifying our market segment becomes more complicated than just assessing social need. For example, in China, we believe one of the best ways of introducing LED lighting to the rural poor is first to target individual retailers at night markets. These retailers are in a better position to afford the initial LED light and will provide an excellent 'showcase' for the benefits of LED technology. Creating a sustainable business serving night market retailers will begin to 'seed' the LED technology into other market segments where the social impact of LED lighter is likely to be greater. Therefore, the initial entry market segments will act as a 'means to an end' and provide a longer-term solution rather than merely targeting segments where the social impact of LED lights will be high but there is no business model to ensure the social benefits are delivered in a sustainable fashion.

Harnessing market forces will provide strong incentives for innovation and continuous improvement in the supply chain. Rather than forcing policies and procedures from the top down through a subsidized model, the combination of actors in the supply chain will follow their own self-interest to decide the most efficient systems to put in place. However, before to ensure these incentives are fully present, our theory of change relies upon up-front investment to 'create the market', as discussed further under principle 3.

3.2 Principle 2 LEDs are the best technology for achieving desired impact

On-going analysis by Evan Mills from Lawrence Berkeley Laboratories will mean the numbers in this section will need updating.

LED lighting has the greatest potential for achieving the social impact outlined in Section 1. Firstly, we evaluate LED lighting versus fuel based lighting to demonstrate that LEDs have a competitive advantage

over existing developing world lighting solutions and therefore can be sold effectively through the market. Secondly, we evaluate LED technology against alternative electrical lighting solutions to demonstrate why LEDs represent the best solution.

Evaluation of LED technology versus fuel-based lighting

Demonstrating LEDs offer a better solution than fuel-based lighting from the users perspective is an important pre-requisite to developing a market-based solution. Although the specific competitive advantage differs by individual market segment (see country plans for more details), a high level evaluation of LED lighting versus Kerosene demonstrates that LED lighting offers a higher quality solution at a lower cost. The user has a financial incentive to replace fuel based lighting with LED lights making a market based solution feasible.

Evaluation of LED versus Kerosene

To ensure consistency, we have chosen to compare the following lighting systems:

LED Light

- 1 Watt LED (Luxeon Star), 4 AA NiMH batteries, recharged with 5W solar panel
- 3 x 0.1W LED (Nichia), 1 AA NiMH battery, recharged with 2W solar panel

Kerosene Light

- Kerosene Lamp 1
 Simple Kerosene Lamp with wick
- Kerosene Lamp 2 Hurricane Kerosene Lamp

The quality and cost of the two lighting technologies should be evaluated against the specific user needs. Within each country plan, users within different segments are described in greater detail and specific value propositions are defined. For the purpose of our general comparison we shall take a typical task, reading, and evaluate the quality of the illumination for each technology.

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	1 Watt LED	0.3 Watt LED	Kerosene Lamp (Wick)	Kerosene Lamp (Hurricane)
Purchase Cost of Light System	\$30	\$5	\$1	\$3
Operating Cost (\$/year)	\$4	\$1	\$9	\$19
Total light output (lumens) 40	10	10	100
Light production (\$/100 lumen hours)	\$0.09	\$0.09	\$0.82	\$0.17
Useful Light Output (Lux typical working dist)	400	100	7	70
Illuminance (\$/1000 footcandle-hours)	\$0.01	\$0.01	\$1.17	\$0.24

Table 1: Comparison of LED Technology vs. Kerosene lighting

Assumptions

On-going analysis by Lawrence Berkeley Laboratories will mean these numbers need updating.

1) For LED, purchase cost of light system includes LED light, batteries and solar panels. For Kerosene, purchase costs include all lighting apparatus such as lantern and wick.

2) Operating cost per month assumes light is operated 3 hours per day. Assumes \$0.30 / liter for Kerosene (research shows range of \$0.10 to \$2 for Kerosene pricing)

3) Light can be measured in lumens (total light output) or lux (illumination falling on useful area). Figures in table refer to illumination (lux) at a 'typical working distance'

Costs

As table 1 shows, LEDs have purchase costs but much lower operating costs due to higher efficiency. With these savings in operating costs, the 1W LED light has a 6-month payback (\$30 purchase cost / 5\$ per month saving) and the 0.3W LED light pays back in less than a month (\$5 purchase cost / \$8 per month saving) compared to the basic kerosene lamp (wick).

Quality

LEDs provide more lux of useful light than Kerosene lamps. According to Lawrence Berkeley Labs, the recommended illumination level for retail (European standards) is 300 lux. In addition to the number of lux, LEDs also offer more consistent lighting levels, both over time (i.e. no flickering) and space (even spread of light over reading area).

Evaluation of LED technology versus other electrical lighting solutions

Having demonstrated that LEDs have a competitive advantage over kerosene, the question remains as to whether LEDs are a better than other electrical lighting technologies. Table 2 uses the same metrics as table 1 but evaluates LEDs against the following electrical solutions:

- Compact Florescent Lighting 5W solar lantern
- Incandescent Lighting
 Flashlight

	1 Watt LED	0.3 Watt LED	CFL	Incandescent Flashlight
Purchase Cost of Light				
System	\$30	\$5	\$75	\$5
Operating Cost (\$/year)	\$4	\$1	\$11	\$7
Total light output (lumens) 40	10	280	20
Light production (\$/100				
lumen hours)	\$0.09	\$0.09	\$0.04	\$0.3
Useful Light Output (Lux				
typical working dist)	400	100	56	10
Illuminance (\$/1000				
footcandle-hours)	\$0.01	\$0.01	\$0.59	\$0.78

Table 2: LED lighting versus Compact Florescent and Incandescent technology

On-going analysis by Lawrence Berkeley Laboratories will mean these numbers need updating.

The evaluation of LED versus CFL and Incandescent lighting is more complex than the comparison with Kerosene lighting. LEDs offer a lower cost solution but also have significantly lower total light output compared to the 280 lumens of a CF lantern. Although it is clear LEDs offer a more efficient solution than Incandescents, (\$0.09 vs. \$0.31 per 1000 lumen-hours) it is less clear why LEDs offer a better solution than CFL (\$0.09 vs. \$0.04). Understanding this point is fundamental to understanding why LEDs have the potential to unlock the electrical lighting market in the developing world and why other electric lighting technologies have failed.

The key barrier to creating sustainable electrical lighting markets for the poorest segments of the developing world's population has not been the *quality of light output* but the *cost of light output*. Therefore the challenge is not necessarily to provide the most efficient lighting system but *to provide an acceptable level of light for the lowest possible cost*. LED technology is better placed than CF and other technologies to meet this challenge because of four key reasons; lower power requirements, better optics, higher durability and rapid advancement of technology.

LEDs have lower power requirements than competing technologies

Stanford University Social Entrepreneurship Report

The cost of light output is dependent not only on the cost of the light itself, but also the cost of energy generation (e.g. solar panel) and energy storage (battery). The cost of power generation and power storage is in turn largely dependent on the energy drain of the lighting system; this is where LEDs become increasingly competitive. Requiring only 1 Watt, or even 0.3 Watt of power, LED lighting systems can be designed with much cheaper energy generation and storage components than the standard 5 Watt CF light, therefore providing an acceptable level of light at the lowest cost.

LEDs have better optics and are therefore able to 'do more with less'

Unlike a compact florescent light, an LED is essentially a point source and can be focused more effectively. These superior optics means even a 0.3W LED that only provides 10 lumens can still provide acceptable task based lighting. For example, in the table above, although a 0.3W LED light only emits 3% of the total lumen output of the 5W CF light, its total lux output is nearly 200% of the lux output of the 5W CF.

LEDs are more durable, therefore leading to lower replacement costs

Another key driver of cost is the expected lifetime of different lighting technologies. Theoretically, LED technology has an average lifetime of 100,000 hours versus 10,000 for CF therefore leading to a much lower rate of replacement. However, in reality, neither technology is likely to last its theoretical lifetime because of the stresses and strains of operating in developing countries. In fact, one of the major problems behind using solar CF lanterns has been the dismal failure rate; up to 50% of CF lanterns stopped working within a year¹. Although there is little direct evidence to suggest LED systems will not suffer similar problems, the solid state nature of LED technology versus the relative fragility of CFLs leads the design team to be optimistic about the expected durability of the LED system.

LEDs technology is rapidly advancing

LED lighting is an emerging technology that is still in the early stages of development. Barely 18 months ago, GE researchers proudly announced a new LED that produced 3.8 lumens per Watt; the 1W LEDs purchased recently for use in our prototype lights already average around 25 lumens per Watt, a 6 fold increase. However, this increase is relatively small compared to the potential increases in efficiencies predicted over the next few years with the advent of 2W and 3W LED lights (see figure 1 below).





The lower power requirements, better optics, higher durability and rapid advancement make LED technology the best electrical lighting solution for the developing world. In addition, LEDs superior economics relative to fuel based lighting means the technology can be introduced by harnessing market forces leading to sustainable social impact.

¹ Observations on low cost solar lanterns in Kenya, Paul Polak, IDE, July 1997

3.3 Principle 3 Philanthropic Investment needed to 'create market'

Although we believe a long-term sustainable market is possible, we also believe that the risk-reward ratio of making this investment is not sufficient to attract investment from the financial markets. Therefore, social investment is needed in order to create the market. This market creation will involve investment in setting up a sustainable supply chain from manufacturing and distribution through to retailing and after sales support. Significant promotional activities will be needed to 'sensitize' the market and create sufficient 'customer pull' to motivate independent entities to enter into the supply chain. The level of philanthropic funding needed to create the market is unclear. Several benchmarks associated with treadle pumps are shown in Appendix 1. These benchmarks vary from \$5 of donor funds per unit for IDE's introduction of 1.3million treadle pumps over a period of 15 years in Bangladesh to \$325 of donor funds per unit for ApproTec's introduction of 28,000 units (mostly water pumps) over a period of 10 years in Africa. Clearly, these benchmarks are very approximate; they take no account of social return on investment. However, economies of scale as well as geography appear to be very important factors in the ratio of donor funds to market creation.

4 Product Design and Development

The quest to develop a lighting system for the poor of the developing world had a variety of challenges associated with it, ranging from a need to keep costs exceptionally low to unique characteristics of the physical environment in which the light will be used. The design team utilized the IDEO product development process in order to develop three prototypes designed to address the needs of the customer.

4.1 Design process

• The Team

The design team brings a variety of different perspectives to the project. There are product designers, mechanical engineers, and electrical engineers. The team's collective experience includes extensive travel and studying abroad, work at a variety of design firms within the United States, and development work in several third world countries.

• The Approach

The Social Entrepreneurship Startup class and the team's design work are based on the principles of discovery-driven planning—the ability to generate and articulate new ideas, to gather feedback, and to iterate on these ideas and improve the solutions. The team constantly updates and refines different aspects of the light design.

• Empathy

The first step in the design process is empathy: a good design relies on a clear vision of the ultimate users and uses of the light. The goals of the empathy research were to decide which segments of the population are most likely to be helped by an LED light and to understand the lifestyles of these users—Which light sources are currently being used? How much do they cost? How many hours of light are used per day? What will people use the light for? Task lighting or ambient lighting? One person at a time or many people at once? Family setting or community setting? Should the light hang from the ceiling, mount on a wall, sit on a table or floor? Should it be portable? How often is the user willing to recharge batteries?

In order to answer some of these questions, the team talked with anthropologists, specialists in international development, international students, and people within the target countries. The team sent shipments with light prototypes, cameras, and questionnaires to be distributed to target users, hoping to answer specific usage questions and to learn more about people's preferences.

Technical research

Focused research was conducted in every area of the light to determine best practices and standards acceptable for out target users. The results are summarized as follows:

- *Power Generation:* Solar power provides the most compelling generation scheme for the singlefamily model. Given the minimal power requirements of LED's, solar power provides the lowest cost, and most versatile solution.
- Power Storage: AA Nickel Metal Hydride Batteries are specified in the design due to their high energy density and long cycle life. NiMHs are not environmentally toxic, a disadvantage inherent to many of their counterparts (alkaline, NiCad, Lead Acid). Due to recent technological advances, NiMHs are comparable in cost per amp/hour when compared to other alternatives.
- Driver Circuitry: A microprocessor-controlled circuit allows for necessary current regulation functionality at a low cost with minimal component requirements. This design improves on traditional analog designs by adding such features as a low battery warning and dimming capabilities. The circuit is 90% energy efficient.
- *Light:* All prototypes use LEDs, a promising, and generally untried solution for our target users in the developing world. LEDs are an actively developing technology with the lowest power

requirements and life expectancies of any light option. The are generally more efficient than other options and are the most durable and reliable lighting solution available.

- Optics: Task lighting demands appropriate optics to harness every amount of available light and focus it on the desired location. Both diffusers and lenses were employed to best leverage the light.<<need more research here>>
- *Housing:* Housing serves as a heat sink, also helps drive the needs of manufacturing. Stamped metal or molded plastic options. << add more here based on recent research>>

Prototypes

Prototypes were designed to test individual concepts and system integration. The prototypes include versions of the driver circuit, a light with adjustable focus, a diffused light, a light with adjustable number of LEDs and LED locations, modular lights that fit together, a light that can be upgraded from one LED to two, a light for a night market, attempts at the cheapest possible light, a light that can sit on a table in many positions, battery doors, and more. Prototypes were actively tested in numerous scenarios to provide data on usability, light output, durability, and other critical factors.

Integration

The final phase of the design process comprises the integration of best design features into two lights that best fulfill the design specifications. Our final designs center on two different LED strategies:

- 1) Fractional watt LEDs for the lowest cost option (manufacturing cost of \$3)
- 2) Lowest cost 1 Watt LED design (manufacturing cost of \$20)

Manufacturing

Throughout the design process, the team developed an active relationship with advisors from Solectron, a leading contract manufacturer based in Silicon Valley. Solectron engineers offered advice and insights into designing the light for lowest cost production and durability.

Intellectual property

All of the design work done by the Stanford team is intended to be open to LUTW as well as any other interested party throughout the world.

The only design work that isn't yet open source is the code for the PIC in the driver circuit. The team has helped Kurt Kuhlmann's development of PIC code, which is similar to code he has written for another company. Kurt is eager to make an agreement with LUTW to provide pre-programmed chips for use in its lights, but he is not willing to show the PIC code to the Stanford team or LUTW.

If LUTW decides to use PIC driver circuits, there are two choices. It can use the PICs customized for the Stanford team's light, sourcing them through Kurt Kuhlmann, or it can work toward the same solution by producing its own PIC code and circuit.

4.2 Development status and next steps

On June 5, the SES team delivered two prototypes to LUTW. The prototypes will reflect two months of technical research, numerous design iterations, and a wealth of interactive feedback from a network of over 40 advisors and coaches from top companies and organizations.

Between June and August 2003, the process will include a user testing/ pilot phase of 100 lights in target markets and a manufacturing feasibility study with contract manufacturers. Final iterations will commence from these processes.

5 Strategic Recommendations for LUTW

5.1 LUTW Status

The LUTW Foundation was the first humanitarian organization to introduce the liberating technology of solid state lighting to homes in the developing world, and the organization continues to be the only one globally active in spearheading efforts to introduce solid state lighting to those most in need. The organization has made significant progress in recent years, getting lights into the hands of over 700 homes of the poor in Sri Lanka, Nepal, India, and several other countries. Interest in the LUTW lighting systems, however, significantly out-paces the organization's ability to satisfy it, and the single biggest challenge facing LUTW is determining how to efficiently and sustainably address this unmet demand in the market.

The LUTW organization remains rather under-resourced with only three employees and a modest annual budget of less than US\$100,000 to cover project costs and modest organizational overhead. With such a small team, LUTW barely has the necessary staff to continue to execute on the projects currently underway and is constantly faced with the challenge of prioritizing the numerous opportunities to expand their programs.

LUTW has realized the importance of partnering with other organizations and individuals in order to fulfill their mission and satisfy this unmet demand. Efforts are now focused on facilitating the success of several on-the-ground projects with a variety of delivery partners. These partnerships are showing promise and providing important leverage to the LUTW staff.

LUTW must now transition from a project based group capable of directly installing lighting systems in hundreds of homes per year to a world-class social enterprise that facilitates the success of reputable and capable in-country socially-minded organizations that can leverage the LUTW model and relationships in order to continually replicate the early success, thereby meeting the lighting demands of potentially millions of people.²

5.2 Vision for the Future

LUTW has had tremendous success to date in getting their LED lights into the hands of hundreds of households in the developing world, but despite this progress only a very small portion of the people in need have been served. In order to deliver on it's mission of lighting up the homes of three million or more people by 2007, LUTW must evolving into an organization that leverages it's proven track record, expertise, and relationships in order to scale up its social impact.

Figure 2 provides an overview of the suggested elements of the organization transformation.

Figure 2: Organizational Transformation

² Portion of this text taken from "Light Up The World - Update (2001 – 2002)" published by LUTW and Light up the World Funding Proposal (Feb 20, 2003)

Existing Organization		SCALE UP	Proposed	Organization	
	Manufacturing	Small, family run manufacturer in Nepal		Manufacturing	Contract Manufacturer (Selectron), key sourcing relationships
	Product Design	2 LED lights, basic pedal power generator		Product Design	Multiple lighting systems tailored to different segments
	Business Model	Range of donors funding small individual projects		Business Model	Market based solution through existing 'in- country' channels
	Staffing	3 person LUTW team		Staffing	In-country subsidiaries managed by local entrepreneurs. Wide range of strategic partnerships
	Scope	1,000 lights over 5 years spread across 8+ countries		Scope	Focused pilots on priority market segments in major markets

5.3 Core Competencies

In order to facilitate this transformation and deliver upon its vision for the future, LUTW must reflect on the competencies and skills that are necessary to achieve success with this business model, critically assess and develop those it must posses internally, and partner with other organizations to provide the remaining pieces of the puzzle.

Critical Competency for Success	Importance as Internal Competency	Current LUTW Level	Recommendations
Fundraising	High	Low	Funding sources exist so LUTW must build a dedicated fundraising organization capable of identifying and securing large philanthropic grants.
Customer Empathy	High	High (in specific countries)	Continue to develop deep understanding of target customer and their evolving needs through in- country research and investigation and relationships with members of the local communities.
Product Development and Design	Low	Low	No need to maintain capabilities internally. When successive product iterations are required, the desire can be outsource to a product design firm (e.g. IDEO or equivalent).
Technical Competence	Medium	Medium	Acquire a technical staff member responsible for staying abreast of technical innovation and linking these trends to the needs of target customers.
Component Sourcing	Medium	Medium (Lumileds)	Existing strong relationship with Lumileds should be leveraged. Developing relationships with PV panel and battery manufacturers.

Table 3: Critical Competencies (in rough chronological order)

Ma0nufacturing	Low	Low (PicoPower)	Partner with Contract Manufacturer (e.g. Solectron or Flextronics) or with high quality in-country manufacturer to ensure products can be produced
			for low-cost with high levels of quality.
Developing World Marketing and Promotion	Low	Low	Develop relationships on a country- by-country basis with organizations or companies that possess the expertise and experience of marketing in the local markets. (e.g. IDE in India or Bangladesh).
Local Distribution	Low	Low (in existing countries)	Leverage existing distribution challenges when possible. When not, develop relationships with existing companies or governments capable of delivering the product to the end- customer. Rely upon market incentives whenever possible.
After-Sales Support	Low	Low	Develop partnerships in-country to provide reliable after-sales support to customers to ensure reliability of product.
Reputation and Brand - Consumer - Non-profit community	Depends High	Low High	Leverage existing strong reputation within the non-profit community to facilitate fundraising and partnership. Work with in-country partners to determine importance of LUTW brand for local consumer marketing.
Project Management	High	Medium	Develop internally a world-class project management organization capable of managing a diverse set of partners and in-country subsidiaries.

The critical competencies required to successfully achieve the objectives defined by LUTW are Fundraising capabilities, Customer Empathy, Project Management capabilities, Reputation, and a moderate level of Technical Competence. LUTW currently posses many of these competencies internal, but will also need to develop or acquire several of these capabilities in order to be successful.

Current Assessment of LUTW Competencies

LUTW is strongest in Reputation and Customer Empathy and has moderate Technical Competence and Component Sourcing capabilities.

Reputation (within Non-Profit Community). Dave Irvine-Halliday and the LUTW organization have garnered a tremendous amount of international press and recognition in their short time as a social enterprise. The organization has a proven track record of significantly improving the standard of living of the poor with whom they work in the developing world. This history of success combined with Dave and his team's infectious enthusiasm for the initiative has generated massive media and public interest n LUTW. Recent awards include:

Awards & Distinc	Awards & Distinctions				
November 2002	President's Internationalisation Achievement Award – University of Calgary				
November 2002	Tech Museum Laureate – Equality Award (USA) (US\$50,000)				
October 2002	Rolex Laureate – Award for Enterprise (Switzerland) (US\$100,000)				
March 2001	Teaching Excellence Award – University of Calgary				
October 2000	Alberta Women's Science network "Mentor of the Millennium Award"				
October 2000	IEEE Third Millennium Medal for "Outstanding Achievements and Contributions"				

April 2000 APEGGA Summit Award for "Community Service"

Recent media coverage includes:

Media Coverage	
1999	1 Newspaper article
2000	18 Newspaper articles
	1 Magazine article
2001	15 Newspaper articles
	5 Magazine articles
2002	17 Newspaper articles
	7 Magazine articles
	19 TV & Radio interviews
	National Geographic special "The Man who Lit Up the Mountains"

Customer Empathy. This is another area where LUTW is very strong. Over the last three years, members of the LUTW organization have traveled to developing countries throughout the world to install and support lighting system prototypes in poor rural households. They have conducted extensive interviews with the end-users and with organizations that serve them in an effort to understand the customer needs and develop products that provide significant value to them.

- **Technical Competence.** LUTW has a variety of technical expertise relating to lighting systems, particularly low-watt solid-state LED systems. The organization has maintained a high level of awareness about the emerging trends in solid-state lighting (and to a lesser degree batteries and power generation techniques) and understands how these technologies should be adapted in the creation of lighting systems for the rural poor in developing countries.
- The founder, Dave Irvine-Halliday has a Ph.D. in Electrical Engineering and extensive contacts in the academic and commercial lighting field. Unfortunately, this is a quickly evolving field and Dr. Irvine-Halliday only has limited time to focus on the technological trends and the new product releases in LEDs and batteries.
- **Component Sourcing.** In 2002 LUTW signed an agreement with Lumileds of San Jose, CA to procure the world's most advanced white LEDs at a discount, significantly lowering the total manufacturing cost of LUTW's lighting products. The organization is now actively engaged with Kyocera of Japan to conclude a similar social pricing agreement for solar panels. Batteries are the third major component of the LUTW lighting systems and have a huge impact on the price and affordability of LUTW's lights. LUTW continues to look for potential battery manufacturing partners that are interested in contributing to reducing the cost of the LUTW lighting systems their in-kind donations and discount pricing arrangements.
- As LUTW expands its operations and begins to create thousands of lighting systems, the manufacturing will necessarily become more sophisticated and very likely be contracted to one or more third parties. The ultimate manufacturer for the product may also be able to identify potential sources of components and may be able to use its purchasing power to gain high-volume discounts, which would reduce the costs of the underlying components. Generally speaking, partnerships such as the one between LUTW and direct suppliers, such as Lumileds, are ideal they provide scale price discounts to LUTW and ensure maximum flexibility with manufacturers.

Competencies to be Developed

There are some critical areas in which LUTW must expand its current capabilities. Many of these are described below. LUTW, however, cannot possibly develop in-house all the necessary competencies to achieve its mission. For many of the competencies that aren't critical to maintain in-house, LUTW should look for third-party partners.

Fundraising. The initial funding for LUTW was contributed by Dave Irvine-Halliday and his wife. Since its inception the organization has received philanthropic gifts from a variety of individuals and modest grants from several philanthropic and award organizations. While this funding has been incredibly valuable to date, the organization remains under-funded given the aggressive goals outlined previously. LUTW therefore must develop a dedicated and effective development capability internally that is capable of raising large government and foundation grants as well as individual contributions. More recommendations related to fundraising are discussed in subsequent sections of this plan.

- **Product Design and Development.** The LUTW team created a very successful initial lighting system as a result of their technological expertise and their deep empathy for the customer. The original system, however, remains too expensive and needs to be updated as a result of further innovation regarding white LEDs, batteries, and power generation systems. As the SES project at Stanford University has demonstrated, this is a function that can be very effectively outsourced.
- If the LUTW team can convey their understanding of the customer and his or her needs effectively, a product design firm (e.g. IDEO or others) could be contracted to efficiently design a product that meets customer needs and that is designed for manufacturability. This approach will utilize the expertise of the design firms and ensure that the products are manufactured at the lowest price possible.
- **Manufacturing.** If LUTW is to achieve it's goal of delivering millions of lighting systems to the developing world, it must find a manufacturer capable of producing in large volumes, at high quality, and for an affordable price. This is best accomplished by outsourcing the manufacturing of the lighting systems to a dedicated manufacturing organization where scale economies can be achieved and quality can be controlled. This could either be a contract manufacturer (e.g. Solectron) or a dedicated electronics manufacturer within a target country if appropriate. The issues surrounding manufacturing are discussed later in this plan.
- **Marketing and Promotion.** Marketing and promotion for the lighting systems will be critical to LUTW's success in each country. Marketing and promotion are inherently a local business what works in one region will not necessarily work in another. LUTW must, therefore, develop relationships on a country-by-country basis with local people or organizations capable of effectively promoting the product.
- **Local Distribution.** Distribution of products, especially to the rural poor in the developing world, is very challenging and potentially very costly. Building a full-scale distribution network for an inexpensive consumer product such as the LUTW lighting systems will not be sustainable. LUTW, therefore, must leverage existing distribution options within each country. In some countries, this means that LUTW can rely upon existing wholesalers, distributors, and retailers and only needs to provide them enough of a financial incentive to stock and distribute the product.
- In other countries, LUTW many need to piggyback off other companies that have already developed effective distribution networks (e.g. IDE in India). In some countries, in fact, LUTW may find it most effective to utilize government sponsored distribution networks. In all cases, LUTW will need to leverage an existing infrastructure to be successful.
- **After-sales Support.** Although critical to the long-term success of the product, after-sales support is not a competency that LUTW must maintained in-house. LUTW must identify partners who have the basic technical capabilities to provide such after-market services. If LUTW can create a model in which these organizations are compensated fairly and in which they can receive the training they require, then individuals and companies can effectively play this role.

5.4 Strategic Initiatives

The following strategic initiatives are critical if LUTW is to reach its potential.

Develop Partnerships

Partnerships will be key to addressing the core competencies that are not maintained internally. LUTW must partner with technical, manufacturing, marketing, and distribution organizations that have the capacity and the reach to help LUTW deliver on their mission. Because of its proven track record, the organization has been very successful to date in developing partnerships with corporate and non-governmental organizations in an effort to design, manufacture and distribute its lighting systems. LUTW must continue to forge additional relationships to fill the competency gaps.

Partnership selection is incredibly important. LUTW should consider the following criteria when selecting a partner:

- An alignment of mission and values
- Proven track record of success (particularly when considering country partners)
- Financial strength and viability
- Reputation within the local market

Focus Efforts and Prioritize Initiatives

Prioritization will be critical for LUTW's long-term success. Initially LUTW should identify one to two initiatives in which it believes it can have significant social impact can run successful pilots. The organization should then work with exiting partners or identify appropriate new partners to provide the necessary marketing and distribution expertise in these countries. Once selected, efforts should be focused on making these countries unquestionable successes and providing out the viability of the sustainable model in each country. LUTW must recognize that these projects and focus on their success even at the expense of launching new pilots in other countries.

Proof-of-Concept Pilots

LUTW has proven that there is demand for its lighting system within several countries when these products are provided at no charge and philanthropic contributions are employ to cover the costs of manufacturing and distribution. The organization now needs to demonstrate that customers are willing to pay for the products and that sustainable businesses can be developed to manufacture and distribute these lights more broadly.

It will be critical for the organization to develop tools to measure the pilot's impact and the organization's performance and to ensure these measures are updated regularly. Theses results will allow LUTW to continually improve their efficacy as well as demonstrate to potential funds and partners the specific nature of their social impact.

• Hire and Develop Local Staff

Local knowledge is essential for LUTW's initiatives to be successful. LUTW must recruit, train, and retain qualified local individuals to build the pilot teams and launch its in-country subsidiaries. These local staff members are absolutely essential in building an understanding of the existing market and in establishing credibility with government and local partners. Most if not all of the senior members of the in-country subsidiaries a success.

• Develop Franchise Model

LUTW will continue to be presented with opportunities in new countries and new regions where their lighting systems can provide social benefit. The organization does not have resources to pursue all of these options simultaneously and therefore will necessarily need to prioritize the options.

In many countries, LUTW may need to initially pass on an opportunity, but may believe that there is enough momentum in that country that simply providing the product, technology, and brand may be

enough for another social entrepreneur to get it off the ground. To support these situations, LUTW should develop a franchise arrangement in which local entrepreneurs, government organizations, or NGOs could submit an application to be granted a franchise affiliation. These franchisees application must be considered carefully, but once select, LUTW would provide them with the product and components necessary to launch their own lighting initiative.

This franchise approach would allow other like-minded organizations to leverage all its accumulated knowledge and experience in order to scale the potential social impact more quickly. At the same time, it would allow LUTW to focus on develop its subsidiaries and initiatives in the countries it has prioritized as most important.

Adopt a Market-oriented Mindset

Whenever possible, LUTW should rely upon existing market mechanisms to provide the necessary incentives to facilitate the production and distribution of lighting systems to the developing work. These market mechanisms ensure sustainability long after the philanthropic funding has disappeared. They also are the greatest way to rapidly scale the impact.

5.5 Key Recommendations

LUTW in order to achieve its mission should undertake the following steps in the very near-term.

- Within the next month conduct a strategic planning session involving the LUTW board and staff members. Determine very clearly the mission and strategic goals of LUTW and how the organization plans to achieve them.
- Drive current partner conversations to conclusion by utilizing the strategic plan to determine alignment of proposed partnerships with LUTW's goals. Go into these partnership discussions with a clear understanding of what LUTW intends to achieve from the partnership.
- Identify one to two pilot regions and push aggressively to develop a sustainable business model within those countries that can be scaled and provides a critical proof of concept.
- Begin the process of recruiting a limited number of trusted and effective in-country personnel to form the foundation of the in-country subsidiaries.
- Hire (or acquire through a consulting arrangement) a CEO with a strong strategic management background who can develop a long-term plan for the LUTW organization and drive it through to implementation.
- Build a dedicated fundraising function to support the growth of the organization by hiring (on a parttime contractor basis initially) a Director of Development.
- Engage a contract manufacturer to refine the Stanford SES team lighting system prototypes and to ultimately manufacture enough lighting systems for the upcoming pilots.
- Develop training material and "LUTW Franchise Kits" that can be utilized by other organizations
 interested in a franchiser arrangement to facilitate the distribution of LED lighting to the developing
 world.

6 The Organization

6.1 Organizational Structure

Developing a lean but effective organizational structure for the LUTW umbrella organization will be critical. LUTW International will be the umbrella organization with each major country initiative having its own in-country not-for-profit subsidiary. The umbrella organization must ensure that all critical roles and responsibilities are covered, but that the organization remains as small as possible and grows to support the rollout and creation of individual country subsidiaries.

LUTW International is a project management, product development, and fundraising organization that works to coordinate activities between the in-country subsidiaries. The organization will provide services to the in-country subsidiaries in the areas of product development, sourcing and manufacturing, technology advocacy, training, and fundraising.

Product Development. LUTW International works with in-country staff to gather customer needs and feedback on current products to influence the product design and development process for future lighting systems. LUTW International then contracts with a third-party to conduct the product development. LUTW International is responsibility for identifying the trends in emerging technology and incorporating those trends into the products.

Manufacturing and Fulfillment. LUTW International contracts with a Contract Manufacturer (CM) for the manufacturing of the lighting systems. LUTW International has a staff to take orders from the in-country subsidiaries, aggregate those orders, and manage the manufacturing and fulfillment of those orders by the CM.

Technology Advocacy. LUTW International is responsibility for identifying the trends in emerging technology and incorporating those trends into the products in order to meet customer needs.

Training. LUTW International will facilitate the exchange of information between the in-country subsidiaries. They will conduct meetings with representatives of the in-country subsidiaries one to two times a year into order to exchange ideas and communicate LUTW global strategy.

Fundraising. LUTW International will provide extensive support for any fundraising efforts, including those originating in the local countries. LUTW International will fund the early stage deployment in each country with the expectation that the subsidiary will become sustainable within three years

International Development Enterprises (IDE) provides a model very similar to the model described above. The organization works in ten countries throughout the world with independent subsidiaries and an IDE International umbrella organization.³

The recommended organization structure is outlined in Figure 3. The organization is broken down into various departments with a Director heading up each. Initially many of these roles may be incorporated into the responsibilities of a single individual or handled by contractors, but as the organization scales dedicated management roles will likely be required.

³ IDE Website (<u>http://www.ide-international.org/index.jsp</u>) and conversations with Paul Polak (CEO of IDE)

Figure 3: Organizational Structure



6.2 Key Management Roles

Several key management roles will be required within the LUTW International organization. The organization will be headed up by an Executive Director and, as the organization grows, and Assistant Executive Director. The individuals will have responsibility for setting the strategic direction for the organization, ensuring it is delivering on its mission, and fundraising.

Director-level department heads will coordinate activates within each of the following areas: Design and Manufacturing (including technology advocacy), External Relations, Development, and Performance Management. Each director will add managers and staff as need order to achieve the departments' objectives. The department heads should all have extensive functional expertise. A primary responsibility of the External Relations department will be managing the frequent interaction between LUTW International the in-country subsidiaries.

In addition, the LUTW International will employ an Office Manager and administrative staff to handle the critical administrative functions.

6.3 Board of Directors

Governance of the LUTW Foundation is currently very informal. It is important that a Board of Directors be conveyed with responsibility for overseeing the activities of LUTW. The Board size should be limited to between six and ten Directors. The Executive Director should have an ex-officio position on the board and the other Directors should be outsiders selected for the expertise in the fields of international development and relevant technologies and/or their commitment to the LUTW organization.

Outside directors should be sought with diverse expertise including empathy and understand of the poor in developing courtiers, experience with related NGO endeavors, related-technology expertise, and business management expertise. In addition, the board members will have extensive fundraising obligations and the board membership should represent those individuals who have made significant contributions to the LUTW organization and those with the ability to support the fundraising efforts of the organization.

The Board of Directors will convey two to four times per year to review the current activities of the organization and conduct strategic planning for the future.

6.4 Staffing

The Executive Director and the department directors will manage hiring into the LUTW International organization. Compensation will be consistent with industry norms.

The hiring of the Directors of the in-country subsidiaries will be handled jointly by the LUTW International organization and the Board of Directors of the in-country subsidiary. An effort should be made to hire local individuals into the leadership positions of the in-country subsidiaries.

7 Fundraising

7.1 Sources of Funding

The LUTW Foundation has raised money from a limited number of private sources over the last three years. Original funding for the group was provided by Dave Irvine-Halliday and his wife. Subsequent funding has been provided as a result of the Rolex Award, and in 2002 LUTW received additional founding for administrative purposes from an anonymous group called PQR as well as several other small organizations and individuals.

The funding to date has been enough to support the current efforts of LUTW. The funding requirements will increase dramatically, however, as the organization works to expand in scale and fulfill its mission.

The near-term funding requests are driven off of the pilot costs in each of the selected target countries as well as the administrative needs of expanding the LUTW organization. The current estimates range from \$60,000 to \$250,000 per pilot depending on the country and scale of the project. Annual administrative expenses could rise as much as \$200,000-\$500,000 per year for the next several years.

The expectation is that this funding will be provided from a variety of private and public sources and will be raised through the efforts of a full-time development staff.

7.2 Fundraising Strategy

It will become increasingly important to create within the LUTW organization a dedicated fundraising capability with experience in raising funds for international development efforts. Initially such a person can be hired as a contractor in order to reduce the financial burden and achieve many of the immediate benefits of such experience and expertise. As the organization scales to deliver on its vision, the full-time Director of Development will be required.

There is immediate need for funding to support the rollout of the proof-of-concept pilot projects. The funding will probably most easily be raised from private individual and smaller foundations with interests in international development.

Once the pilots are completed and the lighting system and business model have been proven, LUTW will need to initiate significantly larger fundraising efforts in order to scale the organization and its impact. These funds will most likely be acquired through appeals to large foundations and government and international agency programs.

Large Foundations

There are a variety of foundations in the United States and internationally that will provide funding to support international development efforts. In addition, there are large foundations that will provide funding to projects that address issues of education, energy conservation, and public health – many of which the LUTW projects address. A list of the largest foundations within the United State by subject area of contribution is provided in the appendix.

International Grant Agencies

Much of the international development work currently underway is funded by grants from international organizations or agencies specifically create to support and facilitate it. There generally exists very formal application processes for such funding requests and management of the grant can be onerous, but the relatively large sums of money available through these channels make sure efforts well worth it.

Individuals

LUTW should always be willing to accept contributions from individuals inclined to give to their cause. The expectation, however, is that ultimately a very small portion of the annual contributions will be from these sources. LUTW does not have a natural constituency on which to draw (as, for example, a university) would. Therefore there will be significant costs associated with outreach to potential individual donors and raising the awareness of lighting issues in the developing world.

8 Critical Risk Factors

8.1 Identifiable Risks

LUTW's project team has several years of on-the-ground experience in community participation, international development and adaptive technology. The organization recognizes the critical risk factors and works to mitigate these whenever possible.

Risks/Assumptions ⁴	Project Management Responses
Political or Social Instability	Planned contingency for alternate region or country.
Funding Shortfall	Scale back project. Reduce number of villages.
Demand Exceeds Ability to	Always. Ration resources to villages most in need (selection criteria)
Deliver	and where local community participation is ensured.
Local Assembly Substandard	Source components or completed lamps from LUTW Canada or Pico
	Power Nepal partner.
Local Partner(s) Lack Capacity	Vet partners in advance. Scale back project, increase resources and
	secure alt. Partner(s).
Technology	LUTW technology and processes are adaptive to local needs,
	renewable energy sources and independent power production.
Health, Security & Liability	Experience/skill redundancies on team. Health & repatriation Insurance.
	Indemnity agreements.

⁴ Taken from LUTW Shell Funding Proposal

9 Manufacturing and Logistics

9.1 Manufacturing Strategy

The essence of LUTW's manufacturing strategy is to use Solectron, the contract manufacturer, to make the lights units. LUTW should not spend money to duplicate facilities and equipment that Solectron has already invested large amounts of resources to perfect.

9.2 Strategy Reasoning

More and more, leading original equipment manufacturers (OEMs) are relying on electronic manufacturing service, such as Solectron, to assemble their products. The major drivers for LUTW to outsource include shorter time-to-market, low upfront costs and simplicity of implementation. Thus, outsourcing will enable LUTW to focus on its core competencies, which include research and development as well as sales and marketing.

9.3 Services Outsourced

Solectron provides a larger selection of services, in addition to the traditional manufacturing operations. These services range from product design to supply-chain management.

a. New Product Introduction (NPI)

NPI processes ensure that no matter who handles design or manufacturing, a product seamlessly flows from one phase to the next, regardless of who takes the hand-off.

b. Component Selection

One of Solectron's largest NPI value-adds is component selection. They leverage their component expertise and buying power to build manufacturing efficiencies in every customer's product.

c. Design for Manufacturability

Their design process often is the driver for the successful manufacturing of a customer's product. Taking into account the necessary design factors that will allow for successful volume production. The earlier Solectron is involved in a LUTW's product design process, the more value they can provide — from time-to-market, time-to-volume and time-to-cost.

d. Prototyping

Solectron's prototyping skills allow them to support product introduction close to their customers and facilitate rapid manufacturing rollout wherever LUTW need such expertise. Prototyping allows Solectron to ensure LUTW, that they have provided LUTW with the lowest total cost and fastest time-to-market and volume, while maintaining the highest quality standards, when products are ready for mass production.

e. Test

With extensive experience in test-set design, test-process design, and development, Solectron's testing services allow them to reduce overall cost, increase product yields, reduce retest of failed products and ensure overall product quality.

f. PCB Assembly/Advanced Packaging

Solectron will fulfill LUTW's PCB and packaging needs. Solectron leverages their global level of expertise and knowledge to utilize the most advanced packaging technologies available.

g. Manufacturing

Solectron is able to offer the very best techniques and practices to provide quality at a relatively low cost.

h. Failure Analysis

Stanford University Social Entrepreneurship Report

Solectron's failure analysis expertise allows them to quickly find the root causes of failures in product design and manufacturing, build error-free processes for their internal manufacturing needs and constantly evaluate their suppliers and partners to ensure their customers needs are met.

i. Logistic Management

Solectron leverages their relationships with key transportation and delivery companies, creating a dedicated worldwide network of logistics and warehousing services.

9.4 Relationship

There is already a relationship started with Solectron and LUTW. Solectron is aware of the mission and purpose of LUTW and has given advice concerning the design for manufacturability of the lighting units. When LUTW is prepared to proceed forward with manufacturing, LUTW needs to provide Solectron with a detailed design specification of the lighting unit, along with justifications for each design component.

9.5 Estimated Startup Costs for Manufacturing

Budgetary Cost Estimates

Design Requirements Specification	\$4,000
	\$4,000
Component Engineering	\$1,000
PCB Layout	\$5,000
Tooling and Programming Fee	\$4,000
Design Verification Test	\$20,000
Design Re-Spin (fixes, improvements, value engineering(\$2,000
Program Management	\$10,000
Total Estimated Startup Cost for Manufacturing	\$50,000

APPENDIX 1 FUNDING BENCHMARKS

The following data represents a quick analysis of the philanthropic funds necessary to support the rollout of several successful product-based international development efforts.

	Company	IDE (Water pumps)		
General Info	ApproTec	India	Bangladesh	
Total Expenditure	\$9.1 million (30% profit, 70% funded)			
Donor Funds	\$6.4 million	\$5 million	\$7 million	
Years	10 years	5 years	15 years	
	28,000 units (22,000 water irrigation,		1.3 million pumps (sales hit 1k/month	
Output	mostly pumps	100,000 pumps	after 3 years)	
Core Products	Super money-maker pump (\$75, 22kg) Money maker plus (\$38 pump, 6.5kg)	Treadle pumps ranging in price from \$12 to \$25 (average price \$12)	Treadle and rower pumps from \$12 to \$35 (cheapest 2 yr version has been most successful)	
# of Staff	72	150 Staff in India	?	
Supply chain information		16 manufacturing companies, 90 distributors, 920 dealers, ??? Installers (note India has extra step in supply chain)	65 manufacturers, 700 dealers and 5000 installers	
Core countries	Kenya, Tanzania and Uganda	India	Bangladesh	
Source of funds			-	
Self-generating	30% (26% product sales, 4% consulting)	?		
Philanthropic	70% (62% Govt dev. Agencies, 7% Private Trusts, 1% Individual)	?		
Total phil. Investment per unit	325	50	5.4	
Annual figures				
Monthly Sales	600 units / month			
Annual Sales	7200 units / year	50,000 per year	80,000 per year	
Annual Budget	2.06 million	1 million		
Philanthropic funding	\$1.5 million	1 million		
Investment / unit (\$)	208	20		