Affordable Lighting Solutions for Shopkeepers

Business Plan, June 2006

d.light team members:
Erica Estrada, Mario Fishman, Sam Goldman, Ned Tozun, Xian Wu
EXECUTIVE SUMMARY

Myanmar presents a unique set of development challenges, including high inflation levels at 50% per annum\(^1\), a majority of the population living on less than $1/day, a military junta controlling access to foreign imports, and a severely constrained transportation, power, and communication infrastructure. One of the most critical development challenges for Myanmar is supplying affordable lighting solutions, the precursor to larger electrification projects. Currently, at least 35 million Burmese villagers rely on low-quality candles as their principal source of lighting\(^2\).

Using LED technology, d.light’s product, **ForeverBright**, provides a comparable quantity but higher quality light than candles, while using one-sixteenth the power of fluorescent lighting. These power saving features allow the ForeverBright to last significantly longer on a signal battery charge. At $3.75 retail, the ForeverBright is surprisingly cost competitive with lower quality $0.02 candles, which have to be replaced hourly, and is far more economical than a fluorescent light. The ForeverBright can be manufactured in Myanmar, and is intended to be powered by locally produced and widely available 6V batteries costing $2.50. We believe the product’s low-cost makes it competitive in urban areas as well.

Meanwhile, lighting solutions represent an important step towards diversifying IDE/M’s product line, which currently focuses exclusively on water pumps. A quality light would allow IDE/M to build its reputation and brand in other consumer products while leveraging its strengths in supply chain management and manufacturing expertise. While many projects worldwide are working to provide more affordable lighting solutions for rural populations, d.light is specifically targeting the 30,000 low-income shopkeepers who are currently using candles and are working within IDE/M’s existing distribution network.

Most rural shopkeepers and 50% of urban shopkeepers\(^3\) currently use locally made candles to light their stores for two to three hours per night. Candles cost about two to four cents each, but only last one to two hours and are fire hazards. Many urban retailers have upgraded to small fluorescent 10W tube-lights and wet lead-acid batteries, which they re-charge every few days using grid power. Rural shopkeepers do not have access to grid power, and with diesel generator recharging costs upwards of thirty cents\(^4\), this makes fluorescent lights prohibitively expensive in rural areas. Therefore, there exists substantial opportunities to provide intermediate solutions between inexpensive low-quality candles, and expensive electric lighting options like fluorescent lights for rural users.

The ForeverBright is one such solution, and is ready for initial market testing and analysis to determine the degree to which form, LED spacing, light quality, power source, and end use will affect both the ForeverBright consumers and is manufacturing process.

---

\(^1\) Conversations with Jim Taylor, IDE-Myanmar. May 2006.
I. Customer Profile

A. Rationale

Burmese shopkeepers are the customer base of team d.light. We focused on shopkeepers not only because there are over 1 million shopkeepers in Myanmar, but also because of the interesting point of view that they bring to the lighting world. Previous affordable lighting projects in the past (such as Ignite and Light Up the World) have focused on a more general customer base with a more general goal in mind: wanting to bring light to their customers. Team d.light is focused on not only bringing affordable light to their customers, but also increasing the customer’s personal income as a result.

First of all, shopkeepers are generally the “more wealthy” of the population, and thus the early adopters for first technologies. For example, some of the wealthy shopkeepers were the early adopters for fluorescent lighting because they were the only ones that could afford the lighting. Shopkeepers can provide IDE with free marketing and live product demonstrations to nearby businesses and clientele. This will serve as the perfect starting point for introduction of our product. Once the shopkeepers adopt our proposed lighting solution, then it will soon disseminate to the rural households.

We believe that shopkeepers would be interested in investing in an improved lighting product because of the advertising element that will be inherent in the light. Shopkeepers desire this higher quality and modern light to attract clients, and well-illuminated products are more likely to be sold. They can also stay open longer with more affordable lighting, thus increasing their income by selling more products in the additional open hours. This notion was confirmed through a comment from an IDE-Myanmar intern showing one of our LED prototypes to a Burmese shopkeeper:

“They did think this illumination was significantly different from fluorescent and just might attract more customers. Several said it made their fruit look more appealing.”

B. Meet Than: The Typical Rural Burmese Shopkeeper

Than, one of the shopkeepers surveyed during our research into the Burmese shopkeeper culture, owns a small snackshop in the village of Hla Pa Ta. One of the villagers owns a diesel generator and offers services to charge batteries which are mainly used to power light bulbs. However, with diesel prices soaring, candles have become the most affordable route.

Than begins his day at 6am with the opening of his shop, just in time for passerbyers seeking breakfast. During the day, business is slow while most of the village farmers are out in the field.
However, as evening approaches, business picks up. Customers begin to arrive in small groups, their paths carefully lit by a flickering candle, a cheap plastic Chinese torchlight bought from last month’s county fair, or merely the natural moonlight.

At about 7pm, Than lights four or five small candles to illuminate his 3’x4’ stand. More and more customers congregate in the light, mulling over candies and candles, and cheerfully conversing with the familiar shopkeeper. Most customers pay with cash, however, some do ask for a credit-based purchase. As the night progresses, and by the time Than closes his shop at about 8:30pm, he has served 16 customers in the previous 3 hours and has made close to 6,000 kyats.

C. Shopkeepers in General

Shops come in generally two categories: rural or urban. The boundary between these categories is drawn by the reach of the electrical grid. Those shopkeepers with grid access are referred to as urban, and those with no grid access are referred to as rural. There exist millions of other rural shopkeepers similar to Than, in Myanmar. Shops usually sell small item such as snacks, candies, batteries, light bulbs. Some small shops merely sell hot food and cold beverages. The bigger stores can sell more expensive products such as pesticides for crops, watering cans, and even IDE pumps. The IDE distribution network is well-integrated into the rural small shop landscape, and therefore our lighting solution will be well-marketed and publicized.

D. Current Lighting Solutions

Most of the more rural shopkeepers are using candles. Candles do have some advantages in that they offer a sufficient signal to customers indicating that the store is open. Furthermore, they sufficiently illuminate products, and of course, they are cheap and easily accessible. However, candles are not used in the first world for many obvious reasons. First of all, any object hanging a certain distance above the candle will cast eerie shadows upon the space. Also, candles are a dangerous fire hazard in the predominantly bamboo and grass-based huts and stores that the Burmese own.

Shopkeepers who are closer to more urban areas are mainly using fluorescent tube lights. Fluorescent tube lights do produce a lot of light, and they definitely outshine a candle. On top of that, they are modern-looking and do not prove to be much of a fire hazard.
However, fluorescent tube lights also have their disadvantages. Most importantly, they consume a lot of energy. This means that the battery that they operate with must be recharged every day or two. These recharging costs are high, and the battery must be recharged every day or two. For an urban shopkeeper, this would constitute a recharge through the grid. However, a more rural user would be recharging the battery from a diesel generator. Diesel prices are forever rising, thus making fluorescent lights prohibitively expensive for rural users. The rural users are thus forced to use candles.

E. Our Opportunity to Add Value: The Black Hole

After examining the current lighting market, one can see that the candle is the low cost-low quality solution available to the rural shopkeepers as illustrated in Figure 3. On the extreme end exists a high quality-high cost solution in the form of fluorescent tubelights. These are sometimes used by the more affluent urban shopkeepers. After a series of user surveys and lighting questions to Myanmar, we have found that there does in fact exist a black hole, and thus an opportunity for a mid-range lighting solution to be made available to shopkeepers. Once this solution is found and validated, the lighting solution will then most likely be adopted by household owners, and more specifically, income generating households.

Figure 3: The current lighting market for shopkeepers has both cheap, low quality solutions as well as expensive, high quality solutions, thus leaving a mid-range black hole.
The ForeverBright is a light-emitting diode (LED) based solution. It is housed in a foot-long PVC pipe of one inch diameter. The circuit consists of four parallel sets of two LEDs, as shown in the circuit diagram in Figure 5. Each set of two has one super-bright white LED and one orange LED. The white LEDs require 3.6 V, while the orange ones require 2 V. A 2.5 ohm resistor is used for the remaining 0.4 V provided by the battery. The system runs off a 6V rechargeable sealed lead acid (SLA) battery, which is commonly available in Myanmar.
The following are the design features of the ForeverBright. These features were determined based on the needs of the shopkeepers in Myanmar.

<table>
<thead>
<tr>
<th>Design Features</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Four pairs of LEDs spread over 1’ length</td>
<td>It was found that most shopkeepers require sufficient lighting to light a table 3’ x 4’ at a 3’ height. The eight LEDs were spaced over a 1’ length to provide this.</td>
</tr>
<tr>
<td>Inclusion of orange LEDs with super-bright white LEDs</td>
<td>Using a 6 V battery, the most efficient use of the energy provided was to provide more light rather than waste it as heat using resistors. The 2 V LEDs with the 3.6 V LEDs make a 5.6 V voltage drop, thus only ‘wasting’ 0.4 V. At five cents each, and providing about 30% more light to the product, the orange LEDs were a sensible inclusion.</td>
</tr>
<tr>
<td>PVC tube</td>
<td>PVC is readily available in Myanmar, and is an easy, low cost solution for a light housing. The PVC pipe is painted in red, to give it a similar look to IDE</td>
</tr>
<tr>
<td>LEDs as light source</td>
<td>The LEDs are advantageous over fluorescents lighting as they require much less power to run. The LEDs will drain the SLA batteries at one sixteenth the rate fluorescents will. The LEDs will not deep discharge the SLA batteries since the diodes will simply switch off after the batteries drop below the required voltage. With fluorescent bulbs, SLA batteries are often deep-discharged, causing the length of the battery life to shorten significantly.</td>
</tr>
<tr>
<td>Uses 6V SLA batteries</td>
<td>Rather than using solar power, which is still considerably expensive, or disposable AAA or D size batteries, the light was designed to run off a power source which is readily available in Myanmar. Local battery manufacturers are common.</td>
</tr>
</tbody>
</table>

A. Design Process

Team d.light began the design process with an interest in energy/lighting solutions for Myanmar. In seeking to better understand the situation in Myanmar, the team corresponded extensively via e-mail and conference calls to Jim Taylor in Myanmar. IDE|M themselves learned a lot about the energy and lighting situation in Myanmar through the questions put forth by d.light.

It was because of the great need for affordable lighting in Myanmar that d.light decided to narrow the focus of the project to a lighting solution. According to Jim Taylor, “the energy sector represents a huge underserved market. 98% of villages in Myanmar are off any kind of electrical grid. And even if a massive rural electrification program were announced tomorrow, it would be decades before millions of families would be served.” By developing a lighting product, d.light would also serve IDE|M by helping them to diversify into other innovative products apart from low-cost, small-plot irrigation equipment.
B. The Shopkeeper

Paul Polak helped the team to narrow down the point of view to focusing in further on shopkeepers. The rationale behind this was that shopkeepers rely on good, affordable lighting solutions as a means of generating income. It is difficult to quantify if families would be willing to pay more for an alternative form of lighting if there is no direct monetary benefit from it. However, the earnings of a shopkeeper could direct benefit from better lighting, thus making it more marketable to shopkeepers.

C. Prototypes and Surveys

Team d.light then built and sent a series of prototypes to Myanmar to get a better feel of the desired needs that users had. Prototype users were surveyed by Sam, an IDE|M intern. Survey and results can be found in the appendix. The prototypes and surveys were designed to find out:

- What many people currently used as lighting solutions
- How much people were willing to pay for light
- If there was a way to quantify the worth of better lighting
- Whether the aesthetics and the packaging of the lighting solution mattered

Figure 6. PVC tube cut in half and wrapped in foil to make it look like a fluorescent tube. This prototype helped generate the idea for the eventual ForeverBright product.

Figure 7. Flashlight in a box. Did the size and robustness of the lighting solution matter?

Figure 8. Sixty hour candles. These were found to be too dim for users' liking, and was deemed "probably too expensive".

Figure 9. Reflectors out of old soda cans.
D. Lessons Learned

Some lessons that were taken away from the responses were:
- The shopkeepers value the “modern look” of the light provided it is affordable.
- The size of the lighting enclosure did not matter so much as long as it was practical.
• Users are extremely sensitive to the variable cost of using the light. An example is fluorescents lighting indirectly relies on diesel prices. As diesel prices have risen, many users have reverted to using candles.
• The source of power for the lighting must be something which is readily available and reliable in Myanmar. These two last points rule out the use of AAA or D batteries since they are costly, and the Chinese brands available there are unreliable.

The following were the needs of the shopkeeper that were generated from the findings from the survey and other correspondence:

Table 2. Needs of the shopkeeper for lighting

| Light comparable to candles | The most common form of lighting is far inferior to fluorescent tubes, is a fire hazard, and has limited ability to light since it lights from below. Customer ability to view the merchandise is important to shopkeepers. |
| Modern and attractive lighting | Shopkeepers desire their shops to be differentiated from other shops. They felt that if they had something which looked like it was from the city and was a new technology, they would have an edge over other shops. Customers would be naturally drawn by bright and nice looking lights. |
| Light for a 3’ x 4’ table, from 3’ height | It was found that majority of roadside stalls all sold their goods from stalls of similar dimensions. This was regardless of what they were selling. |
| Accessible power source | The grid in Myanmar is unreliable, solar power is considerably expensive, as are disposable AAA or D size batteries. SLA batteries are fairly common, although recharging prices have gone up. |
| Low fixed cost, low variable cost | Shopkeepers need extreme affordability. They must be able to pay for it, and to pay for the upkeep of their lighting solutions. |

With these needs in mind, prototyping was done around the idea that the solution could be something similar to the fluorescent in terms of size and housing, in a housing of a readily available material such as PVC, and painted IDE|M red to give the modern look, as well as the reliability associated with the brand.

The ForeverBright was thus designed and prototyped with these needs in mind, with the help of Kurt Kuhlman and his extensive knowledge of LEDs and electrical circuitry. Figure 13 on the following page shows how the ForeverBright matches up with the fluorescent tube and candles.
Figure 16. Clockwise from top: Fluorescent light, a pair of candles, and the ForeverBright
III. Financial Analysis

A. Cost of the ForeverBright

The ForeverBright uses a minimal number of components that keeps the manufacturing cost low. For all component costs, we assumed an order quantity of 1000 to get volume pricing. All materials except for the LEDs (resistors, paint, PVC, wires, etc) can be obtained locally in Myanmar.

**LEDs**

<table>
<thead>
<tr>
<th>LEDs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of LEDs</td>
<td>4</td>
</tr>
<tr>
<td>Fixed cost per white LED</td>
<td>$0.25</td>
</tr>
<tr>
<td>Fixed cost per yellow LED</td>
<td>$0.05</td>
</tr>
<tr>
<td>LED Import Tariff</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Total LED cost</strong></td>
<td><strong>$1.50</strong></td>
</tr>
</tbody>
</table>

Our system requires 4 super-bright white .12W 3.6V LEDs (Part #LWK3333) and 4 yellow .12W 2V LEDs. The only components that need to be imported are the LEDs. The best information we could obtain on import duties was that the taxes ranged from 0% - 40% depending upon the item. We assumed a 25% import duty on LEDs for our cost estimates. We will source the 0.12W super-bright white LEDs from HKJE LED Lamp Center, based in China. The yellow LEDs may be obtained locally in Myanmar. We can source them in the US from Kurt Kuhlmann for $.05 each.

**PVC frame**

<table>
<thead>
<tr>
<th>PVC Frame</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per foot of PVC</td>
<td>$0.10</td>
</tr>
<tr>
<td>Length of PVC needed (in feet)</td>
<td>1</td>
</tr>
<tr>
<td>2 Screws (2 x #6 - 32 x 3/4&quot;)</td>
<td>$0.06</td>
</tr>
<tr>
<td>Paint Cost per foot</td>
<td>$0.10</td>
</tr>
<tr>
<td><strong>Total Frame Cost</strong></td>
<td><strong>$0.26</strong></td>
</tr>
</tbody>
</table>

Rather than using an expensive injection molded frame for our light, we can source cheap and widely available 1” diameter PVC material to construct the light. This provides an elegant frame for the light that looks similar to a tube light. When painted red, it looks sleek and modern. To construct the light, the PVC will need to be cut open and then re-sealed using two screws. We estimate that the cost of red paint for foot of PVC will be $.10.

**Electronics**

<table>
<thead>
<tr>
<th>Electronics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 Ohm Resistor</td>
<td>$0.01</td>
</tr>
<tr>
<td>Electrical Tape</td>
<td>$0.02</td>
</tr>
<tr>
<td>Total wire length (feet)</td>
<td>4</td>
</tr>
<tr>
<td>Cost of wire per foot</td>
<td>$0.01</td>
</tr>
<tr>
<td><strong>Total Electronics Cost</strong></td>
<td><strong>$0.07</strong></td>
</tr>
</tbody>
</table>
Because our system does not require a circuit board, the cost of the electronic components is minimal. All that is required is proper wiring and soldering to complete the circuit. Electrical tape is needed to cover stripped wiring to prevent shorting. And a 2.5 Ohm resistor (which costs less than a penny when purchased in bulk) is needed to complete the circuit. Remarkably, the system protects against deep discharge. The downside of not having a circuit board is that when the LEDs can be damaged if the ForeverBright is plugged into a battery with a voltage higher than 6V.

**Labor**

<table>
<thead>
<tr>
<th>Labor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Skilled hourly labor cost</td>
<td>$0.20</td>
</tr>
<tr>
<td>Hours of labor to manufacture</td>
<td>1.5</td>
</tr>
<tr>
<td>Unskilled hourly labor cost</td>
<td>$0.10</td>
</tr>
<tr>
<td>Hours of unskilled labor needed</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total Labor Cost</strong></td>
<td>$0.45</td>
</tr>
</tbody>
</table>

The labor cost was the cost component with the highest degree of uncertainty. Unskilled labor costs in Myanmar are $1 per day and skilled labor costs are $2 per day. We assumed that soldering wires together qualified as skilled labor. Assuming a 10 hour day, we calculated that skilled labor costs about $.20 per hour. We assumed that the entire process would take about 1.5 hours of skilled labor and 1.5 hours of unskilled labor.

<table>
<thead>
<tr>
<th>Job</th>
<th># of minutes</th>
<th>Skilled/Unskilled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting the PVC</td>
<td>10</td>
<td>Unskilled</td>
</tr>
<tr>
<td>Drilling the holes</td>
<td>20</td>
<td>Unskilled</td>
</tr>
<tr>
<td>Painting the PVC red + the IDE name</td>
<td>30</td>
<td>Unskilled</td>
</tr>
<tr>
<td>Soldering the wires, resistors and LEDs</td>
<td>60</td>
<td>Skilled</td>
</tr>
<tr>
<td>Attaching the LEDs and testing them</td>
<td>30</td>
<td>Skilled</td>
</tr>
<tr>
<td>Re-sealing the PVC</td>
<td>30</td>
<td>Unskilled</td>
</tr>
</tbody>
</table>

**Mark-ups**

<table>
<thead>
<tr>
<th>Mark-ups</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IDE Mark-up</td>
<td>25%</td>
</tr>
<tr>
<td>Store Mark-up</td>
<td>30%</td>
</tr>
</tbody>
</table>

The mark-ups listed here are probably somewhat generous. But we assumed these mark-ups also covered sales and promotion costs as well as transportation costs. We also thought that since the item has a low retail value, IDE and shopkeepers may need a higher margin per unit than is required with the pumps.

**Cost Summary**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total LED Cost</td>
<td>$1.50</td>
</tr>
<tr>
<td>Total Frame Cost</td>
<td>$0.26</td>
</tr>
<tr>
<td>Total Electronics Cost</td>
<td>$0.07</td>
</tr>
<tr>
<td>Total Labor Cost</td>
<td>$0.45</td>
</tr>
<tr>
<td><strong>Total Manufacturing Cost</strong></td>
<td>$2.28</td>
</tr>
<tr>
<td>IDE Mark-up: 25%</td>
<td>$0.57</td>
</tr>
<tr>
<td><strong>Wholesale Cost</strong></td>
<td>$2.85</td>
</tr>
<tr>
<td>Store Markup: 30%</td>
<td>$0.86</td>
</tr>
<tr>
<td><strong>ForeverBright Retail Price</strong></td>
<td>$3.71</td>
</tr>
</tbody>
</table>
B. Rechargeable Batteries

To use the ForeverBright, the customer will need a rechargeable 6V battery that is not included. The cheapest 6V battery available has a 4AH (Amp-Hour) capacity and costs $2.50. The next best alternative would be a 6V 12AH battery that costs $3.60. The 12AH battery has a higher capacity and would allow the customer to recharge less frequently. Also, recharging a 12AH battery is only double the cost of charging up a 4AH battery – whereas the 12AH battery has three times the capacity.

However, despite the long-term cost savings that can be attained by purchasing the 12 Amp-Hour battery, our analysis suggested that given the high monthly discount rate of customers, most users would choose to use the $2.50 battery for our system (assuming a monthly discount rate between 10-15%). This was because the long-term cost savings gained from the 12 Amp-Hour battery didn’t outweigh the extra $1.10 in initial cost.

In the case of powering a 10W fluorescent light, we concluded that users would at minimum purchase a 6V 12AH battery because a 4AH battery would not have enough capacity to provide lighting for a night with this system.

Other rechargeable batteries are also widely available such as 9V and 12V batteries which are typically more expensive than 6V batteries. These batteries can be used with a fluorescent tube, but if they are attached to the ForeverBright system, the LEDs could be damaged.

C. The $5 Light

In all of our cost projections, we tried to be conservative. We hope that the $3.75 retail price is an upper-bound on the price and that over time, the cost can be made even lower with the eventual goal of having a light/battery system under $5. The current battery/light combination is $6.25, which we feel is a good starting point.

A complete electric lighting system under $5 may be attainable in the very near future. For instance, if LEDs drop to $.15 each and we drop the IDE markup to 15% and the store markup to 20%, the retail price of the ForeverBright would be $2.50. With a 6V 4AH battery costing $2.50, the entire system would cost under $5. This would make the product very competitive with fluorescents on the basis of start-up costs. Currently a fluorescent system costs $4.30: a tube light and ballast cost $0.70 and the battery costs $3.60.

D. Daily Cost Analysis

After we had established the retail cost of the ForeverBright, we wanted to understand the daily cost of maintaining our system and how that compared with other solutions on the market. We analyzed our system’s daily cost in addition to the two main lighting alternatives available to our customer: candles and fluorescents. While different shopkeepers keep their stores open for different amounts of time, given our survey data, we estimated that an average store keeps the store open for about 3 hours per night.

These numbers look very different in rural areas vs urban areas. In rural areas, customers must recharge using a diesel generator. Typically there is one diesel generator per village used to recharge batteries. With the costs of diesel skyrocketing, the entire lighting market has been turned on its head. It now costs about $.30 to recharge a 6V 4AH battery by a diesel generator and $.60 to recharge a 6V 12AH battery.

In urban areas that have grid electricity, battery owners can recharge using grid power. Although grid power is only available intermittently, the cost is significantly cheaper: about $.08 to recharge a 6V 4AH battery, $.16 to recharge a 6V 12AH battery.
A Note About Solar Energy

We spent quite a bit of time researching solar powered solutions and ended up putting this solution aside because the cost of solar panels is quite high which would make the retail price of the light unaffordable for our customers. But even if the price of solar panels do significantly come down, it is important to note that the daily cost of maintaining a solar powered system is not free. In Myanmar, IDE estimates that it is sunny only 70% of the time. That means that 30% of the time, customers will be buying their next best alternative, candles, which are $.08 - $.16 per night. This represents an average cost of about $.24 - $.48 per day. This daily cost does not factor in the negative impacts of having inconsistent lighting (electric lighting one day and candles the next) and the fact that the customer may value electric lighting even more on dark and cloudy days since the moon will be obscured.

Daily cost of candles

From our surveys, we have gathered that shopkeepers spend between $.08 - $.16 per day on candles. There are a range of candles on the market. Some are very small, and cost only a penny but last only about 30 minutes. Whereas other candles are larger and cost more but are more economical in terms of amount of candlelight provided per dollar spent. We found that a useful way of looking at this was determining how much it cost to burn a candle for one hour. Depending on the type of candle, this ranged from $.015 - $.03.

Given our survey data, we estimated that an average shopkeeper uses about 2 candles at a time. When we asked how much shopkeepers spent on candle per night, estimates ranged from $.08 to $.16. This seemed to be in-line with our cost estimates. For our financial projections, we assumed that shopkeepers were using medium-economical candles ($.023 per candle-hour) and used 2 of them at a time for 3 hours. This amounted to $.135 in candles per night. We used this number in our cost comparison, but we will later show what the effect will be if we use the lower-end number.

Daily Cost of Fluorescents

There were reports of both 8W and 10W fluorescents in the field. Since 8W fluorescents drain less energy, we used the 8W fluorescents in our projections to get an idea of how fluorescents perform at their most efficient.

On a 6V 4AH battery, the fluorescent bulb will only last a maximum of 3 hours per night. But in reality, the batteries do not operate at 100% efficiency, so we assumed that a fluorescent light would not provide enough light for the whole night. Even if the 4AH battery does provide sufficient capacity, we calculated that the 12AH battery would save a fluorescent user over $2 in the first month, so they would be willing to pay $3.60 (instead of $2.50) for the 12AH battery.

So assuming shopkeepers use a 6V 12AH battery with the fluorescent system, we are able to calculate the number of hours the fluorescent bulb will last and extrapolate from that the daily cost of running the fluorescent lighting.
**Fluorescent Analysis**

<table>
<thead>
<tr>
<th>Battery Voltage</th>
<th>6V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Capacity</td>
<td>12AH</td>
</tr>
<tr>
<td>Wattage of Light</td>
<td>8W</td>
</tr>
<tr>
<td>Current drained from battery = W/V</td>
<td>1.33A</td>
</tr>
<tr>
<td># of hours it will last (ideally) = AH/A</td>
<td>9 hours</td>
</tr>
<tr>
<td>Efficiency of Battery</td>
<td>90%</td>
</tr>
<tr>
<td>Actual hours it will last per charge</td>
<td>8.1 hours</td>
</tr>
<tr>
<td>Cost of recharging: Rural</td>
<td>$.60</td>
</tr>
<tr>
<td>Cost of recharging: Urban</td>
<td>$.16</td>
</tr>
<tr>
<td><strong>Daily lighting cost – Rural</strong></td>
<td>$0.222</td>
</tr>
<tr>
<td><strong>Daily lighting cost – Urban</strong></td>
<td>$.059</td>
</tr>
</tbody>
</table>

**Daily Cost of ForeverBright**

In contrast, the 8 LEDs in the ForeverBright use only 0.48W, an order of magnitude less energy than the fluorescent system. There are several reasons for this:

1) LEDs are more efficient than fluorescents in lumens/watt
2) LEDs are more directional than fluorescents – so there is not very much wasted light
3) The ForeverBright, while providing enough light for a small cart, is significantly less bright than a fluorescent bulb.

Using the same calculations as with fluorescent, we concluded that shopkeepers would go with the 6V 4AH in conjunction with the ForeverBright.

**ForeverBright Analysis**

<table>
<thead>
<tr>
<th>Battery Voltage</th>
<th>6V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Capacity</td>
<td>4AH</td>
</tr>
<tr>
<td>Wattage of Light</td>
<td>0.48W</td>
</tr>
<tr>
<td>Current drained from battery = W/V</td>
<td>0.08A</td>
</tr>
<tr>
<td># of hours it will last (ideally) = AH/A</td>
<td>50 hours</td>
</tr>
<tr>
<td>Efficiency of Battery</td>
<td>90%</td>
</tr>
<tr>
<td>Actual hours it will last per charge</td>
<td>45 hours</td>
</tr>
<tr>
<td>Cost of recharging: Rural</td>
<td>$.60</td>
</tr>
<tr>
<td>Cost of recharging: Urban</td>
<td>$.16</td>
</tr>
<tr>
<td><strong>Daily lighting cost – Rural</strong></td>
<td>$0.02</td>
</tr>
<tr>
<td><strong>Daily lighting cost – Urban</strong></td>
<td>$.005</td>
</tr>
</tbody>
</table>

**E. Choosing a Light**

**Summary of Findings**

<table>
<thead>
<tr>
<th></th>
<th>Daily Cost Rural</th>
<th>Daily Cost Urban</th>
<th>Product Cost</th>
<th>Battery Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Candle</td>
<td>$.135</td>
<td>$.135</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Fluorescent</td>
<td>$.22</td>
<td>$.08</td>
<td>$.70</td>
<td>$3.60</td>
</tr>
<tr>
<td>ForeverBright</td>
<td>$.02</td>
<td>$.005</td>
<td>$3.75</td>
<td>$2.50</td>
</tr>
</tbody>
</table>

Assuming 3 hours of light per night, 2 candles at a time

**What Light Would a Burmese Shopkeeper Use?**

Given the costs above, we wanted to analyze what lighting source a Burmese shopkeeper would use, assuming the shopkeeper was indifferent to the quality of the lighting source. We know that in quality, the ForeverBright is somewhere between a fluorescent and a candle, but it
is difficult to quantify how customers will value the differences between the three. Our initial market testing suggests that LEDs are attractive and may help shopkeepers attract additional business. However, market testing will be needed to make projections on the economic impact in this dimension.

Look at the issue of cost savings over time, we can see that on a daily basis, the ForeverBright user will be spending only $.02 per day on lighting compared with $.08-$1.16 per day for a candle user. But we also know that the poor put a very high value on money now, and a $6.25 investment in a lighting system may be too much to justify a $.06-$1.14 per day price savings. To calculate how a shopkeeper would look at this, we used an extremely high discount rate (by Western standards) of 12.5% per month. We also factored in a 4.17% interest rate.

First we looked at the rural user and compared the three lighting choices. We found that clearly on cost, users would choose candles over fluorescents because of the large cost savings that candles could provide. We were very happy to find that the ForeverBright system not only beat fluorescents but that even with a 12.5%/month discount rate, beat candles within 2 months and would result in significant cost savings for the shopkeeper over the year.

In other words, within 2 months of buying the ForeverBright, a former candle-user would make up the initial investment of $6.25 plus a 12.5% compounded interest in cost savings within 2 months. Not to mention the fact that they would have higher quality lighting that would attract more customers.

We then used our model to make an analysis on urban users, many of whom are using fluorescent lighting charged with the grid. Upon analyzing this user, it made sense that many shopkeepers used fluorescent lighting considering the fact that fluorescents paid back the initial investment within 3 months and provided higher quality lighting than candles.

Although this user was not our target customer, we were happy and pleasantly surprised to find that on cost, the ForeverBright represented a significant cost savings over both candles and fluorescent lighting and also would pay for itself within 2 months, using the same discount rate. Although fluorescent lighting may put out a higher quality of light than the ForeverBright, we feel that there will be a market in urban areas as well for shopkeepers who don’t need the amount of light put out by the fluorescent and who would prefer to save money with a mid-range lighting solution.
Given this, we were also very curious at how our light would compete against people using one candle per night. This would apply to rural households as well as people doing income-generating activities (such as rolling tobacco) at night by candlelight. Fluorescents are not depicted here because they are completely out of reach for rural households.

Although the payback time is longer (about 5.5 months) and the total values here are smaller in terms of net present value of the total savings over a year (about $4.50), this graph shows that LEDs have the potential to be a very viable lighting solution for rural households, showing the tremendous long-term market potential of the product. The ForeverBright may need to be modified to drive to the cost down (perhaps by using fewer LEDs) to drive the payback time earlier.
F. Market Size Analysis

We next wanted to determine the total number of shopkeepers we could realistically expect to reach in the short-term with our ForeverBright product if we were to leverage IDE’s distribution system.

According to Jim Taylor, there are about one million shopkeepers in Myanmar. 100,000 of these shopkeepers will be reached by IDE within the next five years. Out of these, 30,000 use candles. Although our product can potentially be very appealing to fluorescent users as well, as we discovered in our financial analysis, we decided that in sizing the market, we would only look at the candle user. We estimated that out of these 30,000 candle users we would be able to obtain a 30% market penetration within five years. This amounts to 9,000 total shopkeepers.

However, this initial market is only the beginning. We feel that as LED efficiency increases and costs go down, an LED light is going to be the lighting solution in Myanmar and beyond in the near future. If IDE positions itself as the reliable market leader for this type of product, the market potential is huge and can go well beyond shopkeepers.

IDE Initial Market Penetration for the ForeverBright

G. Social Return

Using solely the metric of cost savings, the ForeverBright will make a huge impact. Rural shopkeepers will save over $40 per year using our light rather than candles. With 9000 users, this represents a savings of just under $2 million over 5 years. This is money saved that can be spent on food, education and medicine to improve the quality of life for our users.

The metric of cost savings does not include other benefits of having quality electric lighting including decreased risk of fire and the fact that higher quality light will attract more customers and therefore generate more revenue.

Also, the 9,000 target market is only just the tip of a very large iceberg. There are 100,000s of shopkeepers in Myanmar who would benefit from our product. There are also millions of rural households that perform income-generating activities at night that could save money using an LED lighting system instead of candles. There is also a tremendous potential for the ForeverBright beyond Myanmar for the over 2 billion kerosene and oil lamp users worldwide.
Team d.light is planning to structure itself as a non-profit enterprise. This means that while revenues are important for sustainability, d.light has other stakeholders for which it is maximizing profits as well, namely, the user. This is important from the perspective that d.light’s product can be easily copied by other low cost competitors. This would affect d.light’s market share and revenues. However, according to d.light’s charter this would be completely acceptable because d.light wants to maximize not only its own profits, but also the number of people that will gain access to the market. d.light sees profits as a way to make this product sustainable and the fact that it can be copied by potential competitors means that the solution achieved by d.light is sustainable in the long term.

The plan of implementation has four very distinct phases. Throughout these phases d.light plans to partner with IDE who would be its main distributor in Myanmar:

1) **Test product in the product market.**
   d.light plans to give away a few dozen units of its product to several users in Myanmar and follow up very closely so that we can learn everything about usage, preference, duration, and in general understand any problems with the prototype that might arise. This means d.light must invest in the salary for a person that will be dedicated for at least 60 days to live with the users and interact with them. That person should be well-trained in d.light’s strategy and understand that the main goal of this first phase is not to promote acceptance of the product among the surveyed, but to understand how the product influences the lives of the target market and how the product could be improved.

2) **Iterate on and improve design.**
   This should take place while the surveying team is in place. With continuous communication and feedback between the surveying team in the ground and a group of designers in the facilities in IDE, the prototype should be improved to adapt to the new ideas that come from the users. Also, during this phase, the design of the manufacturing process should be explored. A sensible manufacturing process could be the main differentiation between d.light’s product and other light manufacturers.

3) **Limited product rollout.**
   With what has been learned in the previous phases, d.light will select a very small region in which it will deploy its first 3000 units. According to the financial plan presented in section 3 of this business plan, this should bring profits between $10,000 and $20,000. This positive cash flow would be extremely useful to promote growth in the next phase since it would allow for the investment in inventory and labor that would be necessary for the mass production rollout.

   Furthermore, the limited product rollout would allow d.light to test the mechanisms of its distribution chain and will shed light over the margins that distributors and retailers need to make in order to be motivated to promote the product.

4) **Mass production.**
   If all the previous phases work as planned, d.light should have a solid product and a proved distribution network through which to start reaching at least 200 thousand store owners that compose 20% of the total market size of a million store owners in Myanmar.

Interestingly enough this is a model that could be implemented in several developing countries since lack of lighting solutions is an issue that affects a huge population of the world. Team d.light is very optimistic that it can bridge the need of this potential users and the innovation put forward by the creation of LEDs.
V. Risk Analysis

Ultimately, there is relatively low risk associated with ForeverBright’s product testing and eventual roll-out. This is largely because the initial capital costs for equipment (several hundred dollars) and per unit costs for materials and labor are low, and because the product is almost 100% locally sourced and manufactured. Nevertheless, there are vulnerable points as outlined below.

A. Extensive Customer Surveys

We have assumed, based on short in-country surveys and prototype testing performed by IDE/M staff, worldwide trends in LED use, and our cost-benefit analysis, that LEDs will be readily adopted in rural and urban Myanmar. We need to collect more extensive data from actual users to determine if different colored and intensity LEDs are interesting to our target market, how much light users need, how much light they want and are willing to pay for, and the area over which light needs to be diffused. These are critical steps and will be essential to producing a robust light source that sells to millions rather than just 100s of Burmese. LEDs are only just beginning to be imported to Myanmar for specific applications at $0.05/LED. These LEDs are either of extremely poor quality, and/or they are being misconnected and over-driven. In both cases, they are earning a reputation for mediocre light quality and a short life-span. The degree to which IDE/M can put reliable, high quality lights on the market before users become accustomed to other LEDs may be important. It also remains to be seen if LEDs will be used for inexpensive lighting applications, or if, like in more developed nations, LEDs will first be used for consumer electronics and industrial applications.

B. Battery Source

We need to determine if IDE would prefer a special, locally made IDE battery, or prefer to let clients purchase their own batteries on the local market, or prefer to import and supply the ForeverBright with higher quality rechargeable batteries. Supplying imported batteries provides more charge capacity for less long-run cost, and more life-time hours out of the battery, but has significantly higher fixed costs to buy the battery, and a great deal of uncertainty surrounding import duties and changing government regulations. We felt that importing nickel metal hydride batteries (rechargeable lithium ion battery technology is in its infancy) would represent an insurmountable price barrier. However, prices are likely to come down.

Meanwhile, locally made batteries may have significant environmental implications in terms of lead disposal and hazardous chemicals polluting ground water sources. There are equally severe health implications for the workers in factories exposed to lead, with multiple studies in Philippines and India focusing specifically on wet lead-acid battery factories. Locally made batteries only last about six months under current usage patterns with fluorescent lights, and are made using very primitive technology, making them extremely heavily and inefficient. They are nevertheless widely available in both urban and rural areas, gaining in market share with recent increases in diesel prices, and extremely inexpensive. There is a danger of blowing the ForeverBright’s resistor and LEDs if users hook the light up to local batteries with greater than a 9V charge. There is also the possibility of deep discharging batteries by using them for multiple applications,\(^5\) which completely drains them before going in for recharging. Wet lead acid batteries are not designed to be completely drained, but relatively poorer clients are unlikely to spend money prematurely recharging a battery, much the same way they would be unlikely to pull water from a well and go back for more water before the bucket is empty.

An alternative would be to make a special IDE/M battery designed specifically for the ForeverBright (either a 4, 6, or 8V battery depending on LED combinations), and with a current capacity equivalent to the amount of time most shopkeepers would like the battery to run before needing a recharge. The IDE/M battery would have a unique plug-in making it harder for

---

\(^5\) besides the ForeverBright, which is hard to completely discharge because it becomes too dim
imitators to copy the product, and avoiding the possibility of blowing out batteries by misconnecting them. Battery production would be relatively easy to set-up locally, and distribution would be only slightly more expensive due to the added bulk. However, this would potentially alienate some clients who have their own batteries, or who preferred to use batteries with larger capacities, and imitators could feasibly copy the newer battery as well if the market were large enough to support multiple suppliers.

Ultimately, there are two paths that can be followed. The first is to engage in educating the consumers and battery chargers on how to charge batteries correctly (speed and rate) to maximize battery life, and how not to deep discharge lead acid batteries. The second is to include circuit boards and/or unique plug and battery combinations with the ForeverBright to ensure that consumers cannot deep discharge or incorrectly charge their batteries. Any additions will make the product more expensive (perhaps 30-50%), and there is concern that users could still easily modify the new product. For example, users could cut off plugs, exposing wires and connecting them to their own batteries.

C. Pricing

We are currently assuming diesel prices result in $0.30 recharges in villages using diesel generators. Diesel prices are rising and we are unsure how the effects of diesel prices will affect shopkeepers lighting choices. In particular, we need more robust data on how often current battery users (rural and urban) recharge their batteries, how they recharge them, and what it costs to recharge different batteries. We then need to ask if rural shopkeepers would stay with the ForeverBright if diesel prices increased, or would they revert to candles? Would fluorescent light users switch to the ForeverBright or go straight to candles? Can systems be set up to charge batteries more effectively and efficiently off the grid?

There are also manufacturing unknowns. Based on our experiences making the ForeverBright, we have estimated that it would take one and a half hours of both unskilled and skilled labor per light. It could take either longer or shorter than we expected to build it, which would affect both costs and the number of lights that could be produced per month. We need to determine the ceiling price for our product with most shopkeepers to assure that changes in diesel/labor/etc do not price our product out of the market.

D. Pricing and Technology

We have taken a conservative approach to our analysis and have not included assumptions that LEDs will be both significantly brighter and less expensive in the near future. A similar assumption could be extended to solar generating capacity, which is currently at $4/watt but likely to fall in the next few years. There is also the potential for human-powered generation (bicycles/) to charge smaller 4AH batteries.

E. Imitators and Barriers to Entry

One of the benefits of working with IDE/M is leveraging their extensive distribution network, good brand name, and excellent reputation. If our product is successful, its low capital investment and per unit cost makes it highly likely that local imitators will enter the market, working to either lower production costs or take slightly lower margins than IDE’s current 10%. It may be difficult for these imitators to source high quality ultra-bright white LEDs at $0.25-$0.40, and they will likely cut their costs dramatically by using the locally available $0.05 LEDs. This may or may not be a problem. IDE is not trying to dominate the lighting market, and copycats are considered a victory if they can provide quality products to the masses. In fact, Paul Polak’s goal is to capture 20% of the market, with the rest going to imitators. However, it could be a disaster if consumers begin to associate the new technology, LEDs, with lower quality light. We anticipate that marketing campaigns, which we were hoping to avoid by using shopkeepers as distributors and live demonstrators, will have to be budgeted into the product distribution to reassure consumers of ForeverBrights quality.
Appendix A

**d.Light Survey for Round 1 Prototypes**

**Background:**
After deciding that we want to focus on affordable lighting issues, we would like to get an idea for what the Burmese people (and more specifically Burmese shopkeepers) want as far as functionality and form in their lighting devices.

**Objective:**
We would like for you to distribute each of these prototypes as explained below and both observe and interview the users. The users should be shopkeepers that are currently using cheap lighting sources such as candles and flashlights. If it is possible, each prototype should be left with the user for at LEAST one night. If the device is left longer than one night (and if the device requires batteries), please provide them with the replacement batteries that we provided. We are mainly interested in how they use the devices, what they like about the device, what they dislike about the device and whether or not they would buy it.

**Lighting Profile Questions:**
1. What lighting devices do you currently own? (candles? Flashlight? Tube light with 9V battery?)
2. How much money do you spend per week on this device?
3. At what times each day do you use these devices?
4. For how long each day do you use these devices?
5. What do you do while using this light?
6. How many people come by your store each day?
7. How many people come by your store each night?
8. Do your customers travel from afar? How do they get to your store? (i.e. bus, walking, bike, etc.)
9. Do your customers use a light to travel at night? What do they use? (candle, flashlight, etc.)
10. Do you have any friends that are also storekeepers? What do they use to light up their store?
12. What do you do while waiting for customers to come? (other work such as tobacco rolling? Clean the store? Relax?)

**Prototype Interview Outline: Plastic Light Box**

**Day 1**
1. Ask the lighting profile questions.
2. Take pictures of their current lighting devices.
3. Introduce them to the Plastic Light Box. It can be turned on with the big red switch.
   Give it to them. Observe their reaction:
   - Are they confused?
   - Do they laugh?
   - Are they happy?
   - Do they ask you questions?
4. Allow them to use the light for one night (or a few days, if so give them extra batteries that were provided). Observe how they decide to set it up. Take some pictures of them using it.

**Day 2** (the next day)
1. Observe and take pictures of their setup.
Prototype Interview Outline: Candles

Day 1
1. Ask the lighting profile questions.
2. Take pictures of their current lighting devices.
3. Introduce them to the Giant Emergency Candle. Give it to them. Observe their reaction:
   - Are they confused?
   - Do they laugh?
   - Are they happy?
   - Do they ask you questions?
4. Allow them to use the light for one night. Observe how they decide to set it up. If it's dark outside, stay for about 20 minutes and observe and take some pictures of them using it.

Day 2 (the next day)
1. Observe and take pictures of their setup.
2. Is the device in use? If so, take pictures.
3. Ask the user the following:
   - How long did they use the candle?
   - Who used the candle?
   - What activities were done that night with the candlelight?
   - Did it make these activities easier or harder?
   - What did they think about the brightness of the light?
   - This candle will last for 40 hours. Could they afford to buy another candle after 40 hours of use?
   - What are some complaints they have?
   - What did they like about the device?
   - What do they think about the device? (Ask them to state their opinion about it.)
   - Did the device attract more customers?
   - Did the device increase their items sold?
   - Would they buy this device? How much would they pay?

Prototype Interview Outline: Big Wooden Box
Day 1
1. Ask the lighting profile questions.
2. Take pictures of their current lighting devices.
3. Introduce them to the Big Wooden Box Light. Give it to them. Observe their reaction:
   - Are they confused?
   - Do they laugh?
   - Are they happy?
   - Do they ask you questions?
4. Allow them to use the light for one night. Observe how they decide to set it up. If it’s dark outside, stay for about 20 minutes and observe and take some pictures of them using it.

Day 2 (the next day)
1. Observe and take pictures of their setup.
2. Is the device in use? If so, take pictures.
3. Ask the user the following:
   - How long did they use the Box Light?
   - Who used the Box Light?
   - What activities were done that night with the Box Light?
   - Did it make these activities easier or harder?
   - What did they think about the brightness of the light?
   - Do they see any advantages/disadvantages to the size of the box?
   - What are some complaints they have?
   - What did they like about the device?
   - What do they think about the device? (Ask them to state their opinion about it.)
   - Did the device attract more customers?
   - Did the device increase their items sold?
   - Would they buy this device? How much would they pay?

Prototype Interview Outline: Headlamp w/varying # of LED’s
Day 1
1. Ask the lighting profile questions.
2. Take pictures of their current lighting devices.
3. Introduce them to the two headlamps. Give it to them. Observe their reaction:
   - Are they confused?
   - Do they laugh?
   - Are they happy?
   - Do they ask you questions?
4. Allow them to use the lights for one night. Observe how they decide to set it up. If it’s dark outside, stay for about 20 minutes and observe and take some pictures of them using it.

Day 2 (the next day)
1. Observe and take pictures of their setup.
2. Is the device in use? If so, take pictures.
3. Ask the user the following:
   - How long did they use each headlamp?
   - Who used the each headlamp?
   - What activities were done that night with each headlamp?
   - Did it make these activities easier or harder?
   - What did they think about the brightness of the lights? Was one preferable?
• What are some complaints they have?
• What did they like about each device?
• What do they think about each device? (Ask them to state their opinion about it.)
• Did the device attract more customers?
• Did the device increase their items sold?
• Would they buy this device? How much would they pay?

Prototype Interview Outline: AAA Light
Day 1
1. Ask the lighting profile questions.
2. Take pictures of their current lighting devices.
3. Introduce them to the AAA Box Light. Give it to them. Observe their reaction:
   • Are they confused?
   • Do they laugh?
   • Are they happy?
   • Do they ask you questions?
4. Allow them to use the light for one night. Observe how they decide to set it up. If it’s dark outside, stay for about 20 minutes and observe and take some pictures of them using it.

Day 2 (the next day)
4. Observe and take pictures of their setup.
5. Is the device in use? If so, take pictures.
6. Ask the user the following:
   • How long did they use the AAA Box Light?
   • Who used the AAA Box Light?
   • What activities were done that night with the Box Light?
   • Did it make these activities easier or harder?
   • What did they think about the brightness of the light?
   • Do they see any advantages/disadvantages to the size of the box?
   • What are some complaints they have?
   • What did they like about the device?
   • What do they think about the device? (Ask them to state their opinion about it.)
   • Did the device attract more customers?
   • Did the device increase their items sold?
   • Would they buy this device? How much would they pay?
   • Did they like the weight of the light?
   • Did they carry the light when they went out?

Prototype Interview Outline: Clock Light
Day 1
1. Ask the lighting profile questions.
2. Take pictures of their current lighting devices.
3. Introduce them to the Clock Light. Give it to them. Observe their reaction:
   • Are they confused?
   • Do they laugh?
   • Are they happy?
   • Do they ask you questions?
4. Allow them to use the light for one night. Observe how they decide to set it up. If it’s dark outside, stay for about 20 minutes and observe and take some pictures of them using it.
Day 2 (the next day)
1. Observe and take pictures of their setup.
2. Is the device in use? If so, take pictures.
3. Ask the user the following:
   - How long did they use the Clock Light?
   - Who used the Clock Light?
   - What activities were done that night with the Clock Light?
   - Did it make these activities easier or harder?
   - What did they think about the brightness of the light?
   - Did they hang it from the wall/ceiling?
   - What are some complaints they have?
   - What did they like about the device?
   - What do they think about the device? (Ask them to state their opinion about it.)
   - Did the device attract more customers?
   - Did the device increase their items sold?
   - Would they buy this device? How much would they pay?

Prototype Interview Outline: Candle Reflectors
Day 1
1. Ask the lighting profile questions.
2. Take pictures of their current lighting devices.
3. Introduce them to the Candle Reflectors. Give it to them. Observe their reaction:
   - Are they confused?
   - Do they laugh?
   - Are they happy?
   - Do they ask you questions?
4. Allow them to use the light for one night. Observe how they decide to set it up. If it’s dark outside, stay for about 20 minutes and observe and take some pictures of them using it.

Day 2 (the next day)
1. Observe and take pictures of their setup.
2. Is the device in use? If so, take pictures.
3. Ask the user the following:
   - How long did they use the Candle Reflectors?
   - Who used the Candle Reflectors?
   - What activities were done that night with the Candle Reflectors?
   - Did it make these activities easier or harder?
   - What did they think about the brightness of the light?
   - What are some complaints they have?
   - What did they like about the device?
   - What do they think about the device? (Ask them to state their opinion about it.)
   - Did the device attract more customers?
   - Did the device increase their items sold?
   - Would they buy this device? How much would they pay?
Appendix B


Sam visited three small shops selling fruits and one Betal leaf shop located at Sanchaung Township, Yangon. All were visited at night, all were using candles to illuminate their shop/stand. He wasn’t able to leave the device overnight, but did spend quite a bit of time with each to both interview them and observe how they used the different prototypes.

Emergency Candle
Sam first introduced the shopkeepers to the giant emergency candle. They couldn’t read the label in English, but Sam explained that it was a long lasting candle – up to 40 hours. They were amazed that a candle could last that long – had never heard of something like that before. They thought it was great! So the candle was then lit. They put it on the counter next to their current type of candle. They had no problem figuring out how to use it.
But when lit, it is a bit dimmer than the small candles available here in Myanmar. All of the shopkeepers essentially said that they would rather use small candles (the ones they currently use) because they only need to invest/spend a little bit of money every day to buy small candles. They assumed that the emergency candle was quite expensive…i.e. More than $1.25. So a long lasting candle is not so attractive – even if the cost per hour of burning time is less, because they don’t want to or can’t shell out lots of money in advance. The fact that this particular candle didn’t give off as much light also made it less attractive. They felt they needed as much light as they could get to both attract customers and serve them when they did stop by to purchase something.

Light in a light box
Sam then introduced the AAA light in box first. After talking about it and letting them try it, he brought out the Plastic light box. Size of container didn’t seem to matter at all, what they focused on was the amount of light coming out. They were all intrigued by the LED light compared to a regular flashlight type bulb. They were not confused, but looked at both boxes with curiosity. Didn’t ask a lot of questions, because they could see the light at the batteries and switch – so understood how it works. They said it would be easy to hang up over the counter and they felt it could illuminate their products for sale. They would use a small piece of string to suspend it. That’s what they would use the light for – to illuminate their merchandise. They all said the light is a bit dim (single LED) and it would be much more appealing if the light was stronger. Three or four LEDs perhaps would be better. With one LED they wouldn’t use it to replace their current candles. They liked the sizes and the fact that it was “modern”. They felt a strong LED light would make their store more attractive to customers – perhaps increasing their business, but they weren’t entirely sure it would make a big difference with their business. They would be interested in buying these devices, if they provided more illumination and they didn’t cost too much. Most storekeepers were reluctant to name a price for what they would pay. Our guess is around $5… but entirely sure. They asked how long the batteries would last? When they buy batteries they are used to paying about $0.25 for a single D size. They weren’t familiar with the price of AAA batteries.

Head lamp
To give them an idea of how much light three or four LEDs could produce, we then showed them the headlamp. All the shopkeepers said they liked this amount of light. And the light was good enough to illuminate their stall/counter. But they all wondered out loud if it would be too expensive for them. They balked at the idea of wearing the
headlamp while tending their store. It is a bit strange for them to put the head lamp on because it is not commonly used here. They were curious as to how much this light cost. They could tell it was imported because high quality plastic like this is not available here… so they assumed it would be very expensive… beyond what they could afford. Without the straps, they said this device did seem a bit small to use in a shop. It would be kind of hard to hang above their counter. They did think this illumination was significantly different from florescent and just might attract more customers. Several said it made their fruit look more appealing. One said the light was strong, but a bit too concentrated/narrow. He preferred the broad light of a candle. Most said they would buy this if it cost less than $5.

Clock Light
Several of the shopkeepers kind of laughed or looked perplexed when showing the clock light. the two LEDs didn't give off much light and the clock face without an actual clock was kind of weird. One said it might be nice for a house but not for a shop. They were confused about how they would set it up. One put it on a post to the side of their shop but it didn’t give off enough light to show off the merchandise. After looking at it for a few minutes, none of the shopkeepers seemed interested in it. Just note appropriate for a shop we guess.

Candle Reflectors
We briefly showed the candle reflectors. The shopkeepers typically looked at them like “yeah we have tried something like this, but just a simple candle, openly exposed is better” Not much interest in this and they certainly wouldn’t pay for this – they could easily make it themselves.

Overall, the shopkeepers said that they were not concerned about the shape or size of the lighting device. They only cared about the strength of light and the price. Three LEDs seemed enough to get them interested and the $5 price point was were they expressed interest.

Lighting Profile Survey
All of the stores we observed were using candles. Most used one candle, some used two. They burned 2-4 each night, for light from 7 pm to 9pm. All of the candles were used to illuminate the shop counter where they displayed their merchandise.

Single Store Observations – two non-candle stores

T: Snack shop at Taikkyi township
V: Snack shop at Hla Pa Ta Village

1) How many customers come by?
   T: 25 customers came by.
   V: 16 customers came by.

2) Who are the customers? (men, women, old, young , etc)
   T: 9 men, 3 middle-aged women, 9 girls, 4 kids
   V: 2 old men, 3 men, 7 women, 6 kids

3) How long do they stay for?
   T: They bought things and left. Maybe two minutes
   V: They bought things and left.
4) How many buy something?
   T: 21 bought something.
   V: all bought something.

5) What do they buy?
   T: Snacks, candles, coffee, sweets, drinks,
   V: All kinds of snacks, sweets, candles

6) How much do they pay?
   T: One package of 7 candle=200 kyats
   Snacks range from 100 to 1000 kyats
   Coffee is 80 kyats
   The estimate goods the shopkeepers sold in one hour is about 11,000 kyats. (at night)
   V: The estimate goods the shopkeeper sold in one hour is about 6,000 kyats.(at night)

7) How do they pay?
   T: By cash.
   V: By cash

8) Does the store-owner know the customer on a first time basis?
   T: The customers are people near by.
   V: The shopkeeper is familiar with the customers.

9) How do the customers find the store in the dark?
   T: Streetlight is available.
   V: Some came by flashlight and some by moonlight.

10) From how far has the customers travel to get the store?
    T: Within two miles.
    V: 1 to5 (max) minutes walk.

11) What lightings are used in the store?
    T: 1 ft florescent bulb.
    V: Florescent bulb.

11) Is the store sufficiently lit to see well by?
    Yes

   More about Hla Pa Da Village

   There is one household who own a diesel generator and provides light to the whole village with a charge. One florescent bulb is charged 60 kyats per night. The owner said that the generator consumes two gallons of diesel per night and one gallon costs 4600 kyats. They currently provide light to 200 bulbs in the village.