Mission Statement

To design solutions and manufacture products or services that will provide energy to customers in need, especially in poverty stricken areas such as Sierra Leone.

Concept Development Summary

After analyzing the problem presented to us we started with brainstorming possible solutions to the problem. Below are some preliminary sketches of the ideas we came up with.

We narrowed our selection of options down through a group discussion considering the basic needs of the customer and what we felt were the best solutions to the problem.
We then took our narrowed selection and completed a Design Selection Matrix, which is shown in Table 1 below, to determine how our ideas ranked against one another.
The table below shows the design selection matrix we completed. “A” represents the weighted score we gave each design on how well it would fulfill each criteria on a scale of one to six. We then multiplied this by the weighting we gave each criteria, also on a scale of one to six to obtain value “B”. The total weighted score is a sum of all of the “B” values across each row. What we can conclude from this matrix is that the solar station would have been the best solution to the problem we were given. However, as a group we decided that the hydroelectric turbine would what we wanted to prototype and what would be the best solution to charge a cell phone in developing countries. We overruled the matrix due to the idea that moving water has a lot of kinetic energy and the specific area we would be designing for contained numerous available waterways.

<table>
<thead>
<tr>
<th>User Need/ Constraint (weighting)</th>
<th>Functional (6)</th>
<th>Durable (4.5)</th>
<th>Ease of Use (4)</th>
<th>Cost (5)</th>
<th>Efficient (4.5)</th>
<th>Cultural Acceptability (3)</th>
<th>Total (weighted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gearing on Bicycle</td>
<td>3/18 3/13.5</td>
<td>2/8</td>
<td>4/20</td>
<td>2/9</td>
<td>4/12</td>
<td></td>
<td>80.5</td>
</tr>
<tr>
<td>Solar Station</td>
<td>4.5/27 4/18</td>
<td>4/16</td>
<td>2/10</td>
<td>3/13.5</td>
<td>4/12</td>
<td></td>
<td>96.5</td>
</tr>
</tbody>
</table>

As a group we then came up with 6 criteria for the design and weighted them on importance. The evaluation was based on the following criteria and they are listed in order of importance; Functionality, Economic Feasibility, Durability, Efficiency, Ease of Use, and Cultural/ Social Acceptability. After weighing in on all of our different design options the matrix revealed that our solar station design came in first with 96.5 points, the hydroelectric turbine in second with 90 points, and a mechanical converter in third with 80.5 points all out of a possible 126.5 points. So, based on the matrix our design team should have followed through with the idea of a solar
charging station. However, after reevaluating the matrix and the advantages and disadvantages of the results it provided we decided as a team that the hydroelectric turbine would be the most suitable option for our customer.

**Test Report Summary for Prototype #1:**

A typical dam can produce almost 3,000,000 kWh, and a typical phone like the Nokia 3210 uses 0.444 kWh to charge per year (if the user charges it 8 times per month), so our product needs to produce six millionths of what an average dam does for one phone \( (1)(2) \). An iPhone 5 needs 3.5 kWh to charge per year. So our product would only have to produce a millionth of the total amount of kWh to charge phones that do not use up as much energy as an iPhone 5. Based on the calculations that we have that would be feasible by our prototype.

Our product’s base would be made out of cottonwood and red mangroves trees which are naturally light and can easily float. Those components are naturally found in Sierra Leone which means that they will be able to handle the different weather patterns in the area. Moreover, all the other parts would be readily imported to the location that the people live in. It would be cheaper for it to be imported because the materials can be easily accessed in other countries so it would be cheaper to manufacture out of the given country. The product would be made to be durable and light, for that will make it easier to move and install. The wood would be taken from the natural resources of the surroundings and the way it gets attached would depend on the users’ preferences because it could be latched using rope, or they can be attached using a power tool; using the power tool will require more equipment provided by the team that will be sent to the location. This would give customers a more versatile either to have it be more durable or more cost effective.
Finally, we conducted a survey, that consisted of engineering students, to demonstrate if people would accept the product, and the results showed that 100% of participants believe that they would not mind it being around their living areas if it will provide much needed electricity to the people. An error margin might be necessary because people who have been asked in the survey live different lives from the people whom are targeted by our product. Another survey made by the team shows that when people are given a scale from 1-5 to rate how well they understand how the product works the average is around 4.53 which means that the product can clearly be understood when explained by graphics. Figure 1 shows blah blah blah… INSERT FIGURE ONE DON’T FORGET CAPTION FOR PIC!!!

Concept Refinement Summary

The main difference between the first and second prototype is that the second prototype has curved metal blades have more surface area which will increase the efficiency of the turbine because it can capture more of the water (3). In addition, the wooden logs are made to be round because it is more cost effective in that we would not have to cut a log in half vertically which will also waste more material. Another important issue was the charging station; the first prototype lacked a certain level of safety of phones and protection from the outside environment. The second prototype provides shelter from the environmental factors by providing shade from excess heat and covers for each charging socket which has an added benefit of protecting a user’s phone from being stolen or taken by another person.

Test Report Summary for Prototype #2:
The main first advantage of the second prototype would be the increased efficiency the blades as efficiency was one of the aspects of concern compared to the first prototype. A

![Figure 2](image_url) This picture displays our second prototype of the turbine design as well as the charging station.

aspect of the blades’ design is its resistivity to turn; even though the blades are made of metal it should be able to easily turn from the power associated with the water current. This is due to the fact that in the second prototype in making the blades curved we have increased the amount of surface area the water will contact on the blade and therefore more energy will be transferred to the blades. Additionally we lowered the connection point of the blade spindle on the upright beams to lower the center of gravity and make the assembly more stable in the water and this also increases the amount of area of the blade that comes in contact with the water. Another difference in prototypes is the charging station. The first design lacked certain safety measures for the cellular devices against the natural environment and theft. The slots that the cellular devices would sit in could be accommodated to be locked to provide security if that is an area of concern for the customer however, this will increase the cost of the product. The charging station would be tested against the different weather patterns that are common to areas we have interest in selling. As far as Sierra Leone is concerned, the prototype will be tested against humidity, heat, and high winds. Considerations will be made for the summer season which is the
monsoon season when rain falls and it usually spans from May to December and the drier winter season spanning from December to April (4).

Cost Analysis

This project could be used by a whole village, so the price of the product would be distributed between the locals. The wood that would be used for the design will be brought from the area’s natural growing trees which would be very cost effective. In addition, we will be using aluminum and the price of a sheet would be $0.70 per square foot (5). When multiplied by the amount that would be used to make the blades it would cost around around $25.20 for the blade. When multiplying that amount by by the number of blades we would get that the total would be $201.60.

Another expense that should be considered is the expense of labor. Installation of the product would be done by the people of the tribe with the help of a few experts which will make it cheaper by a considerable amount. Experts will receive the amount of money depending on how many days the installation takes which is around 3-4 days; for each day they will be receiving $50. As for the blades they will be constructed away from the site, so we will work with another company to build the design of the blade. Outsourcing manufacturing will help with reducing the labor cost and will increase our company’s flexibility(6). The size of the blades and the product as a whole will be very customizable according to the users and what they need, and what they can afford. For our current customers (Village of Mende Tribe) the total cost of outsourcing of our blades given that we will be providing the material for would be provided by us the cost would be $300-$400. In addition, we would also have to get a generator which will be $349 for a 4,400 Watt generator that would convert the energy gathered into electrical energy.
Lastly the shipping of the product to Sierra Leone would be the part that is the most expensive. According to our calculation using an rate calculator of parcelbound.com shipping will cost $1,400 to Sierra Leone; the numbers were found by putting the weight and the dimensions of the product that will be shipped.

The village that we will be focusing on consists of 100 families which means that the total amount would be $1000 for the whole village. Our product as a whole would cost much more than that limit; however, there are possibilities to make the product cheaper which will be discussed later in the report. On average the cost has been estimated to $17/ family. The cost will vary greatly depending on the actual power output of the product which depends on the water flow of each installment. This will determine how many families it can support and the larger a population it can support the lower the cost is per family. The cost will also vary depending on how many customers are accessible in a given area and for the same reason this could increase or decrease the price per family.

**User Guides**

The users of the product will be able to use the graph provided below.
In the graph the users will have a reference to how the product will be placed; in addition, it will also show how it will operate and be used. Another important aspect of the guides for the customers is in the form of a team of experts sent to the site to help construct the product. Using wood from the surrounding area the locals would build the raft with the supervision of our team that will give specific instructions to ensure it is built correctly. Accompanying this team will be a translator to enable the locals to clearly understand the instructions given from our team. In total we will have verbal, visual, and in person methods to communicate the idea to the customer. This protects against excess misunderstanding and failure to convey our message appropriately.

Re-Design Ideas/Thoughts

**INSERT HESE feedback.** One of the important ways that we can improve upon the second prototype is to use cheaper materials that would still output the same amount of power. Furthermore, we can decrease the number of blades which will decrease the cost of our product. Possibly construct the blades in a sturdier manner which will consequently increase the output of power even with fewer blades. **PROJECT EVALUATION**

References:


   <http://www.indiabizclub.com>

