Light From Below: Using Earth Energy to Bring Free Light to the Poor

Many undeveloped, dispersed communities in Panama lack essential needs such as lighting. Light from Below will design a lamp that is easy-to-build from accessible materials and powered by “earth energy,” electricity generated from mud. The project brings free light to the poorest, darkest, and most remote places of Panama.

Project Summary

Earth energy is a technology that produces electrical energy from the change in the rate of chemical reactions produced by microorganisms. Among the most electrochemically active bacterial populations are Azoarcus, Azospirillum, and Geobacteraceae. All of these can be found in soil, mud, and decomposed organic material. In order to convert chemical energy into electrical energy, earth energy technologies use a microbial fuel cell (MFC). Using a sealed vessel (oxygen-free environment), bacteria oxidize organic compounds such as glucose and acetate. During these anaerobic chemical reactions, the MFC collects and transfers electrons using an anode compartment to an external circuit. In a 70- to 90-degree Fahrenheit environment, it can produce energy with over 50% efficiency. “For each kilogram of incoming organic contamination, microbial fuel cells net 1 kilowatt-hour of electricity” (Sanford, 2010). Recently, a group of Harvard students experimented with microbial fuel cells and showed that the most recent MFC produces enough electricity to power a small LED bulb for up to a year (Justa, 2010). This technology is not only cheap by also reusable. Additional soil nutrients, such as acid found in lemons and vinegar, or a simple change of soil will “recharge” the MFC battery.

Our project takes this existing technology to the underdeveloped areas in Panama. Light from Below will use the simplicity of these discoveries and maximize the usage of local materials to make these MFC lamps. The goal is to prepare a design that will facilitate the manufacture and maintenance of MFC lamps in the community. The project will finance supplies that will generate free electricity for the community for about one year at an estimated initial cost of $10.00 per lamp. When lamp materials need to be replaced, the maintenance cost will be significantly small. Mud, plastic bottles and cans can be obtained for no cost, copper wires are not expensive, and LED bulbs can be reused.

The Light from Below project has three levels of intended impact:

1. On the community: Social and Economical
    - Provide free lighting to the poor
    - Explore materials and resources that are seen as waste
    - Increase the possibilities of domestic life/work at night
    - Provide a safe environment for children at night
    - Improve tourism opportunities by:
        1. Renting out cabins with attractive, innovative lighting sources
        2. Selling local “Light from Below” souvenirs

2. On the government: Social and Economical

- A temporary and inexpensive solution to the unresolved issue of providing light to undeveloped areas
- An opportunity to help and serve the communities with the most economic need
- Substantial reduction in the capital needed to acquire, distribute, and install expensive alternative technologies such as solar panels
- Less technical staff as compared to staff size needed for solar panel maintenance
- Education undeveloped areas on creative solutions for their own needs

3. On the environment:
    - By using renewable energy, it reduces greenhouse gases and the negative impact of energy production on the environment
    - By using local materials, it reduces the need for transportation of larger equipment
    - By reusing materials such as plastic bottles, the project can minimize the excessive amount of waste that is currently being burned or disposed of in the sea

The Problem

A poverty study made in 2000 by The World Bank reveals that 42% of rural areas do not have access to electricity. In addition, about 62% of poor households in rural areas in Panama do not have electric lighting. Similarly, 93% of poor indigenous communities face the same lighting need (world Bank, pg. 19). In the past, our team members have performed social services in remote areas and can testify to the need that these communities face. They found that a simple light bulb could dramatically change the living conditions of a community. Nights are unproductive and dangerous. Most poor rural and indigenous areas rely on kerosene and firewood, which increases deforestation and respiratory diseases.

The Panamanian government has made efforts to install photovoltaic panels in these communities. Even international organizations such as Global Environmental Brigades from UCSD are making an effort to deliver solar panels to poor areas (Harding, 2011). However, lighting is only provided in public areas like basketball courts, parks, and schools, but not houses. Additionally, the initial costs and transportation of this technology to areas of restricted access represent an economic challenge for the Panamanian government.

Students from Harvard University have researched "earth energy" and found that Microbial Fuel Cells can provide enough voltage and current to light LED bulbs. Additionally, the company Keego Technologies has started to commercialize their version of earth energy, the "MudWatt" battery kit for $44.95. This project, Light from Below, offers cheaper, more portable, and easier to manufacture option for restricted access areas. By using mainly local materials, the project will reduce waste as greenhouse gases, and it will provide free lighting in areas in need of light.

Not only is design efficiency important but also design safety. The casing material, exposed copper, heat dissipation, and moisture permeability will be studied and tested for about 3 months to ensure a safe design. Every possibility of danger or damage will be evaluated and discussed and resolved. Since many in the poor communities are illiterate or use only spoken dialects, the project will develop simple illustrated instructions to educate the indigenous on how to build and maintain their own lamps, using as few words as possible.

Timeline

Phase I: Material research and prototype development	
Master and test the technology already discovered	Feb 1st-26th, 2012
Work on the full proposal and make a 2-minute video for People's Choice Award	Feb 27th-Mar 4th, 2012
Submission of full proposal	Mar 5th, 2012
Travel to Panama (Summer break 2012)	May, 2012
Research on different materials and develop an MFC prototype. Decide one experimental community where we will test our project for a month (case study).	Jun, 2012
Develop illustrative instructions for the MFC. Purchase necessary equipment and make arrangements with local translators if needed.	Jul, 2012
Travel to the selected community; make functional lamps that will be used for the case study. Collect data from the project and feedback from locals. Travel back to the U.S. (Fall 2012).	Jul-Aug, 2012
Phase II: Provide supplies and design instructions	
Continue developing the efficiency of the MFC and the project, its design, fabrication and maintenance. Communicate with community service organizations, schools, and churches to find volunteers willing to travel with the team to the communities.	Sep-Nov, 2012
Travel to Panama (Winter break) and make a presentation and training to the organizations that will assist us on implementing the lamps in poor areas.	Dec, 2012-Jan, 2013
Travel with the volunteers to 6 communities around Panama to educate locals on how to make their own lamps. We expect to fabricate a total of 300 lamps: 50 lamps per community, 1 lamp per household. Travel back to the U.S. (Spring 2013).	Jan, 2013
Travel to Panama (Summer break 2013) and check on lamps. Collect data and feedback from the locals. Present results o the government of Panama to expand the project to other communities in the country.	May-Aug, 2013

Team Members

Being natives who speak the language is extremely valuable to our project. We value our multidisciplinary approach, our experience in research, and most importantly our shared desire to help the poor communities of Panama.

[Name excluded for privacy] is pursuing a Masters in Architecture at UC Berkeley. He graduated with a Bachelors in Environmental Design with magna cum laude honors from Texas A&M University. He has worked as a coordinator for Global Architecture Brigades, where he researched accessible materials from the Ngobe Indians. He has worked as translator and researcher with several social services programs along Panama's borders with Costa Rica and Columbia. Professionally, he helped introduce energy-efficient software at BHDP Architecture in Cincinnati. He has worked in a large group research project, "Horizontal Hybrid Solar Light Pip," a hybrid system that integrates natural and artificial lighting, a project that was awarded $75,000 in an EPA competition. Last year, he was selected to be a Project CANDLE Ambassador to present the physics and geometry of lighting to high school students in TX. His academic and professional experience in environmental design and renewable energy, along with his passion for solving the problems of the disadvantaged, make him an ideal member of the team.

[Name excluded for privacy] a senior undergraduate Electrical Engineering student is focusing his studies on power systems, power electronics, and renewable energy. He holds a minor in Mathematics, has a GPA of 3.87, expects to graduate magna cum laude in May 2012, and worked at Electro-Tech Industries, a company dedicated to industrial generation and power supply systems. His technical skills and academic achievements make him an essential member of the project. His passion to improve the living conditions in the undeveloped areas of Panama, his country of citizenship, is valuable to the success of the project.

Big Ideas@Berkeley 2011-12 Contest Budget Template

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SECTION 1. PROJECTED EXPENSES		
I. Supplies Cost	**Supplies Cost Details**	**Total**
*LED Bulbs	$8.00 per bulb, purchased in large quantities to minimized their cost	$720.00
*Insulated Copper	100ft of copper for $6.00. We will use 20ft of copper per lamp, $1.20 per lamp. This is enough copper to make replacements as needed to powered the lamp for one year	$108.00
*Fish Compost	10lb fish compost. Approx. 1lb per lamp.	$360.00
Other materials	Bamboo, coconuts, ropes	$200.00
Materials for research	Include testing of all the materials listed above.	$500.00
Multimeter	It is necessary to measure the electric current we are generating	$10.00
Electronic Welding Kit	We expect to borough a kit from the University to avoid this expense	$25.00
Printing: Instructions to communities and surveys		$150.00
*Indicates supplies to fabricate 90 lamps		
Subtotal Supplies		**$2,073.00**
II. Travel & Transportation Costs	**Travel Cost Details**	**Total**
Air flight from U.S. To Panama	2 Flights, round trip. The Average Cost of 1 round trip flight is $800	$ 1,600.00
Transportation from the city to the communities. Global Brigades volunteers are not included since they will cover their own expenses	Local transportation (Bus and boats)	$ 200.00
Cabins in Communities		$ 300.00
Transportation during research phase		$ 200.00
Subtotal Travel		**$ 2,300.00**
III. Other Project Costs	**Other Cost Details**	**Total**
Translator	From Spanish-Dialects	$ 100.00
Shipping or Transportation of Supplies		$ 300.00
Labor help in Panama while the team is in the U.S.	Distribute surveys and find local costs	$ 150.00
Unexpected expenses		$ 77.00
Subtotal Other Costs		**$ 627.00**
TOTAL PROJECTED EXPENSES		**$ 5,000.00**

References

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