

## **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.

### **The Idea**

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 bacteria 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 free protons and electrons. Similar to what happens in a battery, 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 but 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 undeveloped 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 obtain 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:
    - Renting out cabins with attractive/innovative lighting sources
    - 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
  - Educate 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 cost 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 a cheaper, more portable, and

easier to manufacture option for restricted access areas. By using mainly local materials, the project will reduce waste and 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.

### 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 a graduate student pursuing a Masters in Architecture at UC Berkeley. [Name] 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 for the Ngöbe Indians. [Name] has worked as a translator and researcher with several social services programs along Panama's borders with Costa Rica and Colombia. Professionally, [Name] helped introduce energy-efficient software at BHDP Architecture in Cincinnati. He has worked in a large group research project, "Horizontal Hybrid Solar Light Pipe," a hybrid system that integrates natural and artificial lighting, a project which was awarded \$75,000 in an EPA competition. Last year, [Name] was selected to be a Project CANDLE Ambassador to present the physics and geometry of lighting to high school students in TX. [Name]'s academic and professional experience in environmental design and renewable energy, along with his passion to solve problems for the disadvantaged, make him an ideal member of the team.

**[Name excluded for privacy]** a senior undergraduate Electrical Engineering student at Texas A&M University, is focusing his studies on power systems, power electronics, and renewable energy. [Name] holds a minor in Mathematics, and worked at Electro-Tech Industries, a company dedicated to industrial generation and power supply systems. [Name]'s 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.

### References

- Sanford, Galen. *Make Electricity, Not Sludge*. BlueTechBlog, June 15, 2010. Web. Nov. 19, 2011. <<http://bluetechblog.com/2010/06/15/make-electricity-not-sludge/>>
- The World Bank. *Panama poverty assessment: priorities and strategies for poverty reduction*. Washington: D.C., 2000.
- KeegoTech. *Meet MudWatt*. Keego Technologies, Web. Nov. 6, 2011. <<http://www.keegotech.com/>>
- Justa, Aditi. *Harvard students harness electric power from bacteria in soil*. EcoFriend, June 12, 2010. Web. Nov. 6, 2011. <<http://www.ecofriend.com/entry/harvard-students-harness-electric-power-from-bacteria-in-soil/>>
- Harding, Dan. *Global Environment Brigades Deliver Solar Power to Panama*. CalFinder, Apr. 13, 2010. Web. Nov. 19, 2011. <<http://solar.calfinder.com/blog/news/global-environment-brigades-deliver-solar-power-to-panama/>>