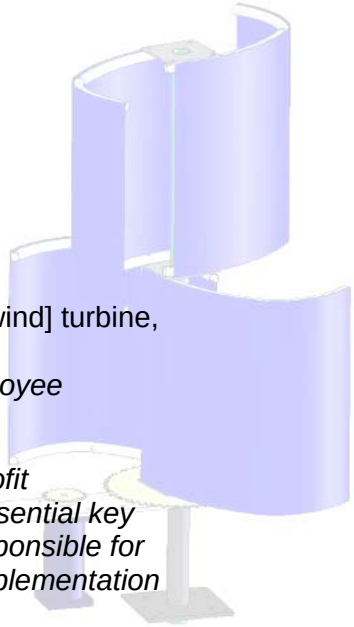
16 February 2009

Pico-Wind Turbine

Quetzaltenango, Guatemala



"Personally it would be a satisfaction to participate in the production of the [wind] turbine, to be a technician that helps protect the environment."

- José Ordoñez, XelaTeco employee

Catapult Design partners with and consults for nonprofits, NGOs, and for-profit organizations around the world. An in-the-field partner organization is an essential key to our program. Each project has at least one in-the-field partner who is responsible for providing feedback, defining requirements, and assisting with technology implementation and evaluation.

Client:
Appropriate Infrastructure Development Group (AIDG), www.aidg.org
AIDG is our in-the-field partner. They are a nonprofit organization with an office and technology development lab based in Quetzaltenango, Guatemala, focused on developing sustainable infrastructure solutions. In the course of their work, AIDG identified the need for a family-sized wind turbine for sale to the communities in which they work. AIDG provided Catapult Design with technical specifications and a materials budget at the beginning of the project and hosts our prototype and implementation trips to Guatemala.

Partner:
Appropriate Technology Design Team (ATDT), http://ewb-sfp.org/projects/ATDT/
The ATDT is a project of the San Francisco Professionals Chapter of Engineers Without Borders-USA. They are a volunteer-based engineering organization and were the first team to work on the wind turbine with AIDG.

Project Description and Background:
Catapult Design is working with AIDG and the ATDT to design an affordable wind-powered generator capable of producing enough electricity to charge a cell phone, power a radio, or operate LED lights for nighttime use. The generator is intended for rural, off-the-grid communities without electricity. Catapult Design's product, a pico vertical-axis wind turbine, is designed to operate in low wind speeds while charging a 12v car battery – this battery will in turn power small electrical devices. Once a fully functional prototype is developed, the wind turbine will go through both performance and marketing testing conducted on-site by AIDG for one year. Design iterations will be incorporated into a final prototype based on the testing results.

Objectives and Constraints:
The following objectives and constraints were originally developed by AIDG based upon their in-the-field experience working in rural Guatemala.

- The turbine should generate 10-20 Watts in 15mph winds.
- An incorporated generator should charge 12v car batteries for use with LED lights, radios, and cellular phones.
- The turbine and associated electronics should occupy a small footprint (~ 2×3 ft).
- The turbine should mount on the top of a small tower no more than 10 ft off the ground.

- The turbine and all components must be manufactured using locally available materials & skills in Quetzalenango, Guatemala.
- The price target for the turbine, generator, electronics, and batteries is $100 US to manufacture (installation is not included).

Design and Technology Notes:
Vertical-axis:
Given that the turbine needs to be installed so low to the ground and the power requirements are so modest, a vertical-axis wind turbine is ideal. Vertical-axis turbines operate much better in turbulent flow, common close to the ground, than do horizontal-axis turbines and are mechanically less involved because they do not need to be pointed into the wind. Vertical-axis turbines generally spin slower but produce more torque than horizontal-axis turbines; this presents a unique design challenge with regard to electricity generation.

Generator:
The expected rotational speed of the turbine is approximately 100 rpm. This is extraordinarily slow for an electricity generator. The option exists to use gears to increase the speed of the attached generator, but they introduce complexity and cost. Additionally, gearing the motor more than 5-to-1 is not practical (3-to-1 is more manageable using bicycle components) and this is still very slow for a generator. Given the limitations associated with gearing the system and the lack of generators on the market designed for our speeds, we have elected to design a permanent magnet alternator optimized for our expected speed and power output. We ultimately expect this to maximize the power output of the turbine while minimizing its cost, size, and complexity.

Impact:
The potential impact of a successful design – a turbine costing less than $100 that is capable of generating 15W of electricity in low-wind speeds and accepted by local communities – could affect a worldwide market. More than 1.6 billion people around the world don't have access to electricity and a few watts of power can eliminate the need for dangerous, polluting kerosene lamps. A low-cost renewable source of power would be an enormous boon to these people: a single LED light can dramatically improve lives by providing a means for after-dark income generation or by allowing students more time for schoolwork and education.

Organizations in both Africa and India are also interested in working with Catapult to implement a wind turbine prototype for testing in their communities.

About AIDG
AIDG helps individuals and communities get affordable and environmentally sound access to electricity, sanitation and clean water. Through a combination of business incubation, education, and outreach, they help people get technology that will better their health and improve their lives.

XelaTeco, founded with assistance from AIDG in Guatemala in 2005, is a micro-manufacturing facility based around the fabrication and sale of appropriate infrastructure solutions for rural Guatemala. XelaTeco employs 11 Guatemalan technicians and is the planned manufacturer of the wind turbine.

Press:
ABC7 News, “Small Wind Turbines to Help Countries”
WIRED.com, “Engineers Without Borders Bring Tech to Villages Without Power”
Core77, Video Drive-by, “Maker Faire: Engineers Without Borders”
TV20, Your Green Life video segment, “Wind Turbine”

Catapult Contact:
Tyler Valiquette, tyler@catapultdesign.org

AIDG Contact:
Catherine Laine, claine@aidg.org

Below is an initial concept prototype we built at XelaTeco (background) in Quetzalenango, Guatemala.