

IPRO 335: Developing Technology to Transform Education in Haiti



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I. Executive Summary

There is a great need for assistance in improving the education possibilities in Haiti. As the poorest nation in the western hemisphere, most of its schools do not have enough materials or equipment to provide a proper education to their student. Also, with an extremely high unemployment rate there a shortage of well-trained and motivated teachers.

In 2008, the non-profit-organization One Laptop Per Child (OLPC) donated approximately 11,000 XO laptops to Haitian students from grades 2 to 5 in 40 schools located in 4 regions of Haiti. This donation was done in the spirit of their mission “to empower the children of developing countries to learn by providing one connected laptop to every school-age child.”

Unfortunately, most of the schools in Haiti do not have a reliable electrical source to charge the laptops. The sad result is that the laptops cannot be used during class and their educational benefits go unrealized. Across the whole country, only 12.5% of the population has regular access to electricity. Most of the infrastructure in Haiti is very old and expensive to maintain and operate. Due to this shortage of electricity many households and institutions have to rely on their own diesel generators, or improvised solutions using car batteries and alternators. Fuel for these is very expensive as well as a source of pollution, which makes current energy situation unreliable and unsustainable.

Our team was called upon to provide a low-cost, reliable, and renewable source of energy to primary schools across Haiti. Our goal is to design a solar powered energy solution that is replicable across Haiti and scalable for schools of different sizes. We have chosen solar power as our energy source, because Haiti is well situated with a high solar irradiance while having lower access to other common renewable energy sources such as wind, water, or geothermal.

With the support of faculty and industry advisers, we are working to improve the conditions of education in Haiti, by helping to support the implementation of the One Laptop Per Child Program. Our team worked with the motivation to enable and empower Haitian children's education through the use of sustainable energy and collaborative technology, as well as expanding our practical and professional experience by pursuing funding and grants.

This semester, our main focus was the design a solar solution to provide power for the laptops, schools and Internet connectivity. We created a prototype-model of our solution and finalized the calculations that can be used to design larger solutions in Haiti. The next step is for us to send a team to Haiti in January 2011 to find out more about the schools in Lascahobas, where we intend to install our pilot and also to gather more information on the availability of solar materials locally in Haiti. The installation at the schools is planned to take place during a second visit in May/June 2011. Once we have accomplished this, we can move on to our further goals in improving education across Haiti.

II. Problem and Objectives

Haiti is the poorest country in the western hemisphere with the lowest per capita income in Central America. More than 65% of the population of 9 million lives below the poverty line and over two-thirds of the labor force are unemployed. Haiti has a literacy rate of about 52% even among those who have attended school for 6 years. Haiti's economy is in drastic need of improvement and one of the best places to start is with the education of its children.

The One Laptop Per Child (OLPC) organization is a group of dedicated technologists and educators whose mission is “to create educational opportunities for the world's poorest children by providing each child with a rugged, low-cost, low-power, connected laptop with content and software designed for collaborative, joyful, self-empowered learning.” The laptop they have developed is called the XO, named for the iconic design of a child on its case. The laptop delivers on all the goals that the OLPC organization set out to accomplish and has had many successful deployments around the world. However, not every XO deployment has been as successful.

In 2008, Haiti received a donation of approximately 11,000 XO laptops from the OLPC Foundation and the Inter-American Development Bank (IDB). This donation was formed on a handshake agreement between the two foundations and one main issue that donors did not consider in their gift-giving was that 95% of Haiti's primary schools lack a reliable source of electricity. The few schools that have electricity get it from expensive and polluting diesel generators, or from equally unreliable improvised sources using car batteries and alternators. Haiti lacks a reliable centralized electrical grid and the power plants it does have are very old and expensive to repair. There are currently three large thermal plants and one hydroelectric plant serving the metropolitan area of Port-Au-Prince but only a few smaller thermal and hydroelectric plants in the outer provinces. It should have been clear that however well-intentioned the donation was, the infrastructure simply does not exist to support such an influx of new technologies.

Anticipating this issue the Coordinator of the OLPC program in Haiti, Guy Serge Pompilus, negotiated to receive fewer laptops than had been previously designated before they were sent to Haiti, and in their place, have funds allocated for teacher training and electrification of the schools. As a result, \$5,000 was allocated for each school's electrification efforts. Unfortunately, when the Ministry of Education put out a bid for a local solar company to give an estimate of the cost, the company's estimate was based on powering 30 off-the-shelf normal laptops, and 24-hour electrification for the entire school's potential needs—this estimate did not take into consideration the lower power needs of OLPC's XO laptops, nor the fact that some schools will have 400+ of these laptops to charge on a regular basis. The private-company's estimate came in at \$14,000 per school, at which point the Minister of Education canceled plans for solar power, and the electrification process has been put on hold.

It was at this point that Guy Serge, in coordination with the President of Green Wifi, Bruce Baikie, approached Professor Hosman at IIT, about forming an IPRO to address the electrification of Haiti's primary schools to facilitate deployment of the OLPC program.

Our primary goal, then, became to recalibrate the solar powering estimate based on actual needs, take advantage of technological improvements, breakthroughs, and other cost-saving measures, and ultimately reach the \$5,000 price point that was the originally budgeted allocation, so that these solutions will be affordable for the schools and the children and teachers will be able to power the laptops they already have, but cannot charge or use. Additionally this solution would have to be adaptable to the unique conditions present at each school.

A secondary goal of ours is to develop a system for collaboration between partners in the US and in Haiti that will allow for us to follow-up on the deployments we work with as well as enable deployments within the country to communicate with each other and share insights on common problems. This would most directly manifest in a partnership with a group of engineering students from one of Haiti's national universities.

A final, ever-present, goal would be to acquire external funding for any of the project needs. Given the economic realities of Haiti we cannot receive extensive financial support from our sponsor and must find means of funding on our own.

From these three primary goals our group arrived at three main objectives for our project:

Design and propose a means for charging the laptops using solar energy.

Establish a method of collaboration between deployments using the XO's laptops.

Secure funding to purchase equipment for a prototype as well as transportation to Haiti to install a pilot model.

III. Organization and Approach

Our team was generally organized into three main initiatives, one for each of our primary objectives. These initiatives each had a dedicated corps of 3 team members who were responsible for directing it and keeping track of what tasks we required next. As new tasks were created they were put before the group collectively and members volunteered for each based on their skills and interest.

One of our first major hurdles was the fact that none of our team members had any experience with solar design and implementing projects in the developing world. To overcome this we held a series of instructional workshops with Bruce Baikie, who has done various sustainable energy installations throughout the developing world. These sessions covered how to find the wattage and solar irradiance numbers that go into designing a solution as well as the calculations involved in selecting components. We also learned about considerations that should be taken into account when working in the developing world. From this base the solar initiative began a search for necessary components for a prototype-model.

The other non-solar initiatives were mostly directed towards brain storming any tasks that could be relevant to their objectives. The collaboration initiative worked mostly on how to facilitate the kinds of collaboration we were looking for while the fundraising initiative look for any relevant funding sources that could be pursued by the team.

IV. Analysis and Findings

From the information in our solar workshops we decided to go with a direct current only design for our solution. This is because it would avoid the high costs of expensive inverters and maximize the efficiency of the output. Additionally if the system is limited only to direct current at the voltage of an XO laptop it cannot easily be re-purposed, making it a less desirable target for theft. We also connected with a group of graduate students at San Jose State University who are working on a docking station for XO laptops that can interface with multiple power sources, which became a part of our design. See appendices A and B for block and line diagrams of our design sized for a school of 350 laptops.

With the design in mind we collected data that directed the sizing of our model. Given that an XO laptop requires 17 watts for 1.5 hours to fully charge and our target region of Haiti has an average solar irradiance of 5.3 hours we would require 1,750 watts of power from panels and 1,000 amp hours of battery storage. See Appendix C for more complete calculations.

With these calculations in hand we priced out a small prototype-model that we could use to better familiarize ourselves with the concerns that would need to go into a final installation as well as be a proof of concept for our design. We completed the prototype and it successfully charges 4 XO Laptops.

The collaboration initiative made little progress as we discovered regular communication with our partners in Haiti could not be relied on. Their tasks quickly transformed into pursuing any possible contacts that might be able to assist us. They also took on the role of facilitating internal collaboration for our group utilizing resources such as PBWorks.com.

The fundraising initiative had mixed success with its projects. Other than the grants we applied for one gave us a commendation of merit, one was denied and one is still pending. In addition to

the grants the team organized multiple fundraisers around campus as well as took on the PR duties of our website.

One thing we discovered was how many people are interested in the XO laptops. From our fundraising activities to the final IPRO day, many different people from young to old were interested in how this new type of education technology works. It was heartening to see how so many people are interested in helping out children in a different country. This motivation was a great asset when looking for outward assistance with the project.

A major accomplishment for our team was successfully building the prototype solar model. In the beginning of the semester the nine-team members knew nearly nothing about photovoltaic and solar connections. From the workshops and research we did during the semester we were able to build the prototype and successfully have it work and power four XO laptops. Another major accomplishment was the successful launch of our website and receiving an award for our idea and purpose. This will provide a very solid base for the project to move forward in the coming semester and beyond.

V. Conclusions and Recommendations

Overall our team's project has shown to be a very expansive and broad one. The best way to begin making progress has proven to be by choosing a particular thrust of focus to address and developing a stable base in a particular niche of the groups intended solution. Because of this it is easy to lose partially the full potential of the groups size to accomplish large progress. However, by focusing the entire group on one or two major tasks at a time the group is able to move quickly and accomplish fair stride in efforts. Future teams should realize this as a major milestone of accomplishment for a group of students in a newly formed project; to find and focus on the projects exact goal and direction.

One major overlooked component of this first semester's initial effort has been with fundraising. This is because generating funds typically takes a lot of energy and cooperation from the group as a whole. Without this being a major and obvious possible detriment to the projects success, it was unable to be focused on with the full force of the group without first establishing some more of the details of the team and project. This should quickly be addressed by the next team by simply initializing grant applications – which typically take a very long time to be reviewed and returned, and if the group felt it would be beneficial some smaller group efforts to run smaller scaled fundraisers around campus or contact local companies in order to try and generate some funds and support from the community.

Another more broad and managerial hurdle the group had to focus its efforts on to overcome and gain more productivity as a whole was to attempt to divide the group into subgroups that focused solely on a set rubric of tasks. This did not typically hurt the group, however through trial and error it was realized that the entire group could bring much more valuable help to a bigger task that could easily be redirected on a need to do basis and help with making notable progress on a weekly basis for the entirety of the team. This tactic, of using

subgroups, might work in a larger group more effectively, however for this small initial group it has proven most effective to utilize the manpower of each individual towards a common goal at a single time.

This project shows need for longstanding continuation in order to fully address all of the initial goals of the group through rotation of specialties within the given group during a semester as well as the continued and improved knowledge that will come with further trial and error of optimal strategies for the group given the unique theme and resources of this project.

There was need for little to no correction of team behaviors as the group shared a strong common desire to bring an equally valuable presence to the team and project as a whole. For this reason, no issues among group members evolved and created a much more facilitating environment that really gave a great force in the projects initial establishment.

VI. Appendix

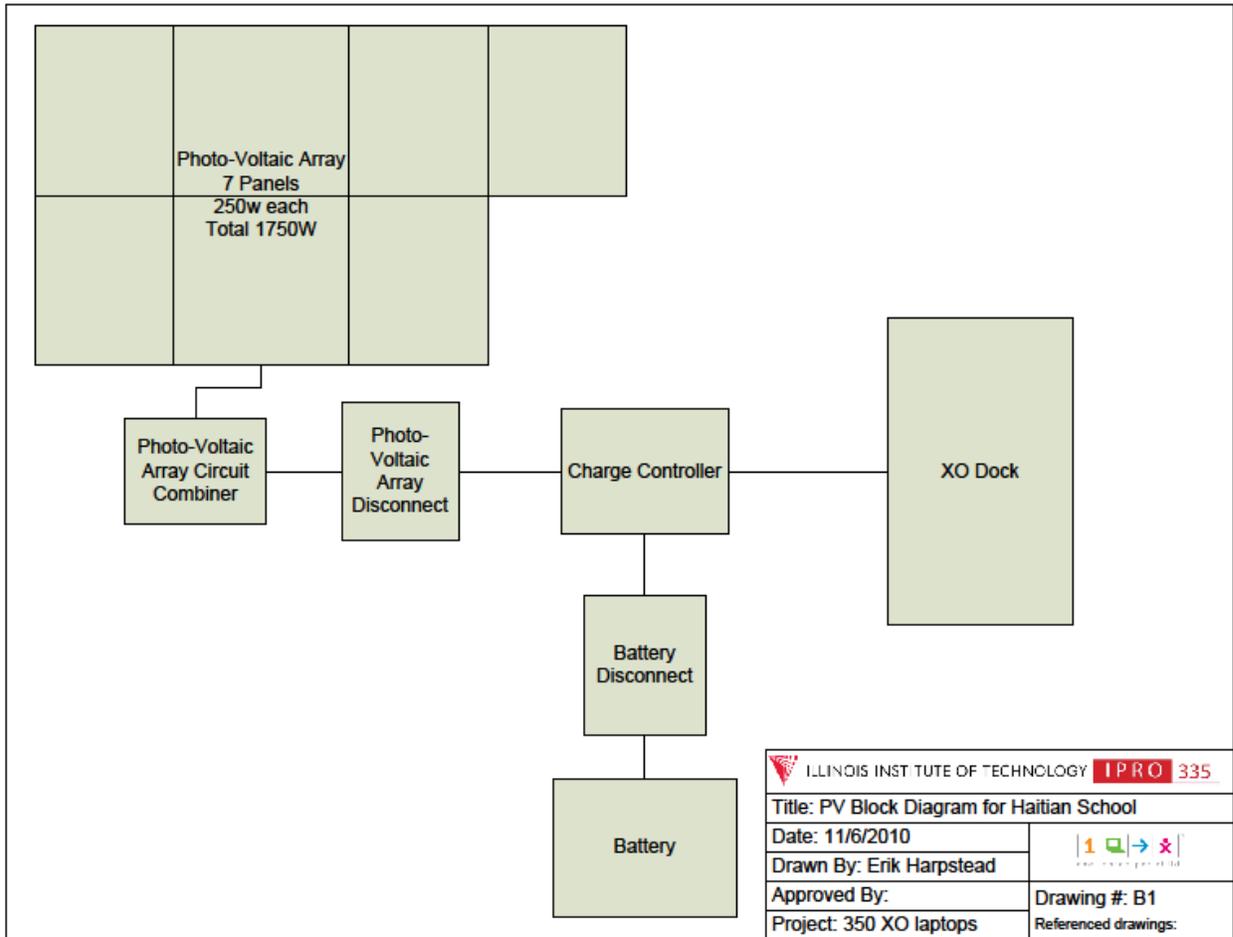
A. Block Diagram

B. Line Drawing

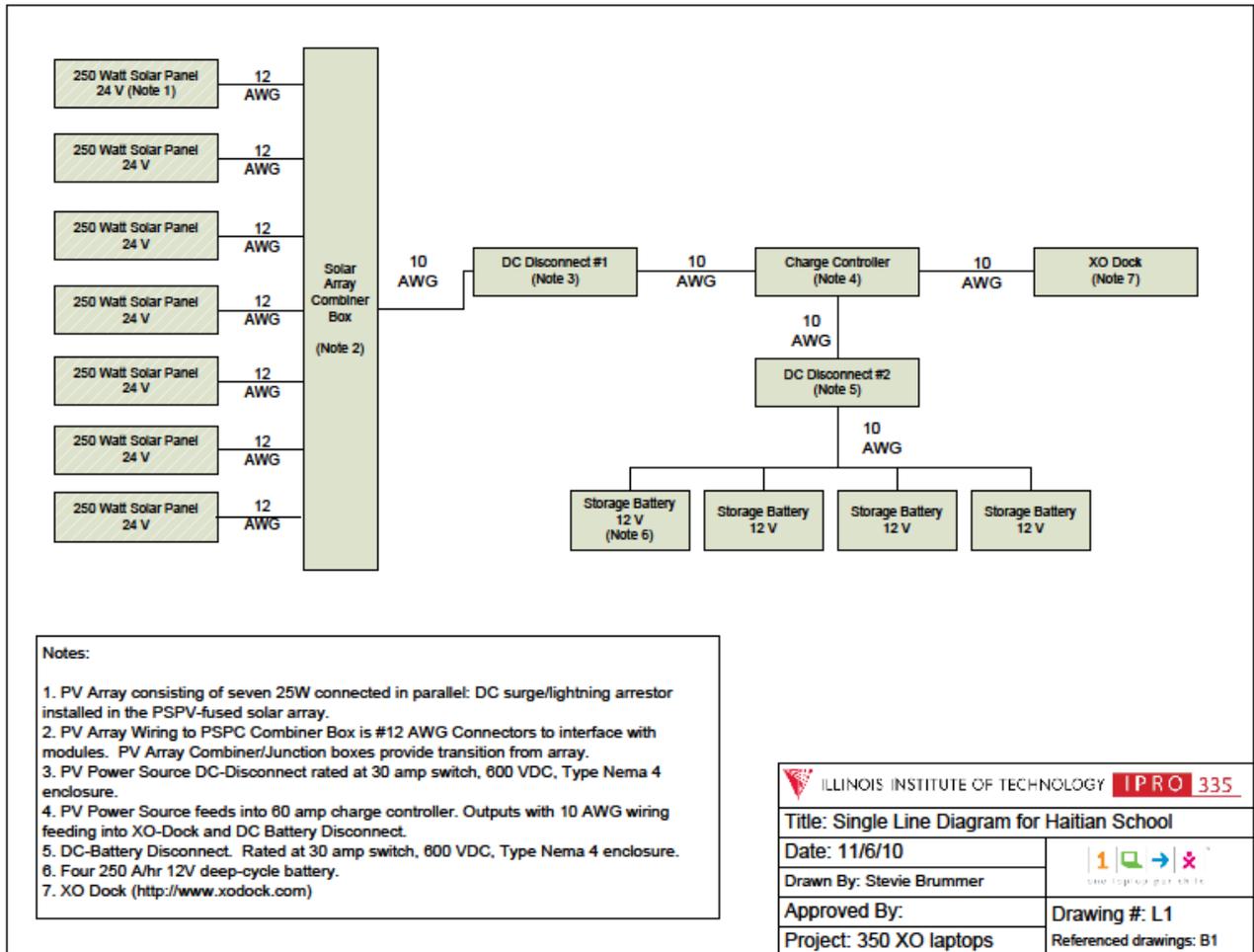
C. Calculations

D. Project Budget and Team Information

Appendix A:



Appendix B:



Appendix C:

An XO laptop needs 17 watts¹ (at 12 volts) of electricity for 1.5 hours to fully charge a dead XO
 THEREFORE
 $17 \text{ watts} \times 1.5 \text{ hours} = 25.5 \text{ watt hours per OLPC XO}$

For 350 XO laptops:
 $350 \text{ XO's} \times 25.5 \text{ watt hrs} = 8,925 \text{ watt hrs}$

Assuming an average of 5.295 hours² of direct sunlight, the size of the solar panel would be....
 $8,925 \text{ watt hr} / 5.295 \text{ hours} = 1,685 \text{ watts from solar panel} = \text{round up to } 1,750 \text{ watts}$

The battery required to charge the 12 volt XO laptops would be...
 $8,925 \text{ watt hr} / 12 \text{ volts} = 743 \text{ amp hr} = 30\% \text{ overhead factor} = 966.875 \text{ amp hrs}$

Notes:
 1. Test results of in class experiment performed on September 16, 2010 at Illinois Institute of Technology.
 2. Data obtained from the NASA Langley Research Center Atmospheric Science Data Center, New et al. 2002. (<http://www.gaisma.com/en/location/mirebalais.html>)

 ILLINOIS INSTITUTE OF TECHNOLOGY I PRO 335	
Title: Electrical Review of PV System for a Haitian School	
Date: 11/6/10	
Drawn By: Stevie Brummer	
Approved By:	Drawing #: E1
Project: 350 XO laptops	Referenced drawings: L1

Appendix D:

<u>Item</u>	<u>Amount</u>	<u>Description</u>
Website Template	\$47.00	License cost of website template
SNCR Application Fee	\$75.00	Cost of application to Society for New Communications Research grant
2 OLPC XO Laptops	\$275.00	2OLPC XO Laptops purchased on ebay for testing
30 Watt Solar Panel	\$117.02	Solar panel for prototype-model construction
PowerStar AGM 12V 12AH Battery	\$32.70	Battery for prototype-model construction
10 amp charge controller	\$49.60	Charge controller for prototype-model construction
Cash Box	\$16.29	Cash box used for fund raising efforts
Vizio Software License	\$180.54	Used in rendering drawings
Total	\$793.15	

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