

# NECA Ghana Project

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Cal Poly's motto is, "Learn by Doing" and for Cal Poly's NECA Chapter, this isn't simply a motto, but a directive for proactive change. For my senior project I will be leading the Cal Poly NECA chapter in the design, pre-fabrication and construction of a 5-7kW solar array, community center, ice production room and technology room in the remote fishing village of Agbokpa, Ghana. The solar array will power multiple industrial DC freezers, high efficiency LED lighting and charging stations while additionally powering water filtration and irrigation systems. Like many other fishing villages around the world, Agbokpa has no means of ice production or access to clean water since they are not connected to a power grid, contributing substantially to their impoverishment.

**Key words:** Solar, development, sustainability, renewable energy, Ghana, Africa

## NECA Chapter Photovoltaic Project

The Agbokpa photovoltaic project was first introduced to the Cal Poly NECA Chapter in the summer of 2018 by one of our lead advisors, and physics professor, Nathan Heston. Nathan recently spent four years working on similar community relief projects in Ghana and is well acquainted with the chief of Agbokpa. One project near our site was an off grid agricultural technology center being developed in a collaborative project with Harvard and MIT. After spending time living in Ghana, Nathan recognized the immense potential for innovative change, specifically, the food preservation process in off-grid locations. Working alongside him, our NECA Faculty Advisor, and other Cal Poly faculty, our team has the combined resources and experience to ensure a successful project.

*Purpose / Objectives / Goals:*

Diving into why we decided to focus our efforts on an ice making system specifically, is largely due to Agbokpa's geographic location. The world's largest manmade lake, Lake Volta, lies within Ghana and Agbokpa borders its shoreline. This lake is essential to Ghanaians' everyday lives providing food, revenue, and hydroelectric energy. Although this lake has enormous potential, it has been far from realized due to the lack of technological development and funding. There are thousands of small fishing and farming villages that are situated on the lakefront, however Ghana's electric grid only connects to a small fraction of them. Providing the village of Agbokpa with access to electricity will allow them to utilize more of the lake's many benefits. There are approximately 500 residents that farm or fish in the village of Agbokpa and these people's income is dependent on making their way across the lake to sell their produce and fish on market days in the larger village of Kotoso. Therefore, it is essential that the fish and produce stay fresh until market day, which typically occurs weekly on Fridays. Currently, villagers of Agbokpa have no access to refrigeration or ice and are storing fish in nets in the water in hopes of keep them alive as long as possible. This current system leads to severe amounts of spoilage throughout the week.

The lack of an effective method of preservation, water filtration and access to information in the village of Agbokpa (and many villages like it), reduces their economic potential and forces them into a cycle of extreme poverty. By giving these fishermen the ability to preserve their weekly catch, and other village produce, the general wellbeing and economic potential of the community will be greatly improved. Fishermen will be able to boost their profits allowing them to, for the first time, invest in education for their children.

### *Student Topic Interest*

I have always had a passion for electrical construction; since a very young age, I was measuring wire and sorting PVC fittings. Being born into a family of electrical contractors has given me the opportunity and knowledge to best represent the Cal Poly NECA Chapter for this project. My grandfather Mike Chiappari started Northern Electric in 1982. I have worked for the family company since the age of 14 and developed a strong passion for electrical construction.

With graduation just around the corner, I wanted to fully immerse myself in Cal Poly's community. Through our NECA Chapter, I have found a team of passionate students and faculty. This team, and my passion for electrical work and helping others, inspired me to take on a serious leadership role within our chapter. I see this project as the perfect opportunity to impact the lives of many by utilizing our team's diverse skill set.

### *Benefit to Student / CM Industry*

This project will serve as an educational opportunity for our entire team consisting of four students from Cal Poly's NECA Chapter and faculty advisor Professor Lonny Simonian; three MCAA students and their faculty advisor Paul Redden (via separate funding); and faculty members Nathan Heston and

Peter Schwartz (via separate funding) who have been conducting research in solar-powered refrigeration in mechanical engineering.

Our team at Cal Poly will prefabricate the electrical system in the Cal Poly SST. Our lab work will serve as an educational study and will be available for viewing by all Cal Poly students and faculty interested in photovoltaic systems. This project will be an extremely valuable opportunity for our student chapter to learn during the pre-fabrication and testing period on campus and in the travel and installation next August/September. The entire project, which perfectly demonstrates Cal Poly's motto of "learn by doing", will be documented in a film. We expect the project to have a very positive impact on our university in terms of publicity and future studies. Monitoring of the success of the project will give valuable data for future publications of the results.

### *Professional Contacts Assisting*

On top of the NECA team, we are also working in conjunction with the Cal Poly Mechanical Contractors Association of America Chapter, a solar refrigeration research team from Cal Poly's Physics and Engineering Departments, with local contractors in Ghana, and with Sundanzer (the industry leader in DC Refrigeration). Through separate funding that has already been partially procured the Cal Poly MCAA Chapter will be building a slow sand water filtration and irrigation system giving people of Agbokpa access to clean water. The success of our project directly relates to the success of theirs as they will be utilizing our community center for their project location & clean water access points.

### *Client/Beneficiary of Project*

Ghana is a country in West Africa with a land mass about the size of Oregon and a population of approximately 28 million, equaling that of Texas, the second most populous US state. It is the first West African country to gain independence and is a stable multi-party democracy. It is sometimes called the gateway to Africa, in part because of its official use of the English language. The world's largest manmade lake, Lake Volta, lies within Ghana. Its 3,300 square mile surface area is about 50% larger than the entire state of Delaware. The lake provides Ghana with a huge source of food, revenue, and hydroelectric energy, but its full economic potential is far from realized. Irrigated farming, transportation, and even the fishing industry are all poorly developed. The major reason for this is the lack of electricity in this area. The jagged perimeter of Lake Volta has a coastline of approximately 2,500 miles. Hundreds of small fishing and farming villages are situated on the lakefront and Ghana's electric grid connects to only a small fraction of them, mostly on the southern (and more economically developed) side.

Agbokpa is a typical village on Lake Volta's shoreline with no access to grid electricity. The majority of Agbokpa's approximately 500 residents farm or fish. Their incomes depend on crossing the lake to sell their produce and fish on market days which occur each Friday on the south side of the lake. A

major challenge for the fishermen of Agbokpa is to keep their daily catch preserved. The lack of access to refrigeration and ice results in fisherman crossing the lake at high costs to purchase ice or trying to keep the fish in nets in the water which can lead to waste or theft. The market, at which those from Agbokpa and approximately 15 other small villages sell, is located across the lake in Kotoso. Kotoso is a town of several thousand with the substantial advantage of having access to a good road and grid electricity. In Kotoso, fish are purchased, packed in ice, and shipped to larger cities.

Solar-powered ice production in Agbokpa would have a major impact not just on those in Agbokpa, but also on other nearby communities on the north side of the lake. Ice could be sold, and profits could be used to maintain the system. By slightly over-sizing the solar array, we will also power a community center with electric lighting that would give children a place to study and allow community members electricity for charging phones and other small devices. This project will demonstrate how harvesting photovoltaic electricity can meet the energy needs of the community. Currently the only school that children in Agbokpa have access to is an elementary school about 1 mile away. No other schools exist in this area and most residents of Agbokpa cannot afford to send their children across the lake to junior and senior high schools. By increasing the incomes of those in Agbokpa we are hoping to also give parents the ability to afford to send their children to school.

### *Final Deliverables*

The final deliverables for my project are my final Senior Project binder and a 10-minute professional documentary; in which, we will recognize all the organizations, companies and individuals that came alongside us, and made our project possible through support and donations. We also plan to christen the building with a commemorative plaque naming all organizations, companies and individuals that helped fund our project. The documentary will premiere at the NECA Now Conference in October 2019 and will hopefully be posted to the Cal Poly Construction Management Senior Project webpage.

### *Work Plan Description*

Since September 2018 I have taken numerous steps in preparation of installing our system in Agbokpa. I have reached out to donors, developed a design, connected with the villagers, established a budget and formed a schedule. Now moving forward, our NECA team has a few tasks we must complete to be fully prepared for the installation of our system in late August. We are currently working to retrofit our project's design to our budget and order all relevant materials to prefabricate our complete solar powered refrigeration system on campus.

Led by our advisors and working with Sundanzer (the industry leader in DC refrigeration), our team will optimize the performance of the DC chest freezers we have purchased for ice production. Once we have optimized our system in April 2019 we will ship one shipping container to Ghana. We are going to be sharing shipping costs with Cal Poly's MCAA Chapter. One of our faculty members will spend from mid-June 2019 until we arrive in Ghana preparing our site and will complete a large

portion of the structural scope of work with help from the local community. Installation and completion of our system will occur in August 2019. To conclude, we will monitor the operation, and analyze the data in preparation for our final presentation in October 2019.

## **Reflections**

At the end of August 2019 Will Myers and I traveled to Ghana, transported all our materials to site and installed the complete electrical system we designed. I compiled a documentary of our journey and presented it at the ELECTRI council meeting in Las Vegas on September 15, 2019.

Leading the installation of the electrical system was easy, Will and I had the entire electrical system complete and running like clockwork before we left.

## *Lessons Learned*

In a project setting there are a lot of ways an individual can learn and grow, and this senior project taught me many things as well as allowed me to grow in both a professional and personal setting. Prior to this project I had worked several years in the electrical field and already had a lot of experience in electrical design and installation, therefore in terms of electrical work this project did not teach me too much. However, I found that I gained a lot of insight regarding project management, working alongside different teams/team members and working with the Cal Poly University.

One of the biggest challenges I faced throughout this project that I was completely unfamiliar with prior to this project was dealing with international shipping. It was my first time dealing with a project with such a large scope that needed substantially large sized shipments delivered to a foreign country. Shipments were consistently delayed, and this caused tension among the NECA club. It was hard as the president of the club to boost morale and push past the difficulties. However, in the end our shipment did arrive in Ghana and we were able to change our flights to ensure the project's completion.

Another challenge I faced that I was not familiar with prior to this project was project management. Upon joining the NECA chapter I was asked to take the role of president and had not realized the tremendous responsibility that would be placed upon me. At times it was difficult to separate my own personal feelings about what would be best for the project, and I had to learn to best manage the project with the villagers' best interest at heart. I am very proud of everything I was able to accomplish as a leader and all of the skills I obtained along the way. I believe this project greatly prepared me for a more professional industry setting.

This project was one of my greatest accomplishments. With all I have learned I do hope to complete more projects like this in the future. I am hoping to return to Agbokpa, Ghana in the summer of 2020

and bring the villagers more resources to help them both socially and economically prosper. Although there were many struggles along the way, I do believe that no single project will be without its downfalls. I appreciate all the lessons being a part of this project taught me, and I look forward to growing as a leader and young professional in the future.

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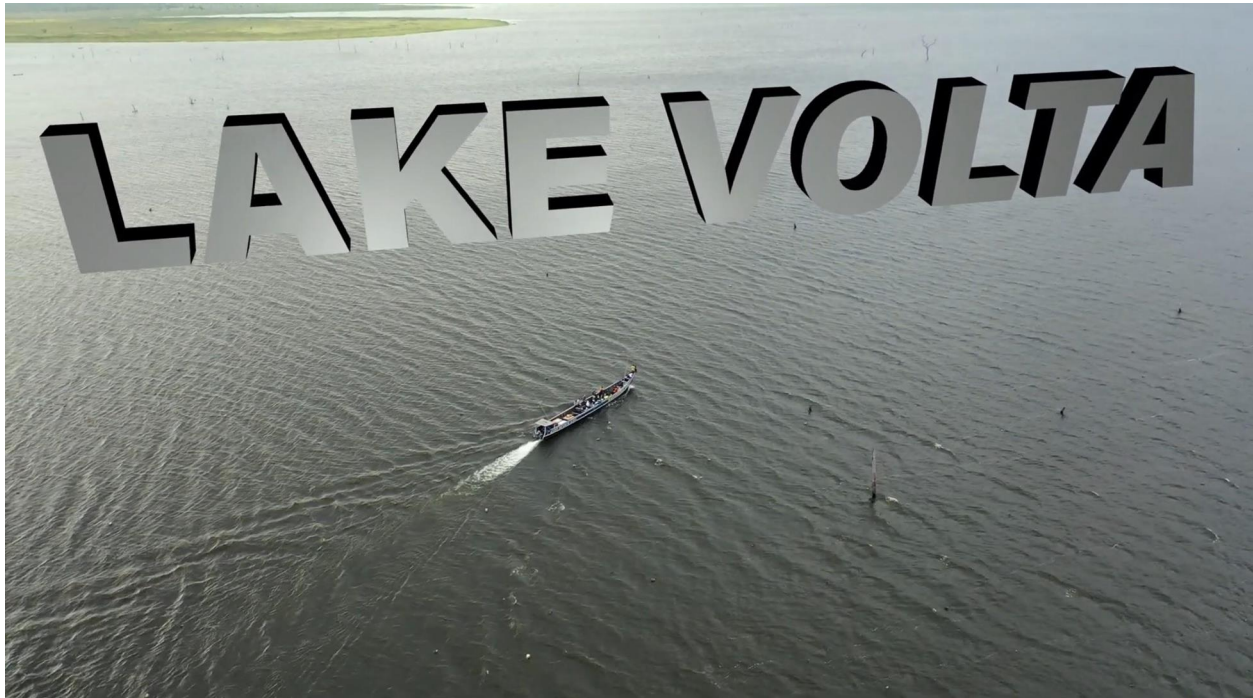


- Agbokpa, Ghana
- Population 500
- Farming/Fishing Village

# TRANSPORTING OUR MATERIALS ACCRA TO AGBOKPA





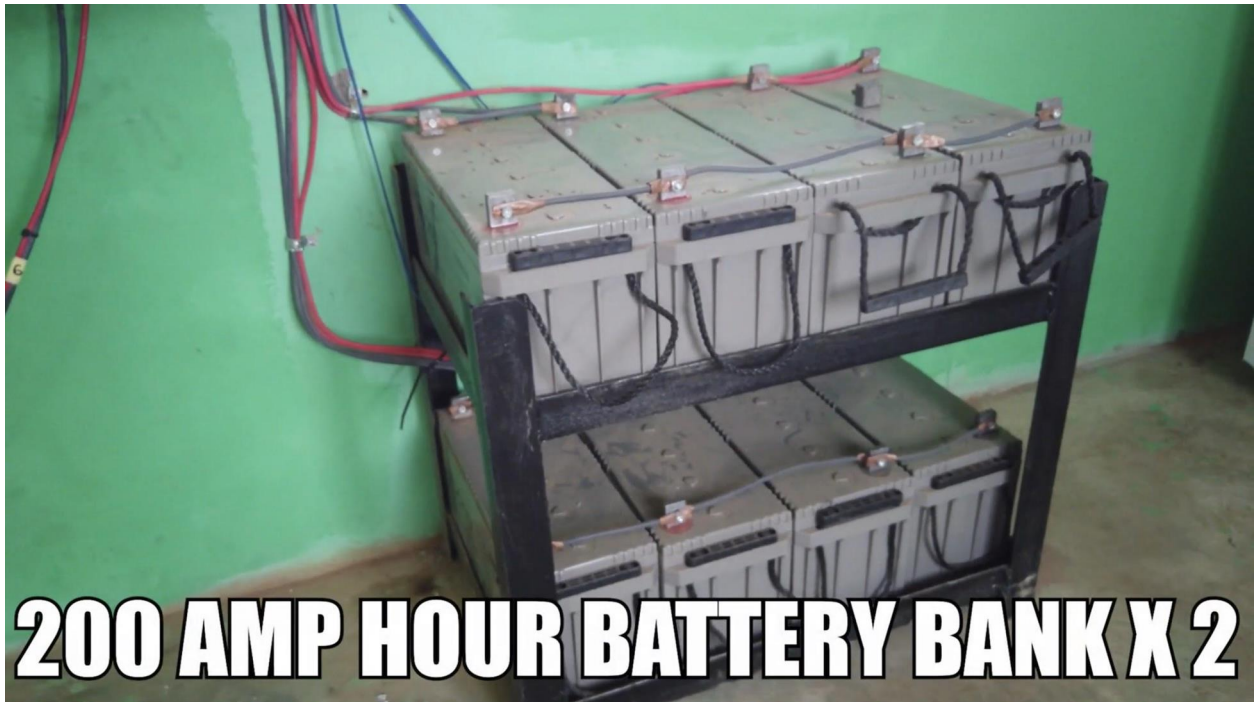




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