FINAL REPORT

Final reports will be published on the Cal Poly Digital Commons website (http://digitalcommons.calpoly.edu).

I. Insulated Solar Electric Cooking In Ghana

II. Project Completed on August 30, 2019.

III. Student(s), Department(s), and Major(s)

(1) Matthew Walker – General Engineering

(2) Grace Gius – Industrial Engineering

IV. Faculty Advisor Dr. Peter Schwartz - Physics

V. Made Possible by Baker & Koob Grant

VI. Executive Summary

In August 2019, we travelled to the unelectrified village of Agbokpa, Ghana to test out our ISEC in real world conditions and acquire personal feedback from real intended users. In surveying this village, we found that all households used biomass cooking either indoors or outdoors, sometimes using up significant quantities of biomass daily, resulting in a large monthly expense. We noticed that predominately women and children spent their time in close proximities to the fires and smoke, which we presume to negatively affect their respiratory health.
Figure 1: A high end indoor biomass cooking system in Agbokpa, Ghana (an unelectrified village).

Figure 2: Woman and children smoking fish over open fire in Agbokpa, Ghana.

Figure 3: Woman cooking over open fire in Agbokpa, Ghana.
From our US lab, we brought several ISECs, and basic materials to build more cookers; we sourced the other materials and solar panels in country. Everyday staples include soup, rice, and beans, which are able to slow cook throughout the day at a low power without burning. Even though optimal sun intensity is not available towards the end of the day near dinnertime, the insulation allows energy to be stored and minimally lost so that the food is still hot during dinnertime.

Figure 4: Rice slow cooked at low power in container insulated with blankets and clothes in Agbokpa, Ghana.

One double walled ISEC pot had a phase change thermal storage material between the double walled insulation, allowing the cooker to store heat rather than directly the food. This thermal storage material greatly increased the maximum accessible energy during cooking and allowed the user to cook even after the panel stops supplying power.

Figure 5: Plantains fried in external-diode cooker in Agbokpa, Ghana.

For 3 weeks, we demonstrated our technology to the people of Agbokpa and had a few of them use the cookers to cook local dishes. The users were able to use the cookers with ease because of their similarity to traditional cooking methods. After
2 weeks, the users were able to set up the cooking system (cooker and solar panel connection) themselves without our assistance and fully use them. In order to continue collecting information on field use and because of ease of adaption, we chose 2 Ghanaians to keep our cookers to use and regularly send updates and feedback.

Figure 6: Cooking demonstration after Sunday church service in Agbokpa, Ghana.

Figure 7: Cooking demonstration in Agbokpa, Ghana.

Figure 8: People serving ISEC-cooked rice in Agbokpa, Ghana.
VII. Major Accomplishments

(1) Several ISEC’s disseminated in a target region after collecting information about their cooking habits and working with them to develop an understanding of this new cooking method, to increase chances of adoption.

(2) Established collaborations with SNV, Ashesi University, Kwame Nkrumah University of Science and Technology and established a local team to build a manufacturing business, supported by a grant.

(3) Formed connections with the end users of the disseminated stoves, who provide helpful information about using new cooking methods in a different culture, as well as data on cooker performance and use.

VIII. Expenditure of Funds

$2500 per student.
$1750 per flight.
$100 per visa.
$400 for food, housing, and in country transportation.
$250 towards malaria medicine and vaccinations, which were well over $1000.

IX. Impact on Student Learning

This trip enabled students to connect directly with target users of the product they are designing, building, and testing. It is important for designers to understand cooking methods and habits of people from the target culture. For example, we expected residents of Agbokpa, Ghana to eat lots of rice and beans because they are cheap. This was not the case. The people of Agbokpa eat mainly what they can source themselves – fish and corn flour. The fish is usually fried, and the corn flour fermented then pounded and stirred into a dough over a raging fire. This type of pound and stir would be nearly impossible using our cooker since it must be covered and insulated to cook effectively. Fish, however, could be fried using the Phase Change Thermal Storage addition to our cooker, which allows the user to store thermal energy by melting a solid, then when they are ready, throw the food in and fry for a long period of time. We found this to be the most adaptable version of our cooker. Additionally, we now are able to get quick feedback by communicating with Ghanaians directly in order to understand what they cook, how they cook it, and how willing or able they are to make a change in their habits.