

MECS-TRIID Oct 2021 Report

Reporting period	June 1st - October 18th, 2021
Report author/s	Pete Schwartz, Olivia Hansel, Nichole Hugo, Martin Osei
Institution/Organisation	Cal Poly Corporation, San Luis Obispo
Project Title	Insulated Solar Electric Cooking (ISEC) - Phase 2

Executive Summary

Our funding period has been extended to March 2022, as indicated in our updated Gantt Chart. School has started at Cal Poly again and we have multiple student groups leading projects on the ISEC. We will start taking Stage III funding applications starting December 1, 2021.

Presentations

- Pete Schwartz:
 - June 10, 2021, Insulated Solar Electric Cooking with Thermal Storage, Engineers Without Borders, Sweden: <https://www.youtube.com/watch?v=hkosRwstw9M>
 - Video demonstrating thermal storage using a 1 liter aluminum puck: https://www.youtube.com/watch?v=Y_5qIXdULQY&t=4s
- Alexis Zeigler:
 - Making an ISEC oven report to SuperGroup meeting: <https://www.youtube.com/watch?v=m4u55G5OWvw&t=15s>
 - Making an ISEC with cement heater: <https://www.youtube.com/watch?v=uzZPstX1CbQ>
- ISEC research team,
 - Feb, 2021, Cal Poly Research Competition Finalists Presentation: <https://www.youtube.com/watch?v=7LhFaJdlsk&t=13s>
 - August, 2021, Summary of summer research for Frost Research Program, beginning at time = 45 minutes, 41 seconds: https://calpoly.zoom.us/rec/play/yban5SNJFO_XQy0WW5y1X6MBPbxWeSEJwyyVGn1VR9xgLEZt9dvkl9MwkcIyl41LBjJAH1G9-fCa0o6L.1aAPdf9sdc0hG2w0?startTime=1628886765000&x_zm_rtaid=JNPBkWmLQRy33hCW7eI6Bg.1633110860571.a42538096cfe371294b80d352c625965&x_zm_rhtaid=813

ISEC Design Collaboration

The global learning community continues to be a hub of shared learning. For instance, Alexis at Living Energy Farm (LEF) has designed an ISEC and produced a manual and videos which are accessible on our research website (<http://sharedcurriculum.peteschwartz.net/solar-electric-cooking/>). Our newest collaborator, Bidjanga, is using Alexis's manual to construct ISECs instead of the manual produced by Cal Poly students. Additionally, Bidjanga is independently exploring many application innovations, for instance a 400 W oven for a restaurant and different "pay as you go" strategies. It's important to note that Bidjanga has no technology background and is able to make technological improvements supported by the Global Learning Community through the forum, SuperGroup meetings, and Email correspondence. This is the type of collaboration we were hoping for since starting the Global Learning Community.

Completed Senior Projects

- Olivia: Is awaiting publishing on digital commons, the report document is accessible: http://sharedcurriculum.peteschwartz.net/wp-content/uploads/sites/3/2021/10/Olivia-Senior-Project_Final-Draft-1.pdf
- Marcorios Bekheit, *Direct Drive Solar Panel Control Circuit*, July 2021: <https://digitalcommons.calpoly.edu/physsp/201/>
- Jack Crofton, *Insulation and Structural Support for Solar Electric Cooking*, June 2021: <https://digitalcommons.calpoly.edu/physsp/198/>
- Simon Ford, Sachin Gokhale, Brendan Lynn, Richard Nguyen, *Consumer-Ready Insulated Solar Electric Cooker*, June 2021: <https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1665&context=mesp>
- Julia Kraatz, *Mapping the Suitability of Cal Poly's Insulated Solar Electric Cookers (ISEC) in Ghana, Togo, and Jamaica*, Oct. 2021: <https://storymaps.arcgis.com/stories/87f5e4446fc444c396dc8a67c873dca4>

UNIV 391 Groups Present Class, Fall Quarter, 2021, *logistics*, back face to face

Pete is currently facilitating his UNIV 391 class. This class consists of student groups at Cal Poly working with some of our collaborators and other individuals interested in ISEC. Below is a list of the collaborators the student groups are working with and links to the students' websites. These websites will be updated throughout the academic quarter (Sept. 20, 2021- December 15, 2021)

4 student groups in 391: <https://canvas.calpoly.edu/courses/60952>

- Collaborating with Salma in Togo: <https://isecintogo.weebly.com/>
- Working with Aid Africa (<https://www.aidafrica.net/>) in Uganda: <https://josephalyssa5080.wixsite.com/aidafrica-uganda> and more recently with the Source Farm, Jamaica (<https://www.thesourcefarm.com/>), which works closely connected to Alexis Zeigler and the Living Energy Farm (<https://www.ic.org/directory/living-energy-farm/>)
- Working with Solar Electrical Lighting Fund (<https://www.self.org/>) in Uganda: <https://cgrubens.wixsite.com/391g3isecuganda>, and developing a global contest challenge model with World Merit: <https://www.worldmerit.org/>
- Working with Bidjanga in Cameroon: <https://sites.google.com/view/isec-in-cameroon/home>

UNIV 392 Groups Spring Quarter, 2021, *Design and Build*, in Quarantine

During the Spring Quarter of 2021 (April-June, 2021, <https://canvas.calpoly.edu/courses/49543>) Pete facilitated the UNIV 392 class. This class is the *Design and Build* section of the group-project service learning class. There are 8 student groups dedicated to ISEC collaborating with:

- Emmanuel in Ghana: <https://sites.google.com/view/isecgroup1/home>
- Hawazin in Kerala, India: <https://isec2021.wixsite.com/isec-in-kerala>
- Salma in Togo: <https://delatorrejonathan9.wixsite.com/isecintogo>
- Ajay of PRINCE (<http://www.princeindia.org/>) in India: <https://isecgroup4.weebly.com/>
- Alexis of Living Energy Farms (<https://www.ic.org/directory/living-energy-farm/>) in Virginia and Jamaica (<https://www.thesourcefarm.com/>): <https://sites.google.com/view/psc392group5/home>
- Bidjanga of GERPAD (<http://www.gerpad.mozello.com/>) in Cameroon: <https://sites.google.com/view/isecincameroon/home?authuser=0>
- Deepak of the Muni Seva Ashram (<https://www.greenashram.org/>) in Gujarat, India: <https://pscgroup7.weebly.com/>

- Working with Aid Africa (<https://www.aidafrica.net/>) in Uganda: <https://cassidymu.wixsite.com/isecuganda>

Collaborator Progress Summary Table

Collaborator	Summary of Progress
Emmanuel (Ghana)	Emmanuel has constructed 4 ISECs with PCM (phase change material) and plans on disseminating 10 total ISECs by the end of October. He has been seeking a different insulation material and has been experimenting with cotton instead of fiberglass. Emmanuel is also experimenting with connecting ISEC users to the grid by using old laptop chargers as a power source instead of, and in addition to, a solar panel.
Salma (Togo)	Salma has been experimenting with compressed sawdust buckets as an outer containment vessel, but has recently redirected his efforts to dissemination and marketing efforts.
Bidjanga (Cameroon)	Bidjanga has made considerable gains on his ISEC project. He received Stage II funding since the last report. With these funds he plans on producing 10 ISECs a month starting in October. Bidjanga is experimenting with different ISEC designs. He is currently constructing an ISEC for an interested restaurant manager along with a stationary ISEC made of cement or earth bricks. Bidjanga has also been in communication with another Super Group member Raphael (Germany), who has helped Bidjanga considerably with the construction of ISECs.
Deepak, Prasad, Ralf (India)	Deepak, Prasad, and Ralf have projected to have 3-5 ISECs, 2 with thermal storage, disseminated by the end of November. Deepak has also connected the ISEC Team to Universal Collaboration for Engineering Education (IUCEE). This organization teaches project-based learning for engineers and is interested in our technology.
Hawazin (Karala, India)	Hawazin has been involved in the sourcing challenges of the Global Learning Community. She has done research into affordable solar panel options that could be distributed among the group along with affordable insulation. Hawazin has also reported she plans on deploying ISECs with a DC adapter because most of the individuals in her community are on grid. She has requested help in finding trusted business partners to help her with the ISEC project in India.
Alexis (Jamaica)	Alexis and the Jamaica team have made considerable gains on their ISEC Project. Alexis recently sent supplies for 10 ISECs to be constructed in Jamaica. Alexis and LEF are partnering with another ecocommunity, The Source Farm in Jamaica plans to build and disseminate ISECs. LEF and The Source Farm have collected helpful feedback from users of the disseminated ISECs. They are also establishing a non profit in Jamaica to support solar cookers with board members from Jamaica and the US. Pete plans to visit the Source Farm in Jamaica for one week in November.
Crosby Menzies (South Africa)	Crosby has acquired a partner with more technical knowledge to build ISECs. They have built ISECs but no ISECs have been disseminated to neighboring communities.
PPB: Project	Communication has come to a halt with the PPB team. The previous contact, Africa,

Peanut Butter (Sierra Leone)	is no longer working on the project. We have no other update on the status of the ISEC project.
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Current Senior Projects

There are 12 senior project students working on different areas of basic research and prototype construction. We meet a few times a week to share knowledge.

There are two year-long Mechanical Engineering Group Senior Projects that started this past September, and will continue until June. Each group has four students:

(1) Solid Thermal Storage: Construction of a consumer-ready ISEC with thermal storage using metal such as aluminum or iron, that will allow the thermal storage to be invoked or disconnected without removing it from the ISEC.

(2) Nitrate Salt Thermal Storage: Construction of a consumer-ready ISEC with thermal storage using nitrate salts. This work could be considered a combination of our most recent publication reporting on erythritol as a phase change material (<https://www.sciencedirect.com/science/article/pii/S0038092X21002280?via%3Dihub>) and the thesis of Matt Alonso (<https://www.ideals.illinois.edu/handle/2142/101168>) of Sunbuckets. Our team of Frost Research Students initiated this work over the summer. Essentially, we are putting a Sunbucket into an ISEC and heating it with solar electricity. However, our design doesn't require the PCA (Phase Change Assembly) to be moved or inverted. Our stationary design will come with reduced design constraints, hopefully resulting in lower cost and the ability to be constructed by collaborators.

I am also advising four individual physics senior projects:

(1) Elsa Micklin: Using xylitol as a phase change material (PCM) instead of erythritol. Erythritol degrades at higher temperatures (180° C) as we reported (<https://www.sciencedirect.com/science/article/pii/S0038092X21002280?via%3Dihub>). Xylitol is reported as being more thermally robust.

(2) Andrew Shepherd: Solid thermal storage. Exploring the thermal questions related to using a solid piece of metal to store the day's thermal energy. For instance, Andrew is exploring the requirements necessary for heat to flow from one metal piece to another.

(3) Michael Fernandez: Thermal modeling in Python. Correctly modeling an ISEC will allow us to explore different designs quickly.

(4) Andrew Perez: Controlled Buck Converter for Better Power Coupling. As we described in our "Hot Diodes!" paper (<https://www.sciencedirect.com/science/article/pii/S2352728519300508?via%3Dihub>), the efficacy of a resistive heater to couple power from a solar panel changes with sunlight intensity. In order to consistently optimally use a solar panel, a buck converter taking input from a microprocessor maximizes the current provided by the solar panel.

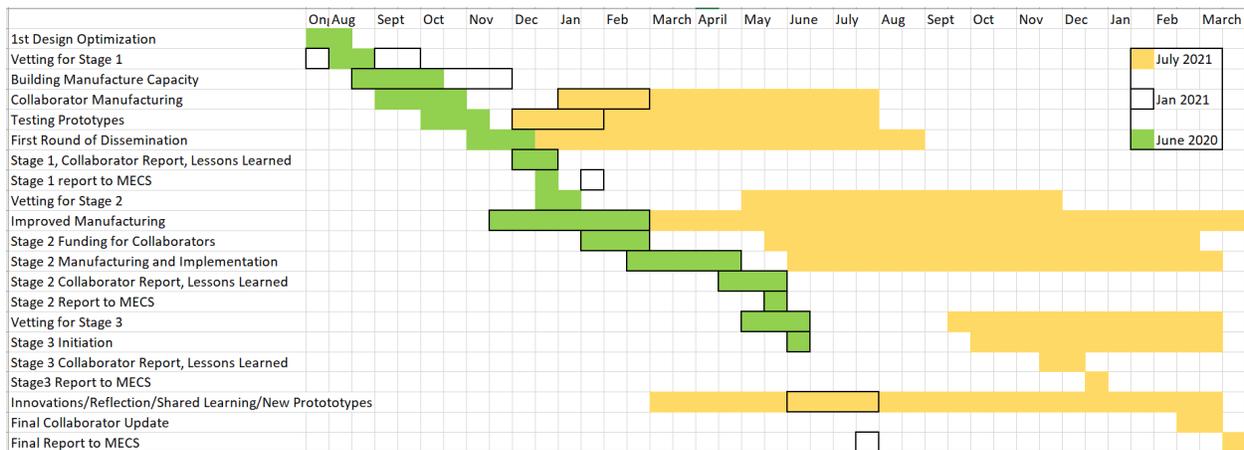
Additional Research

Michael Dalsin is supported on a Frost research stipend this fall. Among other things, he is investigating different insulating materials. In particular, he is looking at refractory cement and how to increase the insulation capability by mixing in organic matter such as straw or rice hulls, which subsequently oxidize with heating to leave small voids, which may be a good, inexpensive, rigid, insulating material.

Changes in Planned Activities

Insulation has been difficult to attain in Africa. Fiberglass is expensive to import and we have been told it is usually imported for industrial purposes. Emmanuel (Ghana) is now experimenting with cotton. Bidjanga (Cameroon) is experimenting with wool as insulation, which has a higher combustion temperature than cotton. We also anticipate experimenting with perlite and vermiculite, which is mined in Uganda.

Our funding deadline has been extended until March 2022. This will give collaborators time to apply for and utilize their Stage III funding. This will also give the ISEC Team time to fully report how collaborators have spent their Stage II & III funding. This extension also included more funding to continue Martin Osei and Olivia Hansel’s work stipend. Their work is essential to the ISEC project.



New Project in Uganda

We have joined a collaboration with the Solar Electric Lighting Fund (SELF, <https://www.self.org/>) and Solar Household Energy (SHE, <https://www.she-inc.org/>), aimed at providing alternative cooking strategies in Uganda. We are including our present Ugandan collaborators: Aid Africa (<https://www.aidafrica.net/>) and Chris Musasizi from Beacon of Hope Boarding School (<https://www.pilgrimafrica.org/category/about-beacon-school/>).

Research

Frost Summer Research

This summer an interdisciplinary group of Cal Poly students along with Martin Osei (Eastern Illinois Graduate Student) conducted summer research through the FROST grant. The research team designed an ISEC that can be used in a 10 gallon bucket; the larger bucket provides better insulation. The research team also designed a “double” ISEC, an ISEC with two pots. This idea came from the team realizing the difficulty of cooking two different meals with two separate ISECs. They experimented with two different types of heating elements: a nichrome wire with ceramic beads laid in cement, and a nichrome wire sandwiched between two circles of thick aluminum foil (0.025 mm). The research group also experimented with different types of thermal storage. The first type of thermal storage was a salt mixture, 70% NaNO₃ and 30% KNO₃. The second was an aluminum puck that can be placed on the bottom of the ISEC. We will be further experimenting with both the salt mixture and the metal pucks as thermal storage.

EIU Research

Martin Osei and students with Nichole Hugo at EIU continue to collaborate with Cal Poly students and Pete Schwartz. Martin is currently attempting to find a sustainable method of keeping the heating element wires from burning in the salt mixture that is used as a PCM. Martin also continues to use the ISEC to receive valuable user feedback.

New Forum Site

After much discussion the ISEC Team decided to move the forum to a new website. The old forum website was difficult to navigate and the process to post pictures was confusing. To help cultivate conversation and a better user experience we have decided to move the forum to www.isecforum.com. Hopefully the Global Learning Community and the ISEC team will have a better experience with this forum.

Gender and Social Inclusion

Our statement in regards to gender and social inclusion remains unchanged. We continue to make strides in including women from the communities where ISECs are disseminated.

Lessons Learned

Funding Deadline

Some collaborators are progressing further than others in regards to advancing through the funding stages. To assure we allocate our funds to collaborators that are progressing, we have decided to start taking Stage III applications December 1, 2021 although some collaborators have not progressed past Stage I. We have let the collaborators know that by December 1, 2021 if they do not have an application for Stage II funding we cannot guarantee there will be funding for them.

Cost Breakdown

Before we finish our quarterly reports to MECS, we asked for an update from each of the collaborators to complete the Collaborator Progress Summary Table above. In this last update from the collaborators we asked for a cost breakdown of the funds spent. We discovered through this cost breakdown that a collaborator was spending too much money on research and development instead of construction. We brought this to the collaborator's attention, who assured us funds will be diverted to construction. This shift in direction would not have been caught without asking for the cost breakdown. We will henceforth be requesting cost breakdown from all of our collaborators to make sure funds are being spent appropriately.

Adding a USB Charger

The research team this summer added a USB charger to their ISECs. This has now been adopted by multiple collaborators. We are hoping this will aid in adoption of the technology, and also be used to charge cell phones and USB-charged LED lighting systems.

Videographers

A member of the Global Learning Community, Pat McArdle, will be giving a talk to Pete's UNIV 391 class on Monday October 18th, 2021. Pat and another videographer, Luther Krueger, will film the research team, Pete, and herself cooking with the ISEC.

The documentary crew from France visited Alexis at Living Energy Farm (LEF) and is in the process of producing a documentary about LEF and ISEC technology.

Conclusion

We continue to learn. The Supergroup Global Learning Community continues to develop as a learning network as well as increase the level of construction and dissemination. We anticipate that we will use the funds by the funding deadline.