MECS-TRIID May 2021 Report

Reporting period	Feb. 1, 2021 - May 31, 2021
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Institution/Organisation	Cal Poly Corporation, San Luis Obispo
Project Title	Insulated Solar Electric Cooking (ISEC) - Phase 2

Executive Summary

- Technology improvement continues. Summer work will explore molten salt and metals as thermal storage media.
- The Global Learning Community meets weekly, with growing autonomous support.
- Collaborator funding should last until the end of December, 2021. ~$3200 requested for continued student stipends.

Journal of Solar Energy Publication and Subsequent Work

Our paper describing phase change thermal storage and our global learning community dissemination model was published in the Journal of Solar Energy May 15, 2021:
Phase change thermal storage: Cooking with more power and versatility Martin Osei, Owen Staveland, Sean McGowan, Justin Brett Unger, Nathan Robert Christler, Matthew Weeman, Marcus Edward Strutz, Matthew Walker, Megan Belle Maun, Nicolas C. Dunning, Marcorios M. Bekheit, Jon Christian Papa Abraham, Liam Cox, Grace Gius, Olivia Hansel, Emmanuel Osei Amoafo, Nichole Hugo, Pete Schwartz, J. Solar Energy, 220, 2021, 1065-1073, https://doi.org/10.1016/j.solener.2021.03.040

ISEC with erythritol PCM has been a reliable, convenient daily cooking technology in Pete's home. However, as indicated in the publication, the melting point of erythritol has decreased after daily cycling over 180 C. Thus, we plan to see if thermal degradation decreases with a reduction of the 180 C cycling temperature and we will explore alternatives including salt PCMs and sensible heat in metals.

Matthew Alonso's PhD thesis (Sun Buckets, https://www.ideals.illinois.edu/handle/2142/101168) identifies value in both sodium nitrate salt PCM as well as thermal storage in solid aluminum. We are also looking at both steel and iron as solid thermal storage media because they have higher volumetric specific heat than aluminum. While a solid puck of steel has much greater mass than the salt PCM and slightly less thermal capacity, a solid thermal storage puck is desirable in its simplicity.

Six students (including Eastern Illinois University graduate student, Martin) will conduct full time research this summer developing these technologies. We have filed a very rough provisional patent out of an abundance of caution, although we do not anticipate it to be of relevance: *Thermal Storage for Electric Cooking*, Application number: 63/181,173, on April 28, 2021. While likely of no value, it seemed a good idea to submit a provisional application while we explore possibilities for the coming year.

Olivia Hansel, Survey Results Identify Adoption Barriers from Kerala, India

Olivia analyzed the preliminary surveys distributed by Hawazin. The report is 25 pages long and includes a literature review on previous research done on solar cooking adoption barriers and the results of the preliminary surveys. This document will be publicly available by summer.

Julia Kraatz, Conclusions from GIS Mapping Research

Julia Kraatz organized mapping data for each country the collaborators are in, with information provided visually to represent the negative repercussions of indoor biomass cooking. Indicators include deforestation, cardiovascular disease and respiratory disease death rates, and indoor air pollution. These maps can be used to assist with determining regions best suited for ISEC. The story maps are posted online and can be found here: https://storymaps.arcgis.com/stories/87f5e4446fc444c396dc8a67c873dca4

Additionally, findings from data analysis and the literature on partner countries suggests that the presence of charcoal production, particularly in Ghana and Togo, presents both opportunities and barriers to ISEC adoption and dissemination. Charcoal is a large industry in Ghana and Togo. It represents a way for rural populations that experience the highest levels of poverty to support themselves in Togo, and in Ghana a way to provide income in the off-season of agriculture/provide support against economic shocks such as drought, which negatively affects agriculture.

Interestingly, large quantities of charcoal are imported to dense urban areas in both countries. Urban areas, however, have electricity: it begs the question of why charcoal is needed. Evidence from the literature and from talking with collaborators suggests that electricity in urban areas is unreliable, and thus charcoal and other biomass is used when electricity is unavailable. This bodes well for ISECs, because it implies that they could be useful even in urban areas that have electricity. It should also be noted that a barrier to adoption may be that charcoal is culturally integrated into the way food is prepared. In the learning community, we are exploring new ways to cook creatively as well as identify ways to cook some of the "boil and simmer" dishes that require little accommodation. More research on this topic should be explored.

Pete's Webinar, June 10, 9 AM PST for EWB, Sweden

Pete was contacted by Stefan Karnebäck <stefan.karneback@ewb-swe.org>, from EWB, Sweden, working on cookstoves in Kenya. Pete will present a webinar for the global solar cooking community, and will send the meeting link when available.

SNV Ghana

In August 2019, we met with Dutch NGO, SNV (https://snv.org/country/ghana) in Accra, Ghana. They expressed an interest to have a PCM ISEC, and asked us to return when we had manufacturing capacity or order to promote our ISEC and find ways to support dissemination. Emmanuel is scheduled to meet with them in Accra, June 17.

Collaborator Activities

February 1st, Mark Manary of Project Peanut Butter (Sierra Leone) flew to Africa with ~$1000 in materials that are hard to source in Africa, to be equally split between Sierra Leone, Emmanuel in Ghana, and Salma in Togo. Mark planned to fly to Ghana, and Emmanuel would ship the parts to Togo by bus. Mark's trip from Sierra Leone to Ghana was delayed and he mailed the parts via DHL in late April (10 kg for $225 - a tiny fraction of the cost to ship from the USA). The long wait delayed work in Togo and Ghana; and there has subsequently been little communication from Sierra Leone. What we learned from this is the importance of each collaborator to either source parts themselves, or cooperate with each other in sourcing parts.

As of March, we have a new collaborator Bidjanga from Cameroon, who is a university lecturer at the Petroleum Sciences and Management University of Yaounde Mbankolo. He is establishing a Green Energy Research Program in conjunction with his university where research and dissemination of ISECs will occur.

In March, we became concerned at the lack of progress, lack of communication, and lack of attendance to the weekly SuperGroup meetings. We sent out a notice to all collaborators that we were concerned, that we didn't know what to do, and that we were going to explore alternative research/dissemination models at the next SuperGroup meeting. This transparent call to action proved

successful. Subsequent SuperGroup meetings have been better attended, with good participation. Collaborators transitioned away from waiting for help from us to finding ways to source parts themselves and/or help each other. We post a picture of each SuperGroup meeting on our research website. One outcome of the transparent call to action is that collaborators participated in a 1-1 meeting late April - early May, outside of our weekly SuperGroup meeting with Pete and students including technology research students, dissemination research students, and/or students in project groups (See "Online Technology Support" below) dedicated to the collaborator. These meetings provided tremendous insight into the difficulties, confusion, and accomplishments of our collaborators.

Collaborator Progress Summary Table

Collaborator	Summary of 1 – 1 meeting and Progress
Emmanuel (SolCook, LLC, Ghana)	Emmanuel has been building both direct-connect and PCM ISECs and has distributed about 10 direct-connect ISECs in a community, Kojo Nkwanta. Some people are cooking with ISEC while others complain that they can't cook the way they are used to. We encourage Emmanuel to have the successful adopters talk to people who are reluctant to use their ISECs. Additionally, Emmanuel should collect data with the Treks (blue-tooth data logger) that we received from Nexleaf. SolCook, Ghana is being established as the sourcing hub in West Africa, to distribute imports to Togo, Sierra Leone, and Cameroon. We encouraged stage II funding application.
Salma (Togo)	Salma experienced a delay in receiving essential components for building ISECs. We discussed his technical questions and resolved them. We also requested he deploy a few more ISECs because he is well able to make them now. We gave him deliverables of building 6 ISECs and disseminating them to make him eligible for Stage 2 funding. Salma has received 5 Treks from Emmanuel.
Bidjanga (Cameroon)	Bidjanga is the most recently-added collaborator, joining in mid-March. He is a university lecturer and principal of a vocational school, and so has proximity to technical people. Although he has no formal technical background, he learned how to build an ISEC and enthusiastically sourced parts and is building and testing a unique breed of ISEC with bare NiCr wire. He sends updates on a near weekly basis that has provided material for reflection in SuperGroup meetings. We agree that as soon as exams are over this month, he will advertise for technical partners in ISEC construction. After building and disseminating ISECs in homes, we encourage him to apply for Stage II funding.
Deepak, Prasad, Ralf (Gugarat, India)	Prasad (in India) and Ralf (in Germany) have joined Deepak's ISEC team. Prasad and Ralf provide critical technical and business experience. Ralf will be researching materials for thermal storage and Prasad will build and disseminate ISECs in India. Steel may be the best solid thermal storage medium per unit volume. We agreed that ISEC production in India should commence as soon as possible, before Ralf finishes optimization of materials. We agreed that if a product is designed for the poor, the adoption will be stymied by poverty stigma. Thus, the ISEC must be made in a way that is attractive to the middle class. Alibaba doesn't serve India because of political discord between India and China.

Hawazin (Kerala, India)	The Covid 19 crisis has provided barriers to gaining supplies in India. Hawazin was able to find essential parts for her ISECs such as thermal protectors produced in India, and has begun building and cooking with ISEC. She still has $300 from stage 1 funding. For Stage II funding: - She should design and build one direct-connect ISEC that she can be confident in and disseminate it to someone who will use it. - Hawazin also agrees to move her ISEC into the kitchen, requiring longer wire, which she can't yet buy under lockdown. - Because Hawazin has a family and a full-time job, we agreed she identify a collaborator with shop access to scale up ISEC manufacturing for Stage II funding.
Alexis (Jamaica)	Alexis at Learning Energy Farms (LEF) is running impressively with ISEC design, construction, and dissemination. He modified the direct-heat ISEC to be built with locally-available inexpensive materials (Jamaica). Their comprehensive construction manual is posted on our research website and is presently being used by Hawazin. At LEF, nearly all the cooking is done with ISECs modified to use 100 W and 300 W. They have sent several ISECs and a team to Jamaica to begin local construction. These models are insulated with perlite and can go to very high temperatures. They are also not protected by thermal protectors, but they have sent thermal protectors to be incorporated into the ISECs in Jamaica. They have received Stage II funding, with which they plan to ship $4000 of solar panels directly from China, logistically supported by a Cal Poly student living in Beijing.
PPB: Project Peanut Butter (Sierra Leone)	We have a new contact for the project, named Africa. Africa does not have internet access, but can communicate via WhatsApp. He had questions regarding construction of the ISECs, so we have put him in communication with a graduate student doing ISEC research, Martin Osei. However, so far, there has been no response.
Crosby (South Africa)	Crosby remains enthusiastic, and has assembled the parts necessary for an ISEC, but has not yet made an ISEC. We stressed that the first step should be simple (get a pot hot). Crosby agrees to find a collaborator with a solid technical background who wants to produce ISECs. We encourage Crosby to come to the SuperGroup meetings.

Online technology support

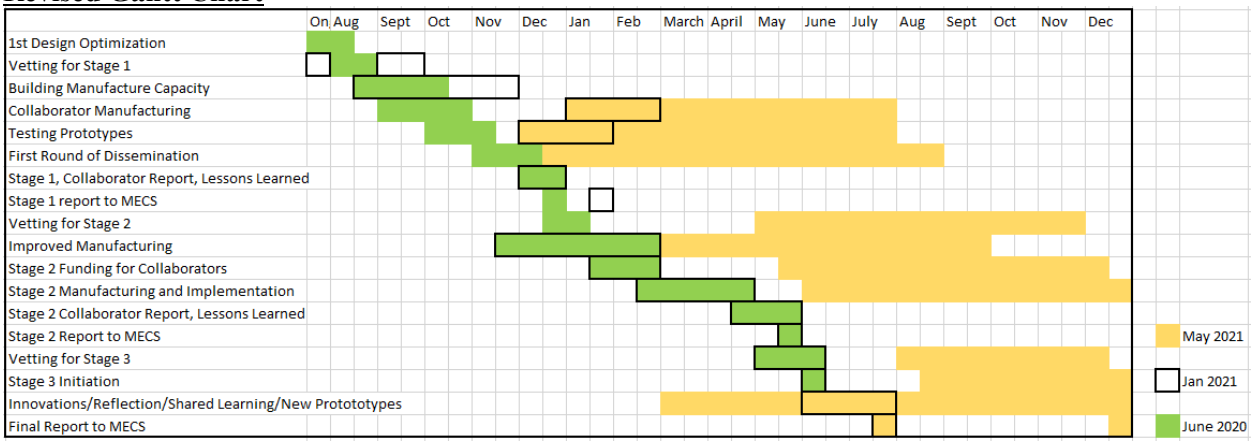
An industrial engineering senior project team focused on improving technological instruction. The team has developed an updated structure for the manuals, which are being tested by the project groups in Pete Schwartz's Appropriate Technology class, as each group is tasked with building ISECs. The ISEC project groups are documenting their experience on websites (accessible from https://canvas.calpoly.edu/courses/49543). They also provide material for an updated construction manual and some have made construction videos such as: https://www.youtube.com/watch?v=unsCbEdfUNs.

The industrial engineering senior project team also created a forum (https://isec.forumotion.com/c1-isec-discussion) where collaborators and other interested parties can post their experience building and cooking with ISEC. This forum has been an excellent way for collaborators to share ideas on ISEC design, ISEC-friendly recipes, and sourcing needed materials. The forum website is not user friendly, and we are exploring other hosting options.

Changes in Planned Activities

Due to multiple barriers, building working ISECs has taken longer than expected for most collaborators. This longer than expected time in stage 1 can be attributed to difficulty in finding materials, technical assistance, and resources - all exacerbated by COVID's stifling of the economic processes. However, since the beginning of May, activity has increased for many collaborators, partly resulting from our transparent call to action.

Revised Gantt Chart



We have extended the end date until the end of December 2021 and now include two final reports: end of July and end of December. Collaborators have moved at vastly different paces. Therefore, the time period for many processes has been spread out in order to cover all collaborators. Knowledge sharing (Innovations/Reflection/Shared Learning/New Prototypes) well beyond December 2021.

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

1-1 meetings better identify collaborator challenges than SuperGroup meetings.

As described in key activities, each collaborator participated in a 1-1 meeting with Pete and fellow ISEC research students. The 1-1 meetings were extremely successful giving us insight into the barriers each collaborator is facing. The research team found that collaborators were more likely to discuss their barriers to building ISECs more openly in the 1-1 meeting than in the weekly SuperGroup meetings. We plan another round of 1-1 meetings in July.

Overcoming activation barriers to start building

Some collaborators delay building until they are confident they have comprehensive knowledge in sourcing parts and building. We are creating video demonstrations to improve collaborator confidence. We are also emphasizing the value of experimenting, making mistakes, and learning from each other. As few materials are universally available, experimenting is crucially important. Recent experimental efforts have been highlighted during SuperGroup meetings and collaborators are learning from each other.

Shipping within Africa

As indicated above (collaborator activities) it is far cheaper to ship supplies within Africa than shipping supplies from the US to each individual country. Collaborators can source parts in bulk directly from China and India. Hawazin has found Indian manufacturers for her needs, and Emmanuel (Ghana) has shipped parts to Salma (Togo), and Bidjanga (Cameroon) and they have settled the expenses independently.

Group Project Classes Support Collaborators

Many of the project groups in Pete's classes are enthusiastically engaged with both the project and their assigned collaborator. Their participation was appreciated by most of the collaborators and brought the research team new knowledge. The student groups also seem to greatly benefit from working with the collaborators.

Financial Outlook Until 2021 year's end

At the end of the funding period, July 31, 2021, we will likely still have about $18,000 for collaborator support, and about $500 for student stipends. One stipend recipient, Grace, will be leaving mid-June. Two stipend recipients (Martin and Olivia) will continue to receive stipends until mid-December, requiring $4500, of which we will still have $500. We have other funding sources that can cover materials, in which category we have ~$800 remaining. If we can transfer the $800 from materials to student stipends, we will only need an additional $3200. We will make the $18,000 collaborator support last until the new year. If we are considered for renewed funding, we can prepare a proposal near the end of August, or as MECS requests.

Appendix

Please find attached in this Email:

- Excel Spreadsheet of Finances
- 49037 Back up: Receipts and Transaction Details
- Journal of Solar Energy Publication
- Provisional Patent Application