CAL POLY
SAN LUIS OBISPO

Insulated Solar Electric Cooking (ISEC)

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1. Electrical Engineering
2. Biomedical Engineering
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4. Mechanical Engineering
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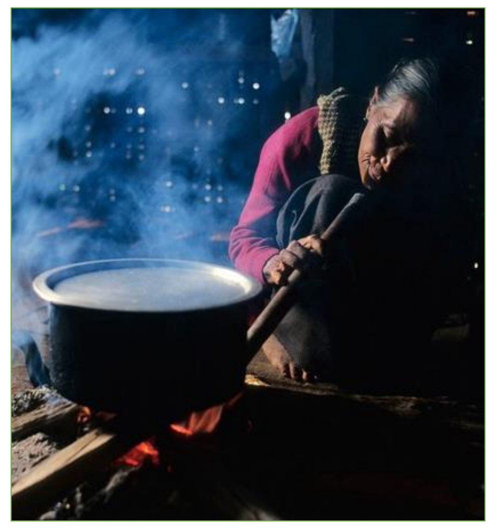
Problem Statement



The goal of the ISEC is to create a clean cooking alternative to biomass cooking, which has been linked to long-term health and environmental problems. Despite its development in the past few years, the most recent ISEC design lacks a formal bill of materials and lacks a repeatable manufacturing plan. Our project focuses on creating an ISEC prototype that can be scaled for manufacturing, is compliant with the manufacturing specifications, and remains low-cost for user purchase in Ghana.

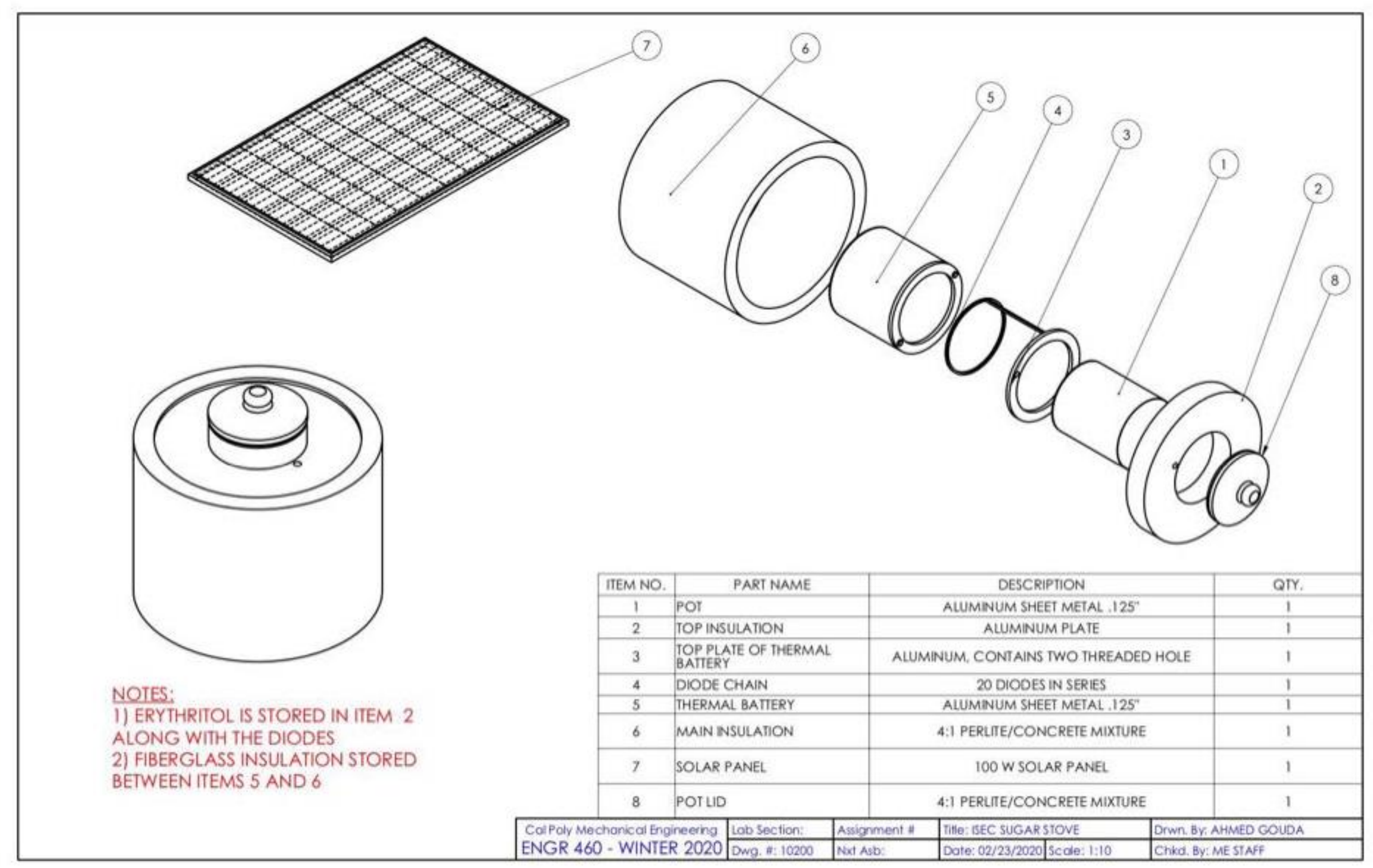
Objectives

Our objective is to create a robust, mass-manufacturable insulated solar electric cooker (ISEC) capable of meeting the needs of a Ghanaian community. The ultimate, long-term goal of the greater project is to implement the ISEC into as many developing countries who still use biomass fuel as their main cooking method. To boost local economies, all ISECs will be manufactured locally and with as many locally sourced parts and supplies as possible. The formal customer requirements prioritize making the transition from using a pot over an open flame to using the ISEC as seamless as possible. We aim to create an ISEC that allows for a familiar and uncomplicated experience, is intuitive to use, and is easy to clean.

Bill of Materials

Part Number	Item	Quantity	$/Quantity	Total $
None	Erythritol Sweetener Granular (2.5 lb. / 40 oz)	1	$14.99	$14.99
None	J-B Weld 8281 Professional Size Steel Reinforced Epoxy Twin Pack-10 oz	1	$14.79	$14.79
BYV10X-600PQ	Diode Standard 600V 10A Through Hole	16	$0.41	$6.48
PLP900-1	Loose Absorbent, Universal, Perlite, 8 gal.	1	$19.90	$19.90
GS-STAR-100W	High Efficiency Polycrystalline Photovoltaic Module	1	$100.00	$100.00
None	QUIKRETE 90-lb High Strength Concrete Mix	1	$4.10	$4.10
89015K126	Multipurpose 6061 Aluminum Sheet, 0.016" Thick, 48" x 48"	1	$88.33	$88.33
1610t68	Multipurpose 6061 Aluminum, 10" Diameter	1	$61.12	$61.12
9833k23	Breather Vent, Nickel-Plated Steel, 3/8 NPT Male	1	$2.44	$2.44
9193t12	Chemical-Resistant Push-In Connector Set, 2 Poles, 15 Amps	1	$17.27	$17.27
9346k38	Fiberglass Insulation Sheet, 2" Thick x 48" Wide x 10 Feet Long	2	$40.08	$80.16
8873K22	Mirror-Like Multipurpose 110 Copper Wire, 1/4 lb. Spool, 0.020" Diameter	1	$8.87	$6.87
		Total Costs	$370.30	$416.45

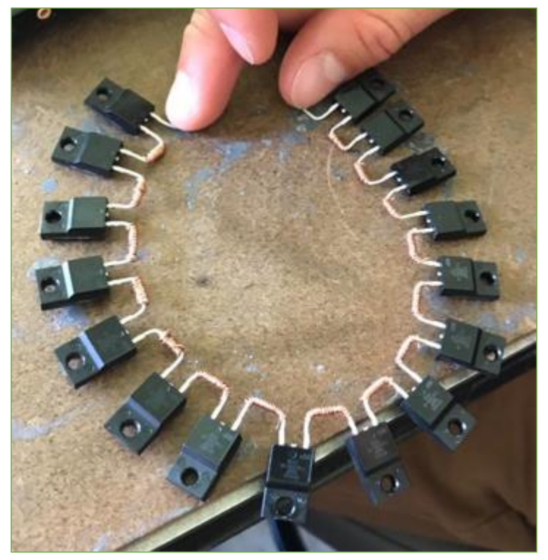
Chosen Concept



Because our group was new to the project, we were able to bring a consumer perspective on what was frustrating about using the ISEC. Our natural design process led us to an ISEC configuration more like an oven than a singular pot. The main lesson was that the focus on manufacturing these ISECs for further testing and experimenting is repeatability. Most of the problems we saw from our perspective was the inability to recreate consistent prototypes, preventing conclusive results. The final design focuses on two critical design principles:

1. the system must be easy to manufacture consistently
2. the system should focus on redirecting heat instead of adding more

Manufacturing Plan



In the favor of manufacturability, we have determined that well designed fixtures for JB-Welding the sheet metal would remove any human error that would result from welding inexperience. Additionally, this removes the challenge of finding or training a technician skillful enough to weld sheet metal to thick metal.

Ideally, certain steps can be pre-prepared such as the manufacturing of the battery top and the anodization of select parts. This will allow ISECs to be largely assembled on-site with tooling like clamping fixtures and ceramic molds that can be brought along.

Testing Plan

#	Parameter Description	Engineering Requirement	Final Measurement	Result
1	Peak Diode Heat (PDH)	$130℃ < PDH < 140℃$	TBD	PASS/FAIL
2	Thermal Contact Heat Loss	< 20% heat loss	TBD	PASS/FAIL
3	Time to Melt Erythritol	< 6 hours	TBD	PASS/FAIL
4	Time to Heat Thermal Battery	< 6 hours	TBD	PASS/FAIL
5	Power	100 W	TBD	PASS/FAIL
6	Food Safe	No contamination	PASS	PASS/FAIL
7	Cookability	Easy transition from biomass	PASS	PASS/FAIL

Testing will be done in three stages:

1. Detailed Design – test individual components using insulated environment and thermocouples to measure heat dispersion
   a. Diodes
   b. Phase Change Material
   c. Thermal Conductivity
2. Architectural Design – test individual subsystems of the design; testing thermal battery as a system
3. System Testing – test system as a whole and see how effectively it cooks a meal

Heat Transfer Calculations

Conduction, convection, and radiation are present. Additionally, heat transfer occurs through the phase change material and all three states of matter. The heat transfer calculations required to fully understand exactly what's going on in the battery are very complex for an undergraduate; instead, we've made certain engineering assumptions and simplifications to proceed with the best of our abilities. The analysis shows that the driving design feature to direct heat within the ISEC system is the insulation, as the nature of heat is to flow through the path of least resistance.