# Low Cost, High Efficiency Stove for Developing Regions

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## Mission

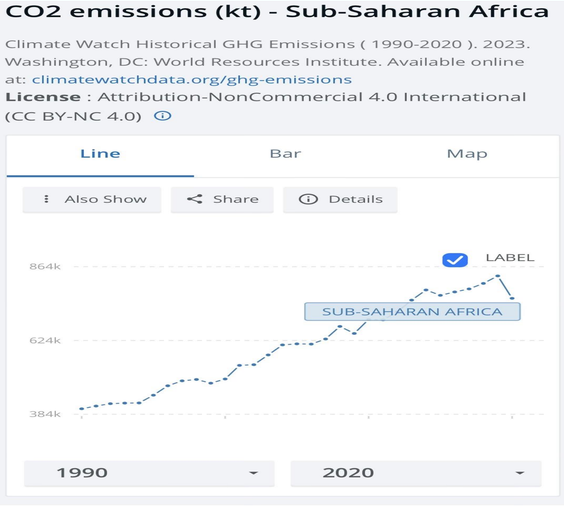
The Mission for this project is to design and engineer a new stove that can meet the needs of about 75% of the population in Sub-Saharan Africa. The design will cover the features:

- Low-cost, high efficiency stove for developing regions that currently use biomass stoves.
- Aimed to improve health and living conditions by eliminating harmful emissions.
- Engineered to have a renewable source of energy that powers thermoelectric material.
- Durable materials and ensuring the stoves usability and safety.

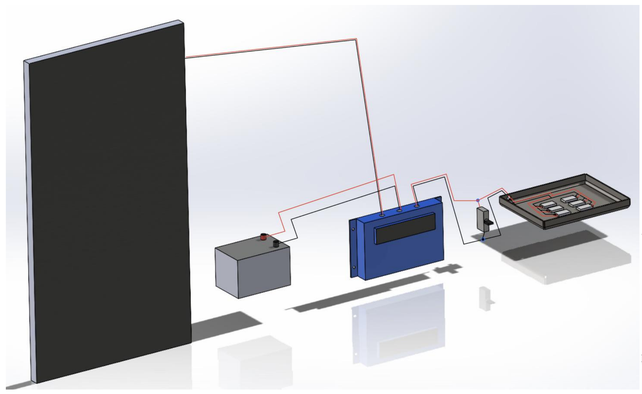
## Research

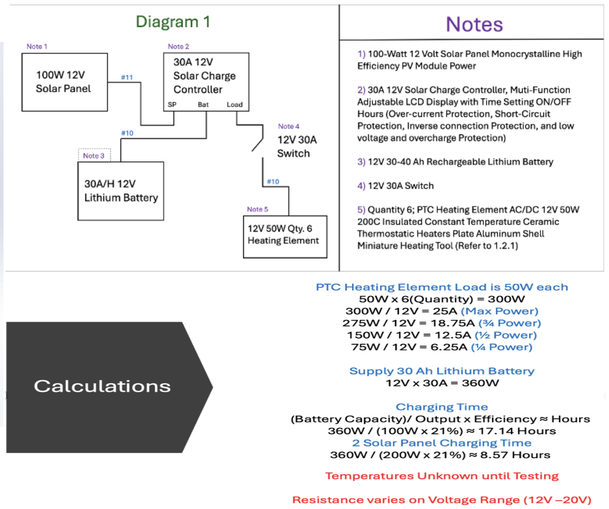
The developing region targeted for this project is Sub-Saharan Africa where they struggle to have resources due to transportation, deforestation, air pollution, and other challenges.

- Sub-Saharan, a developing region that depends on traditional cooking methods such as mud stoves and wood burning.
- Approximately 85% of people use polluting fuels to cook or heat their homes.
- In this region, emissions has caused many premature deaths especially in women and children by inhaling toxic fumes.
- Major challenges, low access to modern energy, supply shortage, and rapid urbanization.
- The region is experiencing rising temperatures caused by emissions.




## Final Design






Calculations

PTC Heating Element Load is 50W each
50W x 6(Quantity) = 300W
300W / 12V = 25A (Max Power)
275W / 12V = 18.75A (¾ Power)
150W / 12V = 12.5A (½ Power)
75W / 12V = 6.25A (¼ Power)

Supply 30 Ah Lithium Battery
12V x 30A = 360W

Charging Time
(Battery Capacity)/ Output x Efficiency ≈ Hours
360W / (100W x 21%) ≈ 17.14 Hours
2 Solar Panel Charging Time
360W / (200W x 21%) ≈ 8.57 Hours

Temperatures Unknown until Testing

Resistance varies on Voltage Range (12V –20V)

Our solar stove design provides a low-cost and sustainable cooking solution for developing regions by utilizing renewable energy from the sun. It is designed to reduce reliance on traditional biomass and gas fuels by offering a cleaner, more environmentally friendly alternative. This stove not only addresses fuel energy but also minimizes smoke emissions, improving health conditions in areas where traditional stoves are commonly used.

The stove operates with six heating elements connected in a parallel circuit that is powered by a battery that is charged via a solar panel. A solar charge controller regulates the charging process and protects the circuit against overcharging, reverse current, short circuit, overload, low-voltage, over-voltage, and more. The purpose of the charge controller is to provide a trickle charge to maintain battery health. The stove is controlled by a switch with an of on or off setting. The goal in the future is to replace the switch with a variable resistor knob that will give customers the ability to control the heat of the elements. The stove capability can reach a temperature of 392 °F (200 °C) which exceeds the heat needed to support basic cooking needs . The battery can power the stove for at least one hour of continuous use. The charge time for the battery is the only disadvantage, due the variability of weather and how that can change throughout day, the charge the battery may change accordingly. The durability of this stove should last about 10 years, but parts may be effects by the amount of use. The option to really improve the ability of this solar stove is to include a bigger battery which will give longer cook time and can eliminate the reliance of time to charge the battery.

<u>Attachments Capability:</u>

- LED lights - Minimal power consumption and will not significantly impact the battery life
- Variable Resistor Knob - Control the temperature of the heating elements;  adjust heat levels
- Larger Battery - Increase cooking time; rely less on charge time
- Moveable Elements - Allowed to heat one big pot or heat several pots

<u>Key Benefits:</u>

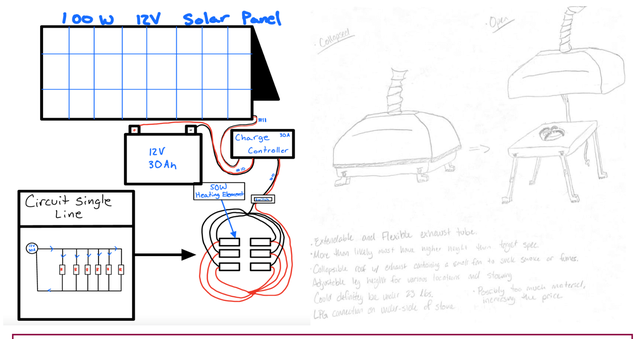
- Low Smoke Emission - Clean cooking experience with reduced harmful fumes
- Affordability - Eliminates fuel source
- Durability - Expected to last 10 year
- Eco Friendly - Plays no factor in deforestation or air pollution

## Concept Development

Our group initially considered developing a gas stove for use in developing regions. However, the idea had complications particularly regarding the supply of fuel, safety concerns, and the need for infrastructure that might not be readily available in our target region. We pivoted towards a solar stove design which harnesses the benefits of renewable energy. The use of solar power offers significant advantages for developing regions as sunlight is abundant. The objective was to eliminate the need for external fuel sources and reduce harmful emissions typically produced by biomass stoves.

Through our research and concept development we found that our solar stove capabilities should be able to meet these requirements to satisfy customer needs for daily cooking:

- Solar Stove's Temperature (212 °F / 100 °C - 392 °F / 200 °C)
- Solar Stove's Cook Time (1hr or more)
- Solar Stove's Durability (25lb - 40lbs)
- Battery Charge Time (Within a day)
- Solar Stove's Time of Max Heat (1-10mins)
- Solar Stove's Air Quality

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•"WHO Publishes New Global Data on the Use of Clean and Polluting Fuels for Cooking by Fuel Type." World Health Organization, October 4, 2021. https://www.who.int/news/item/20-01-2022-who-publishes-new-global-data-on-the-use-of-clean-and-polluting-fuels-for-cooking-by-fuel-type#:~:text=Unfortunately%2C%20millions%20of%20people%20continue,crop%20waste%20and%20kerosene%20i.
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•Phillip, Eunice, et al. "Improved Cookstoves to Reduce Household Air Pollution Exposure in Sub-Saharan Africa: A Scoping Review of Intervention Studies." *PLOS ONE*, vol. 18, no. 4, 27 Apr. 2023, pp. e0284908–e0284908, doi.org/10.1371%2Fjournal.pone.0284908, https://doi.org/10.1371/journal.pone.0284908.
•Interviewees-
  •Kenzie Chesters – Took a mission to talk about God in Zambia for 6 months and talk about the struggles of transportation and the ways of life in Zambia.
  •Jayne Murrill- Vacation to South Africa to hunt various kinds of animals where she got to experience the way of life for a month. She stayed with many guides but explained the different tribes and their struggles.
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• Smokinlicious. "Barbecuing with Wood- Know the Risks!" Medium, May 15, 2017. https://medium.com/cooking-with-dr-smoke/before-you-cook-with-wood-know-the-risks-3454d4856152
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