Harnessing the Sun's Energy, for cooking!

Building a Solar Cooker, Engineering Design Challenge

For the Arctic and Earth SIGNs/ Renewable Energy Alaska Project "ED595 Climate and Energy Connections in My Community" course for educators

NGSS Alignment

NGSS ETS 1-4

Science and Engineering practices: Asking questions and defining problems, Developing and using models, analyzing and interpreting Data, engaging in argument from evidence

Disciplinary core ideas: Defining and delimiting engineering problems, developing possible solutions, optimizing the design solution

Crosscutting concepts: Influence of science, engineering and technology on society and the natural world

Introduction

All cooking and baking requires heat. Since the first Hominids discovered how to create fire, we have been using the heat of open flames to bake, sear, simmer, and grill. Globally, ~3 billion people still rely on open wood fires for cooking. This method is labor and time intensive. It also contributes to poor communal air quality and unhealthy environmental practices like deforestation. Cooking over an open flame also takes practice, skill, patience, and intuition.

In industrialized nations around the world, gas and electric stoves and ovens are used to create the heat needed to cook and bake. This method requires expensive equipment, ample space, and, in most cases, incurs a monthly utility cost. The power provided by electricity and petroleum also come at a cost to our environment, as it emits carbon dioxide into the atmosphere with every use.

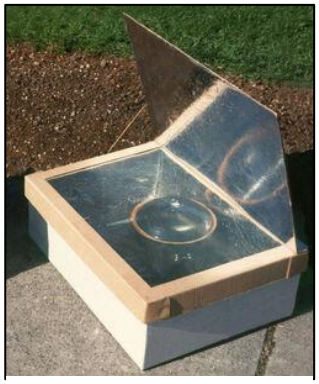
But there is a third method of cooking that requires minimal investment and relies only on sunny skies: solar cooking. Solar cooking is accessible, inexpensive, and does not require the burning of organic or inorganic material. Solar cookers simply collect and concentrate the radiative solar energy emitted by the sun to heat an insulated compartment containing a choice morsel you wish to cook. Solar ovens come in a variety of shapes and sizes. They can be purchased or handmade from easily accessible items typically found around the house.

Solar cookers are not just used by devoted enthusiasts. Solar cookers are being implemented more in developing countries where organic, combustible materials are scarce and electricity and petroleum utilities are almost non-existent. In Alaska, power is expensive! Residents in some rural communities pay over $1/kWh (kilowatt hour) for electricity and spend over ½ of their take-home-pay on heating and powering their home. This cost disproportionally affects our rural and primarily indigenous communities. Increased access to clean energy technologies, such as solar cookers, is a great way to reduce power costs, decrease our dependence on fossil fuels, and lower our carbon footprint.

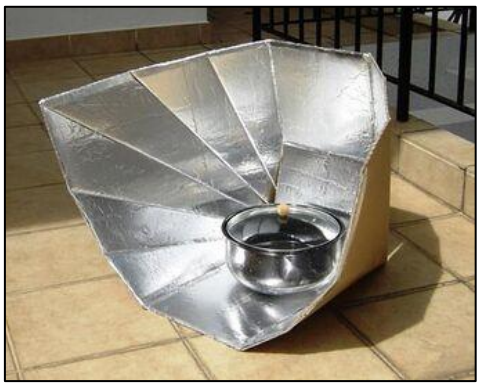
Solar cookers are yet another way to harvest the sun's energy. The sun is the original source of energy for almost all living things on earth and it's essential to many traditional lifestyles and activities.

From the time of breakup, beginning in March, through the long days of summer, Athhabascan people have long enjoyed the benefits and energy from the sun. (In Ahtna, sun is Saa; Gwich'in, Srii'; and Koyukon, So.) The light and heat from the sun affords more freedom to travel and with access to unfrozen lakes and rivers, the summer fishing season can commence. In his book, "Make Prayers to the Raven," Richard K. Nelson writes: "Most salmon are caught in the warmth of July and August" and the drying power of the sun helps in the preservation of protein-rich salmon for much-needed food supply during the long winter months in Alaska. <UNITE US ©2010 - 2012 Geophysical Institute, UAF>

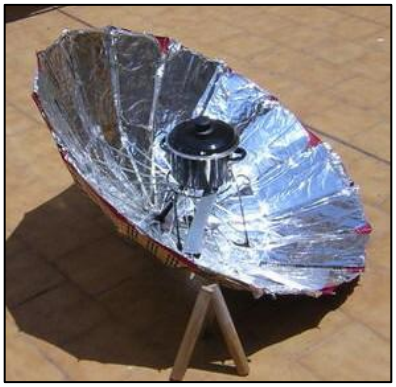
There are three main types of solar cookers. The first is the box cooker. This is the simplest design to build at home. It requires a reflective wall that directs sunlight into a box where it is held under a clear covering, usually in the form of glass or plastic wrap. This is the best method for slowly heating larger amounts of food. The second design is the panel cooker. This design uses several reflective walls to direct the sunlight into a system where a dark pot or glass or heat-safe plastic container traps the converted heat energy. The third and most difficult solar cooker to build is the parabolic cooker. Parabolic cookers use rounded walls to concentrate sunlight where the food or food container rests. These types cook food much faster, but must be precisely adjusted so they are aimed at the sun



Box solar cooker
Image courtesy of solarcooking.fandom.com



Panel solar cooker
Image courtesy of solarcooking.fandom.com



Parabolic solar cooker
Image courtesy of solarcooking.org

Challenge

Create a solar oven with materials found around the house or community. You must be able to measure and record the internal and external temperature of the system during various times in the cooking process. You may create any kind of solar cooker and may draw inspiration from any number of resources.

Whatever approach you take, keep in mind the three main components consistent across almost all solar cooker designs:

1. Reflectors (foil or mirrors) that will direct the sunlight onto the food or the food container
2. Dark interior or cooking pot to help convert the light energy into heat
3. Insulative material like cardboard or newspaper to retain heat and maintain temperature

It is not required that you turn out a tin of blueberry muffins, fudgy brownies, or flaky croissants. Many folks choose to heat up some S'mores and call it good. But if you do create a culinary masterpiece, it can be mailed to the REAP and AE SIGNs office addresses located in your course information packet.

Materials

This list provides some basic materials that could be used to build a simple solar oven. Please do not feel constrained to this list. There are infinite ways to create a solar cooker.

- Boxes of various sizes
- Tin/aluminum foil
- Plastic wrap/plexiglass
- Dark pot/glass/heat-safe plastic container
- Food or drink to heat within your cooker
- Thermometers to measure internal and external system temperature
- Stopwatch
- Duct tape
- Dark/black construction paper
- Writing utensil
- Insulative material

Report

Please record results with photos, videos, storyline, or data tables that can be uploaded onto Canvas and possibly shared with the class on the final day of Zoom sessions.

Resources

There are many options for solar cooker design and lesson plans available. Below are some links to draw inspiration:

- https://www.solarcookers.org/
- https://gosun.co/blogs/news/the-ultimate-solar-cooker-guide
- https://www.teachengineering.org/activities/view/cub_energy2_lesson09_activity3
- https://www.teachengineering.org/activities/view/duk_solaroven_tech_act
- https://www.nasa.gov/pdf/544871main_E3_Solar_Oven_C4_Final.pdf
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- https://www.solar4rschools.org/sites/default/files/cooking-with-the-sun-unit-overview.pdf