Solar Cooking course
For people interested in cooking using the sun.
(April 30, 2012 version)

Course Introduction

- Instructor - _____
- Instructor solar cooking background - _____

Topics

Weather permitting: go outside and start a solar cooker cooking

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Course objectives

In this course you will learn how to cook using the sun.

Introduction to solar cooking

What is solar cooking?
Solar cooking means cooking using sunlight and not electricity, propane, wood, ... It's done in the middle of winter in Scandinavian countries so chances are you can do it too.

Why cook with the sun?
Cook with the sun:

- for the fun of cooking a different way - For those who really enjoy cooking different things in different ways, solar cooking opens up a whole new range of things to try.
- for the fun of making and trying solar cookers - If you're a DIYer there are many different types of solar cookers to make and master.
- to save energy - The sun's energy is free. There are no electricity bills, no propane or natural gas to buy, no wood to chop. I get a buzz from knowing I'm getting away with not paying for energy.
- to stay cool - Solar cooking almost always means cooking outdoors. On those steaming hot days when cooking indoors would heat the house further, solar cooking simply won't do that.
- for the environment - No fossil fuels are used in solar cooking.

What, when and where can you cook?
You can cook anything (e.g. bread, meat, cake, eggs, rice, ...) though for some things you have to have the right type of solar cooker. This is the same as cooking indoors where sometimes you'll use the burners on top of the stove, sometimes the oven and sometimes the microwave. More about the types of cookers below.

Solar cooking can be done any time of the year as long as the sun is out but again the type of cooker may be an issue depending on how far north (in the northern hemisphere) or south (in the southern hemisphere you are.) This is because of colder temperatures and because the sun is lower in the sky in the winter. People do solar cook in the Scandinavian countries in northern Europe in winter.

Different types of cookers
Most cookers fall into these types:

- Panel cooker - A cooker with large reflector area that doesn't reflect all of the sun to the cooking pot at one time. Surprisingly, this can do most of what an indoor oven can do.
  Frequency of adjustment: Not frequent. Some need to be turned to face the sun only every half hour or hour even.
  Insulation/glazing: The cooking pot is usually in a cooking bag or a glass or Pyrex container.
  Temperatures reachable: With a Pyrex container and depending on how cold it is outdoors, this can reach temperatures of 375F (190C).
- Solar box oven - A cooker with an insulated box and reflectors directing the sunlight into the box through a glass window. Much of the cooking is done by the heated air in the box. Much like an indoor oven.
  Frequency of adjustment: Not frequent. Every half hour or hour.
  Insulation/glazing: The box has insulation in its walls. The glass window is typically a single pane of tempered glass.
  Temperatures reachable: Depending on the construction, this can reach 400F (200C).
- Parabolic dish or Fresnel lens - A cooker that directs all the sunlight to the cooking pot.
  Frequency of adjustment: Frequent. Since all sunlight is reflected to the pot, as the sun moves, that reflected sunlight quickly move elsewhere too.
  Insulation/glazing: None.
  Temperatures reachable: This is like putting something on a stove top element. It quickly boils water, and fries eggs and meat.

Where to get a solar cooker
Solar cookers can be made or bought. Panel cookers are very easy to make, involving just cutting cardboard, aluminum foil and gluing stuff. Solar box ovens and parabolic cookers are more work but still buildable by anyone with a some time on their hands and no physical handicap that would prevent it.

Purchasable solar cookers
Some solar cookers you can buy are (all prices are approximate):

- Global Sun Oven (GSO): This is a very popular solar box oven cooker.
  Price: $350
  http://www.sunoven.com
- Copenhagen: This is a panel cooker with a very flexible design to accommodate all sun angles for cooking any time of the year.
  Price: $33
  http://sclaustoys.com/Solar%20Oven.html
- Hot Pot: This is a panel cooker useful for when the sun is high in the sky. If the sun is low, as it is in the winter in many locations, then you'll need to use something else during those times.
  Price: $130
  http://www.solarcooker-at-cantinawest.com/hotpot-solar-cookers.html
- Solar Burner: This is a parabolic solar cooker.
  Price: $170
  http://www.solarcooker-at-cantinawest.com/hotpot-solar-cookers.html

Make it yourself solar cookers
Here is a sample of homemade solar cookers with enough details to make your own.

- Car sunshade solar cooker
  Perhaps the simplest solar cooker to make is the car sunshade solar cooker. Just go get a car sunshade, use clips, Velcro, clothespins, ... to give it shape, get a cooking bag to put your cooking pot in, aim it all at the sun and you're done! This one works best when the sun is low in the sky. It can be difficult to tilt upward for higher sun angles.
  http://rimstar.org/renewnrg/car_sunshade_solar_cooker_windshield.htm
- Modified CooKit panel solar cooker
  Another simple to make is the Modified CooKit solar cooker. All you need is a single piece of 3'x3' cardboard, some aluminum foil and glue and you're done! This one is good for both low and high sun angles.
  http://rimstar.org/renewnrg/modified_cookit_solar_cooker.htm
- Fresnel lens solar cooker
  A Fresnel lens is a lens that can be used to focus a large amount of light to a smaller area. This concentrated light allows for conversion of sunlight to plenty of heat. Large 2'x4' Fresnel lenses can be found in discarded rear projection TVs. You can find one example of a solar cooker made using a lens on the following webpage.
  http://rimstar.org/renewnrg/fresnel_lens_solar_cooker.htm

The parts of a solar cooker

The parts of a solar cooker are as follows:

- Reflectors: These are panels of some sort that reflect sunlight to where it's needed. Their purpose is to increase the amount of sunlight used. They are most often either aluminum foil (from your kitchen) or aluminized Mylar. Aluminum foil loses some of it's reflectivity after a few years due to oxidation but is cheap and easy to replace. The backing can be cardboard, coroplast (the corrugated plastic that election signs are made of, or wood. The coroplast is better than cardboard if it will be left out in the rain. Wood is heavier.
- Lenses: This refers to a fresnel lens which is fun to try out but few people use it. They serve the same purpose as reflectors, to increase the amount of sunlight used. They do this by focusing a large area of sunlight to the cooking pot/pan. These are available in discarded rear projection TVs though you can buy them online too.

- Insulation: Solar box oven cookers have insulation in their walls. This slows down the loss of heat through the walls. Some options are:
  - a few layers of corrugated cardboard with the holes in the layers in alternating in direction,
  - shredded paper,
  - rigid boards of polyisocyanurate.

  Of the above ones, the polyisocyanurate will prevent heat loss the best and so allow higher temperatures. Avoid using Styrofoam or polystyrene as it has a low melting temperature.

  Another way to insulate is to put your cooking pot inside a larger glass, usually Pyrex, container. This is often done with very good results with panel cookers.
- Glazing: This is glass, Pyrex or a cooking bag that's used to trap hot air and to prevent wind from blowing over a cooking pot and cooling it. Examples of glazing are as follows:
  - The glass window on a solar box oven. This is usually tempered glass which is a glass that can handle higher temperatures than regular glass. It is more expensive though and has to be cut by the glass supplier unless you find a piece that's a useful size.
  - With panel cookers you'll often put the cooking pot inside a larger container that is either Pyrex, glass or a cooking bag. By using something thick like Pyrex or glass you can get results as good as most solar box oven cookers.
- The cooking pot/pan/jar: For a panel cooker or a solar box oven cooker it's important that the cooking pot be a dark colour because this dark coating is what turns sunlight into heat. For parabolic or fresnel lens cooker it doesn't matter since the concentration of sunlight is so high. If you don't have anything that's dark then you might be able to paint something using BBQ and Stove spray paint, available in hardware stores.

  The jar can be a mason jar. Because of the pressure that will build up inside when the inside cools after removing from the cooker, it's preferable to put the lid on loosely or make a tiny hole in the top of the lid.

  It's useful if the container has a transparent part somewhere so you can look at the food without opening it. For a pot that can be a transparent lid. For a jar you can leave a small portion of it unpainted, around one inch square is good.

Setting up the cooker

Aiming the cooker at the sun

For a panel cooker and a solar box oven cooker your cooker doesn't have to be pointing perfectly at the sun since the at least some part of the panels will still reflect some sunlight at the solar cooker over a wide range of sun angles. But a parabolic or fresnel lens cooker must be pointing directly at the sun.

A few of the ways to aim your cooker are as follows:

- If the cooker has a flat front then make a shadow in front of the cooker by holding your finger vertically on the ground or table a few inches/centimetres away. If the shadow is more or less perpendicular with the front of the cooker than the cooker is pointing at the sun.
- Some cookers form shadows behind them that tell you when the cooker is lined up with the sun.
- Use a special tool like sun finder. It's basically a tool that at one end has a hole for the sunlight to enter into. That sunlight then lands on a vertical piece of material. The position of the sunlight on the material indicates if the sun finder is pointing directly at the sun and if not, can be used to tell which way to rotate it to line it up.

Turning sunlight into heat using an absorber

When sunlight arrives at any material, some of it is converted into heat. The material doing this is call the absorber. The darker the colour and less reflective the material the more that's converted to heat. For that reason, black is best when you're talking about converting visible sunlight. A flat material is better than a more reflective material because by definition, the reflection is sunlight that was not turned into heat.

In a solar cooker, the absorber is the dark coating on the cooking pot. Note that for a parabolic cooker or a fresnel lens cooker the colour and reflectivity of the cooking pot is not so important because of the high concentration of sunlight.

Infrared light (which is not visible) has nothing to do with colour though by definition is a result of a material's interaction with visible light. However, some materials are better than others at absorbing infrared light. With solar cooking we don't usually worry about that though.

Optimal reflector angles

The angle that sunlight reflects off of a surface is the same as the angle that it arrived at. Keep this in mind when making reflectors. Sunlight may hit your reflector, then hit another reflector further into your cooker and then reflect right back out again without hitting your cooking pot. That's why it's important to understand how sunlight reflects. If your reflectors are designed properly then all you need to do is aim the reflector at the sun and you'll be okay.

You can read a lot more about this on the following webpage about designing reflectors:
http://rimstar.org/renewnrg/how_design_solar_cooker_sun_reflector.htm

Cooking

Panel cookers and solar box oven cookers are slow cookers. The temperature isn't always as high as an indoor oven and so cooking times are usually longer. However, this means there is less juice and flavor lost and the result tends to taste better.

The first few times you use a new cooker, check to see if it's lined up with the sun every fifteen minutes or so. It may not need to be lined up each time and you'll eventually figure out how often adjustment is required. It's not usual for adjustment to be required only every half hour or hour.

Frying food is done with a parabolic or fresnel lens solar cooker. These concentrate the sunlight more to a smaller area and so produce higher temperatures on the cooking vessel.

Safety

Sun glasses, goggles

Solar cookers concentrate sunlight. The light can be so bright that it hurts or even damages your eyes. For a panel cooker and a solar box oven wearing sun glasses is advisable. For a parabolic or fresnel lens cooker you should wear welding goggles. The latter can be bought at hardware stores.

Some solar cookers are designed so that you don't see the sunlight. For example, with a fresnel lens solar cooker that uses a mirror to reflect the sunlight up to the bottom of the cooking vessel so you don't see it. But when you move the vessel away you may see it then. So it's best to wear at least sun glasses in that case.

Oven mits

Solar cooking is still cooking and cooking vessels get hot. Wear oven mits.

Also, when glass is very hot and you touch it with a cool finger, the glass may break due to the temperature difference. I've shattered one Pyrex lasagna pan and cracked one mason jar just by a light touch of my finger. This can be prevented by wearing oven mits.

Safe cooking temperatures to avoid bacteria

When cooking food it must get hot enough to kill any bacteria. Also, there are temperatures at which some bacteria thrive. In a typical indoor oven, when you set the dial you can be reasonably sure the temperature will be what you set it to. With solar cooking you have to be more watchful.

Make sure your food cooks about 140F (60C) for more than ten minutes.
If using a panel cooker, you can monitor the temperature by putting an oven thermometer inside the Pyrex or glass container or cooking bag. With a solar box oven cooker put it in the oven bu such that it's visible through the window. To look at it you can always rotate the oven away from the sun briefly so you don't get blinded. It's best if the thermometer not get direct sunlight otherwise the sunlight may be heating the thermometer directly. The temperature inside the cooking vessel will likely be lower than the temperature of the food inside the cooking vessel. But this is the same for an indoor oven too.

Other references

http://solarcooking.wikia.com - Big solar cooking website.
http://rimstar.org/solar_cooking - Website of the original author of this course. Plenty here too.

http://www.solarcooker-at-cantinawest.com - Very good source of solar cookers and parts, including reflective vinyl for making reflectors.

http://sunnycooker.webs.com - A variety of easy to make cardboard and foil cookers.

http://www.williamgbecker.com/MakeSolarOven.html - Details for building a very fancy, high temperature solar box oven cooker.

http://solarcookingadventures.wordpress.com/2011/08/02/the-long-road-to-a-parabolic-cooker - Good comparison of different parabolic cookers.
http://solarcooking.org/plans/parabolic-from-flat-sheet.htm - Blueprint for making a parabolic cooker.