Comparing Portable Solar Cookers for Kaua'i

Erik Burton, 2010

ABSTRACT

This paper discusses the process of determining the best design of solar cooker to use at the beaches and parks on Kaua'i. A set of requirements is developed; different models are built and tested, results are analyzed and recommendations are made for the best portable design for use here on the Garden Island.

INTRODUCTION

Life on Kauai (fig. 1) is idyllic by most standards and our weather is legendary. Most of the year, the temperature and humidity are perfect, an ideal climate for outdoor activities and an active lifestyle.

Figure 1, the island of Kaua'i
Image courtesy of Google Earth

As a parent of two young boys (4 and 7), I often hear the cry of "I'm hungry". We bring snacks, but after playing or swimming for a while they often want more. This usually means that we cut the day short and head home for a meal. If only we had a way to easily cook food at the parks and beaches.

It turns out that I am a second generation solar cooker. As a boy, my father taught Solar Energy at the local community college and, during summer break, brought home some solar "toys" which were used for their traveling demonstrations.

Figure 2, Po'ipu beach park, Kaua'i.
Photo by Erik Burton

One of these was a solar oven made out of wood with large, mirrored reflectors. It comfortably achieved temperatures in the mid 300's F. During the summer, we would cook a variety of things including bread and, once, even a large turkey. I was almost 13 at the time and thought it was pretty cool, but had other things on my mind.

30 years later, and I am wishing there was an easy way to cook at the beach without dragging a dirty BBQ around in the car. After doing some research, including reading the Solar Cooking Wiki, I decided to try building some cookers to get a better feel of what would be the best design for our Kaua'i weather.

PORTABLE SOLAR COOKER REQUIREMENTS

A good portable model for Kaua'i needs to be easy to set up and simple to use. It should be wind and water resistant, lightweight yet stable, and tolerant of partial sun. It also needs to achieve, and maintain slow cooking temperatures around 225°F. I chose this temperature target because it was hot enough to cook most foods but safer to have around active children.

BUILD AND TEST

Based on reviewing the models profiled on the Solar Cooking Wiki, I decided to build and test several designs including the Pringles can hot dog cooker, a slant faced cardboard box cooker, a Kyoto style cardboard box cooker and a car window shade funnel cooker. Each of these designs was placed in good sun, properly oriented and left for 1 hour. The internal heat was recorded using an oven thermometer.

Pringles Can Hot Dog Cooker

I decided to start at the bottom of the scale with the Pringles can hot dog cooker. Instructions were online at:

http://www.youtube.com/watch?v=0NADsg-v9q8

The fabrication of this simple little cooker was a breeze and took me about 5 minutes (fig. 3), mostly spent fiddling with taping down the plastic cover. As there was not enough room to put in an oven thermometer, I skewered a hot dog and closed up the container.

Figure 3, a Pringles can hot dog cooker
Photo by Erik Burton

Slant Faced Cardboard Box Cooker

Next I tackled the easy to make slant faced cardboard box cooker as a way to gauge how much heat could be generated with no reflector. The design (fig. 4) was based on the model displayed by solarcookingnut's video on YouTube:

http://www.youtube.com/watch?v=BFMl26gVeTM&feature=search

Figure 4, a slant faced cardboard box cooker.
Photo by Erik Burton

Kyoto Cardboard Box Cooker

The "Kyoto box" was selected to test what reflector assisted cardboard box cookers can do. I used an acrylic window with a wood handle which helps for keeping fingerprints off and makes it easier to open. Layers of cardboard served for insulation and black BBQ paint was used for the interior color.

This design (fig. 5) was based on one listed in the Solar Cooking Wiki:

http://solarcooking.wikia.com/wiki/Kyoto_Box

Figure 5, a Kyoto style box cooker.
Photo by Erik Burton

After one hour the box had reached cooking temperatures and some food was added for a cooking test.

Car Window Shade Funnel Cookers

This design was chosen because of its simplicity to make and potential weather resistance.

Both a **standard** (fig. 6) reflective car window shade and a **higher quality** (fig. 7), diamond plate model were tested.

This design was based on Kathy Dahl-Bredine's design described on the Solar Cooking Wiki:

http://solarcooking.wikia.com/wiki/Windshield_Shade_Solar_Cooker

The cookers were place directly on the ground to help provide protection from the wind.

Glass pots, with black stoneware plates or bowls, were placed in the focal point of the parabola.

The higher quality car window shade was also tested in the vertical position (fig. 8), using an old trash can as the base.

Several large rocks were placed in the trash can as weights to help stabilize the unit.

After the one hour test, the units had reached cooking temperatures and food was added for a test.

The cooking test of the vertically oriented unit was interrupted by a strong gust of wind. The shade toppled over, breaking the glass pot and spilling the food onto the ground.

The rock filled can was still standing.

Figure 6, a cooker made from a standard sunshade. Photo by Erik Burton

Figure 7, a cooker made from a high quality sunshade. Photo by Erik Burton

Figure 8, a cooker made from a high quality sunshade. Photo by Erik Burton

RESULTS COMPARED

The test results are summarized in the following table (fig 9):

DEVICE	AVG. TEMP	ADVANTAGES	DISADVANTAGES
Pringles can hot dog cooker	not measured	simple, easy to make, portable	does not get very hot, small capacity
Slant faced cardboard box cooker with no reflector	200°F	simple, easy to make, portable, large capacity	gets marginally hot, additional collectors are necessary for reliable performance
Kyoto style cardboard box cooker	250°F	simple, easy to make, portable, large capacity, 250°F+	reflector panels are unstable in the wind and cardboard breaks down when it gets wet
Standard grade car shade funnel cooker	200°F	simple, easy to make, portable, water proof, medium capacity	flimsy material does not hold parabolic shape very well and the crinkly texture of the reflective material is not as efficient as it could be
Deluxe grade car shade funnel cooker	225°F+	simple, easy to make, portable, water proof, wind resistant, medium capacity, highly reflective, heats up and cooks quickly	thicker material is still subject to gusts of wind although this can be abated somewhat with the use of the triangular braces and tie downs

Figure 9

As this table suggests, cooking temperatures were achieved in 4 out of 5 models. The Kyoto box made the most heat, while the Pringles can made the least.

DISCUSSION

There was something to learn from building each one of these designs, even the little Pringles can hot dog cooker.

<u>Pringles Can Hot Dog Cooker</u>

This design certainly was simple and easy to make yet it incorporates some of the same principles used by much bigger cookers. Although my hot dog did not get hot, it did get warm so some heating did occur with some condensation collecting on the window. The limited heating and extremely small

capacity are enough to remove it as a serious candidate. It is very easy to make, the most portable of all the models built, and fairly weather resistant.

Slant Faced Cardboard Box Cooker

This design was simple, easy to make, portable and has a large capacity. It did not have a reflector which was limiting its heating potential but it served its purpose to demonstrate its capabilities. The simple design has the lid lift up for access to the food and uses a cooking bag for the window.

Although 180°F is just enough to start cooking food, it was not enough to get me to try. From reading the Solar Cooking Wiki, I understand that a reflector could bring it up another 25°F but chose the Kyoto design to test reflector assisted systems.

In the end this design satisfied many of the requirements but was rejected primarily because it did not get hot enough. Cardboard also has the issue of not holding up well to our frequent tropical rain showers.

Kyoto Cardboard Box Cooker

I put it out at midday so that I did not have to angle the box, and after an hour it was up to 250°F. As these temperatures were good enough for cooking, I put in a glass cooking pot with a frozen raw hamburger patty and a piece of cold pizza to reheat. After 45 minutes the hamburger patty was fully cooked. The slice of pizza was a little overcooked but still quite edible.

This was the first of the designs I built to actually get up to cooking temperatures. The oven has a good amount of internal space and the acrylic lid is easy to open with the little wooden handle I installed. It is lightweight enough to be carried short distances and the reflectors fold down, overlapping for storage.

This is actually a fully functional oven although tilting it to meet the suns angle is a little tricky. It really works best during the midday hours will be used for cooking larger items. The only design requirement missing here is the weather resistance.

The cardboard reflectors are lightweight and react to even light breezes. Rain, of course, can have catastrophic effects on cardboard although I think that it could probably handle a few light showers. This is something that I might bring over to a friend's house for a BBQ, but not to the beach or a park.

Figure 10, car shade cooker with cooking pot moved forward to track focal point.
Photo by Erik Burton

Car Window Shade Funnel Cookers

The **standard quality** (fig. 6) reflective car window shade works but is a bit flimsy and not as reflective as the higher quality (fig. 7) shades. It needs some support to maintain its shape and the crinkly finish of the reflective material decreases the levels of reflected sunlight. It is portable and waterproof.

The **higher quality** car window shade, with better reflectivity and thicker backing, forms a more curved parabola (fig. 7). This results in a more efficient cooker. The stiffer backing provides an

acceptable measure of wind resistance and the material is naturally water proof.

It sets up in less than 60 seconds and weighs less than 1 lb. The cooking pot can be a glass solar pot or a simple metal pot with glass lid. Both will reliably get to 225°F. With a metal pot, make sure to use a little rack to lift the pot up in the air, so that light can be reflected on to the bottom for even heating.

The parabola created by the high quality car window shade is very good at directing the sunlight into the "pocket". This means that it does not have to be moved as much as some other designs. During the morning or afternoon hours, simply point it towards the sun and don't worry much about adjusting it.

During the midday, it does benefit from being turned every 30 minutes or so. Also during this time, the focal point will migrate towards the front of the parabola (fig. 10) and become somewhat more diffused. This causes some reduction in efficiency, with temperatures in a glass solar pot averaging about 200°F. During the midday, this design is effectively a trough parabola. It can cook food during the midday, but is most efficient during the morning and afternoon hours.

RECOMMENDATIONS

Based on these simple tests, it is clear that the high quality car shade cooker is the best suited of these models to be taken to the parks and beaches:

Figure 11, car shade cooker with black rimmed universal lid cooking hot dogs and buns. Photo by Erik Burton

- Easy to setup and simple to use: The car window shade parabola sets up in less than a minute, and does not need to be turned very often. Just point the parabola to the sun and put your cooking pot in the focal point.

- Wind and water resistant: The plastic material is naturally water resistant and the stiffer backing provides a degree of wind resistance. Tie downs, rocks or triangular pieces of wood are easily used to stabilize the parabola.

- Lightweight yet stable: The parabola weighs less than a pound yet is stiff enough to reliably hold its shape. A cooking bowl or pot can be transported in a 5 gallon bucket along with food and other necessities.

- Tolerant of partial sun: The size and shape of the parabola combined with a solar cooking pot are efficient enough to achieve 200°-225°F temperatures on days where the sun is playing peek-a-boo.

- Achieve and maintain slow cooking temperatures: This design creates an efficient parabola that achieves cooking temperatures around 225°F in about 10 minutes. The lid can be opened for a peek of the food without dropping below 200°F.

The parabola created by folding the stiffer car shade material concentrates the solar energy into the "pocket" of the parabola. This pocket reflects the light in such a way as to bathe the cooking pot in 360° of sunlight. Glass solar cooking pots can be used, or even a black pan with a glass lid, to reliably get to 225°F.

LIFE WITH THE SOLAR FUNNEL COOKER

At a recent day at the beach with friends, two of these cookers prepared enough hot dogs, hamburgers, chicken nuggets and taquitos to feed 5 hungry kids and 4 adults. In between watching the kids, taking a swim and having a beer, I did not have to worry about burning food, trying to put a greasy BBQ in the car, or having enough charcoal.

Figure 12, funnel cookers at the beach – success! Photo by Erik Burton

We take them with us just about every weekend. I don't have to worry about buying charcoal or propane, as both are quite expensive here on Kaua'i.

In addition to the weekends, I have started taking one to work for making lunch. A marinated chicken breast with a few vegetables, cooks in less than an hour, and comes out very tender. The cooker fits easily into the bed of my truck. With the tailgate down, the parabola is still fairly well sheltered from the wind.

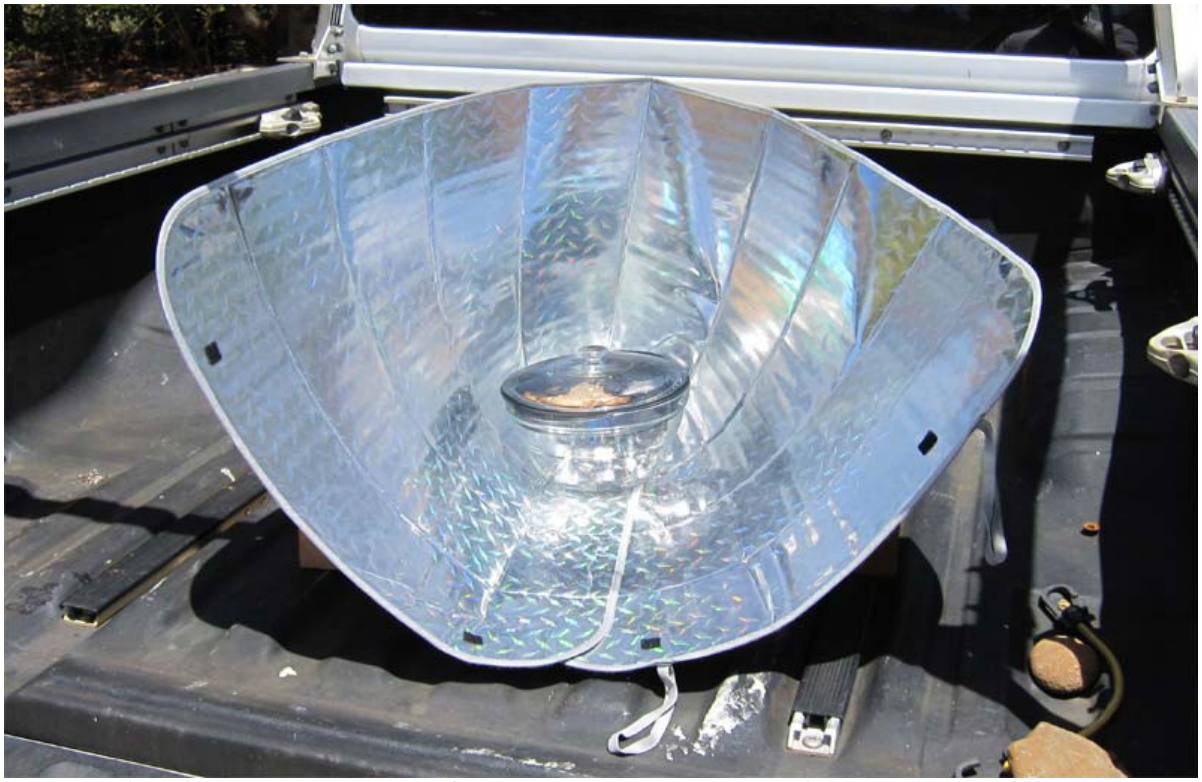

Figure 12, funnel cooker in the back of my truck, with lunch ready after 50 minutes of cooking. Photo by Erik Burton

This is a great little portable cooker that can heat up frozen chicken nuggets faster than my kids can say "I'm hungry". More photos and video are online at:

http://www.flickr.com/photos/13470115@N08/sets/72157624587541059/