COOKING FUEL CONSERVATION—
A Guide to Stovetop Food Heating Efficiency

Introduction:

The fuel efficiency of cooking can be significantly increased with a few simple practices. At one time, one person at the Kerr-Cole Center cooked breakfast, lunch and dinner full time for herself and dinner for another person part time, using a two-burner countertop stove. A single five-gallon propane tank lasted for 17 months. That is almost a year and a half! Our Center mainly uses solar cooking for casseroles, roasting and baking, which contributed significantly to this fuel economy. However a consistent habit of fuel conservation techniques would be very effective even without the use of solar energy. These techniques comprise using a small flame, skirting the pot, using insulation on the cooking vessel and using retained heat cooking.

We know such strategies work because they have been used in our cooking for years. We found it little trouble to do these simple things once the kitchen was set up to accommodate them. The basic principle of fuel conservation is to direct maximum heat into the food and allow minimal heat to escape. Conservation is accomplished by holding the heat as close to the cooking vessel as long as possible, and over as much of the surface of the vessel as possible.

Guidelines:

The following guidelines have worked for us using propane. The same principles apply whether cooking with gas, electricity or a small wood fire.

(1) Only heat that gets into the pot can contribute to cooking. Heat that escapes into the room is lost to cooking. Ideally, as the hand is passed above a cooking pot, little or no heat should be felt.

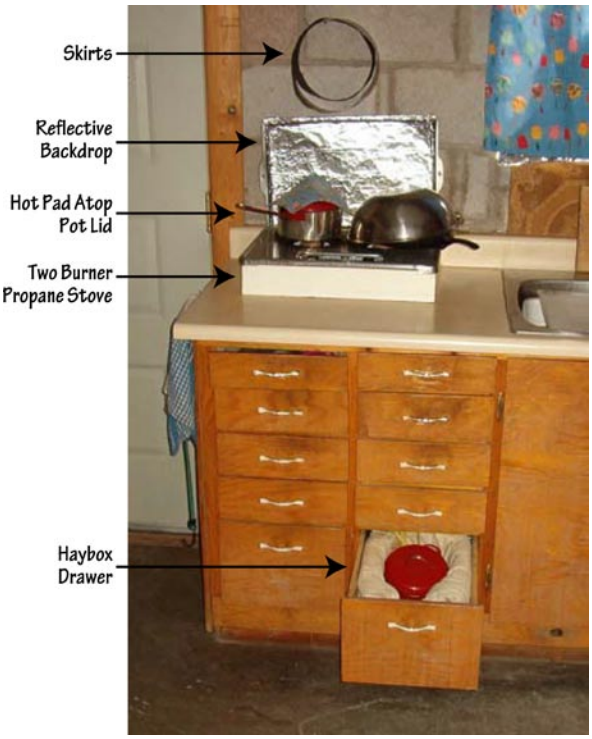
(2) Each pot needs a well-fitting lid to keep the steam in. When the pot lid is hot to touch, steam has filled the pot and the burner may be turned down to the point where it just keeps steam in the pot. Lifting the lid unnecessarily allows steam to escape, carrying with it precious BTUs (heat).

(3) The hottest part of a flame is at the blue tip. A 1/8 to 3/8 inch flame, properly positioned, is all that is needed. A little steam may escape during simmering, but it should be minimal because that carries wasted heat.

(4) The tips of the flames need to strike the middle of the bottom of a pot, and not flare out visibly around the bottom edge of the pot.

(5) A skirt directs hot gas (air and combustion products) up the sides close to the pot. If made of shiny metal, the skirt also provides an insulating function by reflecting heat radiation from the pot back to the pot.

(6) A hot pad or layer of foil covers the top.



Barbara Kerr's Fuel Conservation Setup

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The Pot:

A short, broad-bottom vessel, such as a covered skillet, heats more efficiently than a tall, narrow pot. A thin metal pot with a good lid is ideal for cooking, as the heat flows quickly through the bottom and sides into the cooler food within. The lid is essential to prevent heat loss by steaming. The pot should be dark in color if also used for solar cooking. Pots can be darkened by spraying with a black or deep-colored barbecue paint (red, navy, brown, orange, etc.). High heat, fire-resistant and engine paint do not work well due to out-gassing, failure to harden completely, and potential toxicity. Barbeque paint is food safe and will readily withstand direct flame. A pot darkened in this manner conforms to the cardinal rule of solar cooking convenience; it can be easily moved back and forth between solar and fuel stoves—for example to continue cooking if sunlight fails, to preheat to hasten solar cooking, or to reheat cooled food.

The Flame:

The first conservation method is the use of a small flame. This alone will reduce the use of fuel. If the flame is the right size, food will heat and cook but not stick to the pot. Cooking this way takes a little longer. However trouble, time and food are saved by being able to simply wash the pots instead of having to scour off scorched food.

The Skirt:

A second conservation method, used simultaneously with the low flame, is to place a cylindrical metal skirt around the pot as it is cooking. It should be as tall as the pot with 1/8 to 1/4 inch clearance between it and the pot. This forces the heat to flow upward in contact with the sides of the pot and maximizes heat transfer while preventing heat from blowing away or dissipating into the kitchen. A skirt is most highly beneficial when using a small or tall pot. An alternative approach is to invert a metal mixing bowl over a cooking pot, but custom-fit metal skirts insure greater fuel efficiency. For maximum heating efficiency, both bowl and skirt may be employed.

For cooking in a skillet or round-bottomed vessel such as steel salad bowl, the use of a skirt is less beneficial. The inverted bowl will definitely improve heating efficiency for a skillet. While the skirt should help, it may not be needed.

Pot with Skirt and Top Insulating Pad
Skillet with Inverted Salad Bowl

Skirted Pot

Constructing the Skirt:

The metal skirt to contain maximum heat around the pot may be made of layers of kitchen foil for initial trials. Permanent ones are made of unpainted, thin aluminum roof flashing (the lightweight "economy" grade, 0.0092-inch thickness), which is available in USA hardware and building supply stores.[3] Galvanized flashing should not be used because of the toxic zinc coating. The width of the skirt is measured from pot bottom level perpendicularly up to the rim. The length of the strip is long enough to surround the pot with a 1-1/2 inch overlap. Flashing can be cut with sturdy scissors or tin snips. It is formed into a ring and fastened with the brass brads used for school papers. Holes for the brads are punched with a nail or ice pick. A segment may be cut out from the top of the skirt to accommodate a pot handle, if necessary. By selecting a few favorite pots and pans and tailoring the flashings to their size

and handles, a few varied sizes can serve for all the pots. The skirts may hang decoratively inside one another on a peg near the stove.

NOTE: We have found that some types of aluminum flashing are coated with a thin and nearly invisible clear paint. Flame will blacken and smolder this material, releasing fumes of potentially toxic character. To be sure you are buying the unpainted kind, obtain a small scrap to hold directly in the flame of a fuel stove. If no smoke develops, you have the right stuff.[3]

Insulation:

This third conservation practice takes the form of a fabric hot pad or aluminum foil pad placed over the pot lid. A hot pad can be used without danger of fire if the flame is small enough. A pad made of several layers of foil will not burn, of course, and can be formed to fit particular pots while overlapping the top of the skirt loosely (to allow flame to pass). This is particularly effective with broad vessels such as a skillet.

The Haybox:

Retained heat cooking is the fourth conservation method, in addition to small flames, skirting and insulation. A retained heat cooker, commonly referred to as a haybox, is an insulated space where the pot is tucked in snugly after an initial simmering period. Food will continue cooking on heat available in the pot.

According to an article on the Lost Valley Educational Center & Intentional Community website:

> *"Haybox cooking . . . is an age-old method that can be used to conserve energy not only during times of crisis, but anytime. Depending on the food item and amount cooked, the use of a haybox or insulated cooker saves between 20% and 80% of the energy normally needed to cook a food. The longer an item usually takes on a stovetop, the more fuel is saved. For example, with a haybox, five pots of long-cooking dry beans will use the same amount of fuel to cook to completion as just a one-pot cooker without a haybox.*
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> *. . . the larger the amount (of food) cooked, the more effective haybox cooking is, since a full pot has more mass and therefore more heat storage capacity than a half-full pot."*[1]

Haybox Drawer, Top Insulation Removed

In the Haybox, after a short simmering time, smaller quantities cook for an hour or two; larger quantities continue to cook for three to five hours. When moving the pot to the haybox, one should take care not to release the pocket of steam that has accumulated under the lid. The heat retention time is often long enough to finish a pot of meat, potatoes, rice or other foods. If necessary, food can be reheated briefly to bring it back to a second boil and returned to the retained heat cooker. For example, dried beans may need to be reheated after three hours and returned to the cooker for another hour or so. After browning, barbecued meat can be moved into a retained heat cooker to finish cooking to the bone. This also helps to avoid carcinogenic compounds possibly produced by charring. The delicious barbecue taste is maintained and the meat becomes delicately tender.

As a bonus, a retained heat cooker, once constructed, is great to keep food hot and/or cooking when sunlight ceases during solar cooking—such as late in the day or when clouds roll in. Also, regardless of how the food was cooked, a haybox will keep food warm while one awaits or greets guests.

Again quoting the Lost Valley article:

> *"If you want to prepare multiple items for a meal but have only a limited number of flame sources, hayboxes can also greatly facilitate the logistics of food preparation. For example, you can bring your beans to a boil, simmer them 15 minutes, put them in a hay box; then bring your rice to a boil, simmer it for 5 minutes, put it in another haybox; then prepare your vegetable stir-fry or soup, etc. At the end, you'll have a uniformly hot, unburned, multi-dish meal, all off a single flame, probably consuming less total fuel than you would have used simply to cook the longest-cooking item alone without a haybox. You'll also have used one-quarter less of your drinkable water supply in preparing the food."*[1]

RETAINED HEAT COOKING TIMES – Approximate

FOOD	SIMMERING TIME	HAYBOX TIME
White rice	5 minutes	1–2 hours
Brown rice	10–15 minutes	2 hours
Potatoes, whole white	5–10 minutes	1–2 hours
Creamed soups	2 minutes	1 hour
Dried beans, etc., soaked	10–15 minutes	3–4 hours
Meat roast	20–30 minutes	3–5 hours depending on size

Making a Haybox:[2]

Any insulated area will work for retaining heat. The simplest method is to wrap the pot in a quilt, sleeping bag or winter jacket. This is very practical for occasional use. Using sections of an old quilt, we have insulated one of our kitchen drawers convenient to the propane stove (see Fig.1). The Sport solar cooker also serves well as a "haybox" by placing insulation over the glazing. This can be done whether the food was heated in the solar oven or by conventional fuel. This same technique also works for other box cookers. An even more effective strategy is to place the insulation inside the cooker directly over the pots.

To construct a retained heat cooker, select a box, drawer or mixing bowl preferably with two inches or more clearance all around than the pot. Line the cooker with towels, blanket material, wool, hay or other insulation material. The insulating material must be kept dry, since wet materials don't insulate as well. An inner layer of aluminum foil next to the pot helps keep cooking moisture from entering the insulation. The shiny metal surface also reflects heat radiation back to the pot. Reflective Mylar (which can be salvaged from used food storage containers, potato chip bags, plastic balloons, emergency "space blankets", etc.) tends to be a more durable inner layer than aluminum foil. The clear plastic bags used for oven roasting also make a good vapor barrier, but are not as effective for retained heat cooking since they do not block radiation heat loss as well as a metallic surface.

The pot should nest into the cooker with minimal space between it and the insulation, with a thick insulating cover over the top—such as a folded towel or pillow (which can be made for the purpose). An inexpensive retained heat cooker may be fashioned quickly from a cardboard box large enough for crushed newspaper wadded into loose fist-size balls two to four inches deep to surround the pot, with a thick layer over the top.

Physical Facts:

(1) Food steamed for a few minutes will reach but not exceed the boiling temperature of water. This temperature varies with altitude; for instance water boils at 212 degrees Fahrenheit at sea level, but will only reach about 204 degrees Fahrenheit at 6000 feet. For this reason, food cooks more slowly at higher altitudes than at sea level.
(2) Food will cook at temperatures as low as 180 degrees Fahrenheit.
(3) Retained heat cooking utilizes the stored heat from the boiling/steaming food until it slowly cools down to 180 degrees Fahrenheit.

General Safety Precautions:

Microbiologically, the precautions are the same for food cooked by retained heat as for any other cooking system.

(1) Cooked food always should be kept at temperatures either above 150 degrees Fahrenheit (60 degrees Centigrade) or chilled to below 50 degrees F (10 degrees C).
(2) Danger of food poisoning arises when cooked food is held for more than three hours between 50 and 150 degrees F. Therefore, one must be aware of the time food is left in the retained heat cooker. Heat does not destroy all the types of toxins that may have been produced, so reheating the food does not reduce the danger.
(3) Any food raised into the 50 degrees F to 150 degrees F incubation range, regardless of for how long, must be brought to a full boil to destroy spoilage microbes before it is cooled for refrigeration.

(4) If food has remained in the temperature danger zone for 3 hours or longer, it should be considered spoiled and should be discarded without tasting it. Taste is not a definite criterion and can be dangerous.
(5) If temperatures below 50 degrees F (10 degrees C) cannot be obtained, it is still valuable to drop food temperatures as low as possible and as quickly as possible before serving, rather than allowing food to remain warm, since bacteria grow more slowly at lower temperatures.
(6) Be aware that boiling kills active microbes, however the spores from which certain spoilage organisms develop are heat resistant, and will reactivate above the 50 degree F refrigeration temperature.

CAUTION: Food does not have to be visibly spoiled in order to be toxic. Spoiled food can cause illness evidenced by nausea, vomiting and diarrhea. Even if food has not been at the incubating temperatures of the danger zone for the full three hours, you must absolutely discard food when it is bubbling, is foaming, has a bad smell, is discolored, or exhibits any other indication of spoilage. Discard it and keep it out of reach of animals and children. Thoroughly wash the pot. Discard the food without tasting it. Even small amounts can make an adult very sick.

References

1. Lost Valley Educational Center & Intentional Community, 81868 Lost Valley Lane, Dexter, Oregon 97431 (541) 937-3351, http://www.lostvalley.org/haybox1.html, "Haybox how to and description."
2. The Solar Cooking Archive at http://solarcooking.org/docs.htm has a number of haybox cooking articles under the heading *Retained Heat Cooking:*
   - *Retained Heat Cooking* (also in French)
   - *Efficient Haybox Construction*
   - *Information on Hayboxes*
   - *Heat Retention Cooking vs. Solar Cooking*
   - *Interview with Mike Bridgwater about his work in combining solar cooker and heat-retention cooking in Tanzania*
   - *Tanzania 2001 Report*
   - *Building a Hay Sack Cooker*
   - *Introducing fuel-saving cooking methods in southern Tamil Nadu*
3. We used to good effect the reflective aluminum roof flashing material described below. We trust, without being entirely certain, that this product would always be sold without a clear paint coating, and thus will never smolder when subjected to flame. Similar products from other manufacturers may also work satisfactorily, but we have not tested them.

   Aluminum Roof Flashing, Economy Grade
   0.0092 inch (0.23 mm)

   Sold in various size rolls, the smallest being;
   Product #68306, 6 inches by 10 feet
   Universal Product Code 0 4982168306 1
   Ace Hardware Store # 5082151

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   450 Richardson Drive, P O Box 4515
   Lancaster, PA 17603
   1-800-347-2586