Solar Household Energy, Inc.
Solar Cooking for Human Development and Environmental Relief

SHE Technical Report no. TR-35

Compilation of Solar Cooker Heating Experiments, Summer 2017

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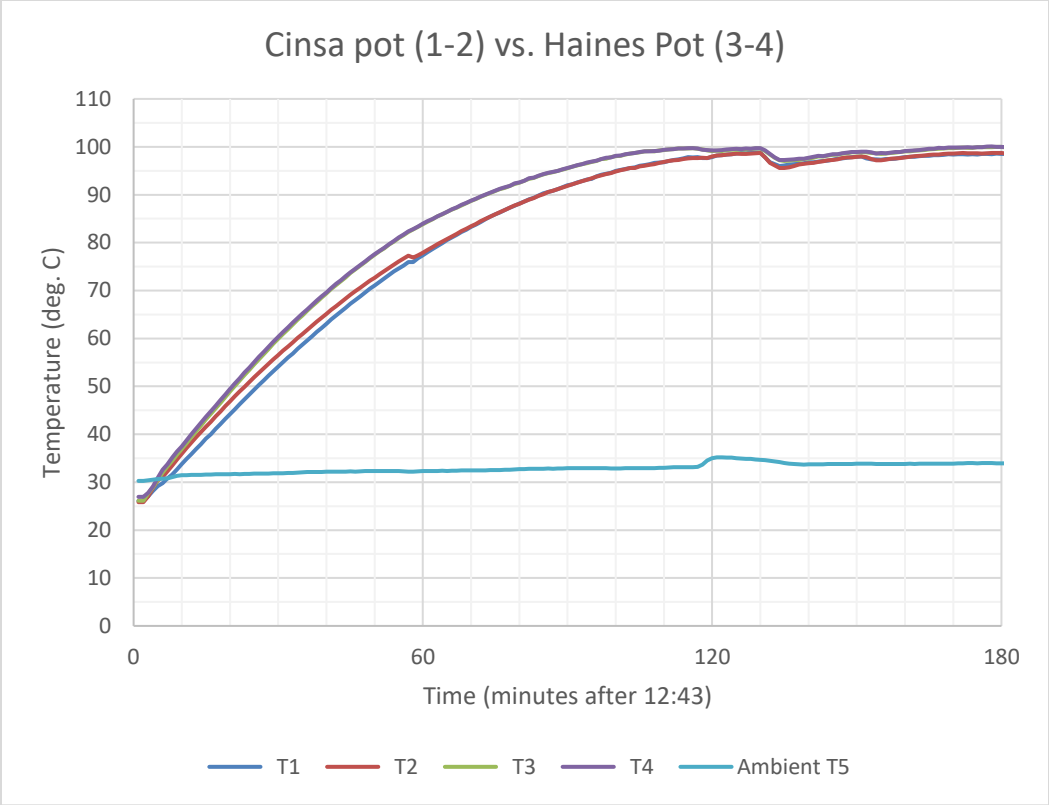
Compilation of Solar Cooker Heating Experiments, Summer 2017, Rockville, MD

This is a compilation of solar cooker internal temperature, solar irradiance and wind speed data collected in 2017 at latitude 39.0475 deg N, longitude 77.1412 W (in Rockville, MD). Dates of each experiment are shown on the graphs, in yyyymmdd format. Plot color code: B=blue, R=red, G=green, P=purple, LB=light blue.

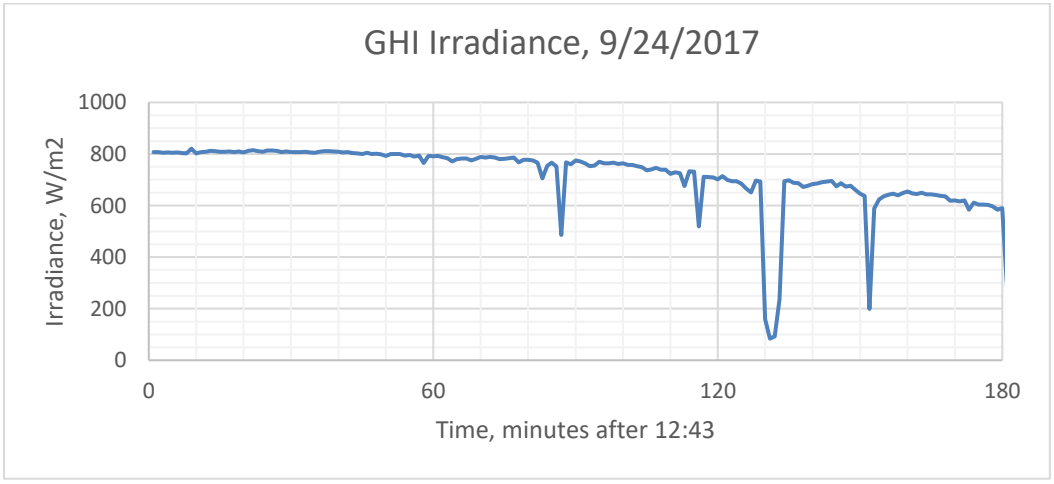
These are "raw" data that in most cases have not been time-averaged or otherwise processed. In some cases a load of 1 liter of water was used, but in most cases the load was determined based on standard ASAE S.580.1, which calls for 7 liters per square meter of intercept area of solar cooker reflectors (at the angle for maximum power). However, power calculations are not include here. These results will be published later.

The above photo shows a typical test setup (Sept. 24, 2017). Usually two cookers are measured at the same time in order to exclude variations in solar irradiance in the comparisons. The box in the center is a "Stevenson box" that contains the data loggers and instruments for measuring temperatures, solar irradiance and wind speed (see TR-09). (A small solar PV panel is used to provide power to the instruments.)
Most of the temperature plots contain data from four thermocouples and one thermistor (which is used to measure the ambient temperature). Often two thermocouples are placed inside each pot, so that there is a check on the placement of the sensors in the water of the pots.



20170924

Cinsa is a large manufacturer of enameled steel cooking pots sold in Mexico. The experimental setup is as shown in the previous figure. Here the Cinsa pot (red and blue) is compared to the baseline Haines Model 1 Solar Cooker #2 with its Dutch Oven pot (purple and green). The ambient temperature is light blue. Both pots had a load of 1 liter of water. A 3-inch support was added to the Cinsa pot to elevate it.



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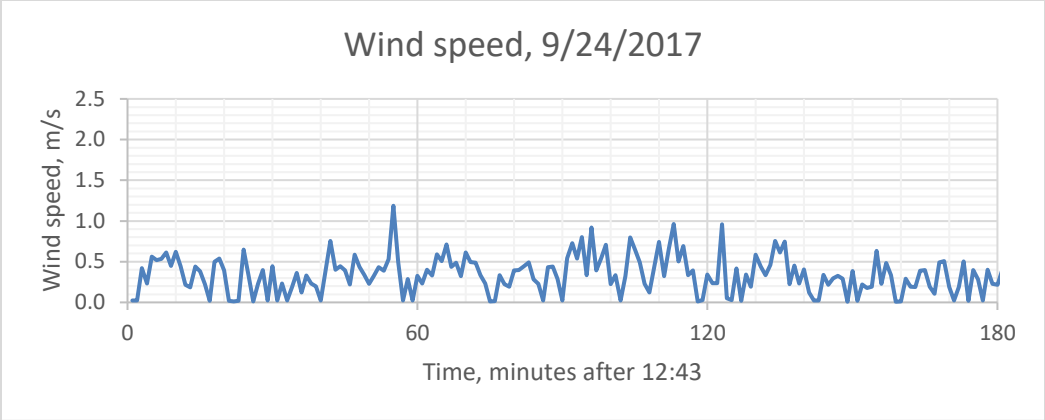

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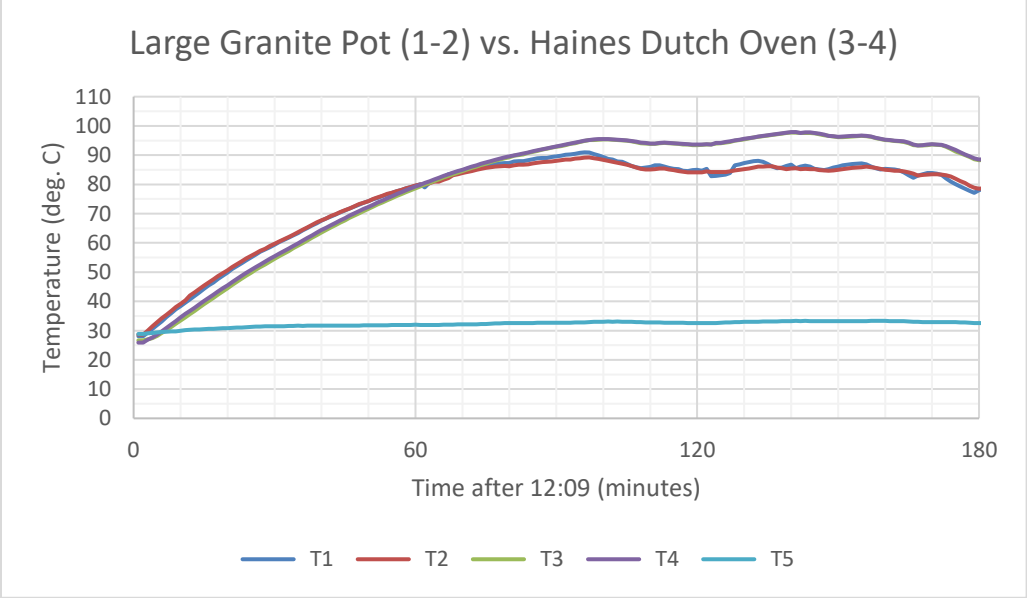
Experimental setup on 20170925.



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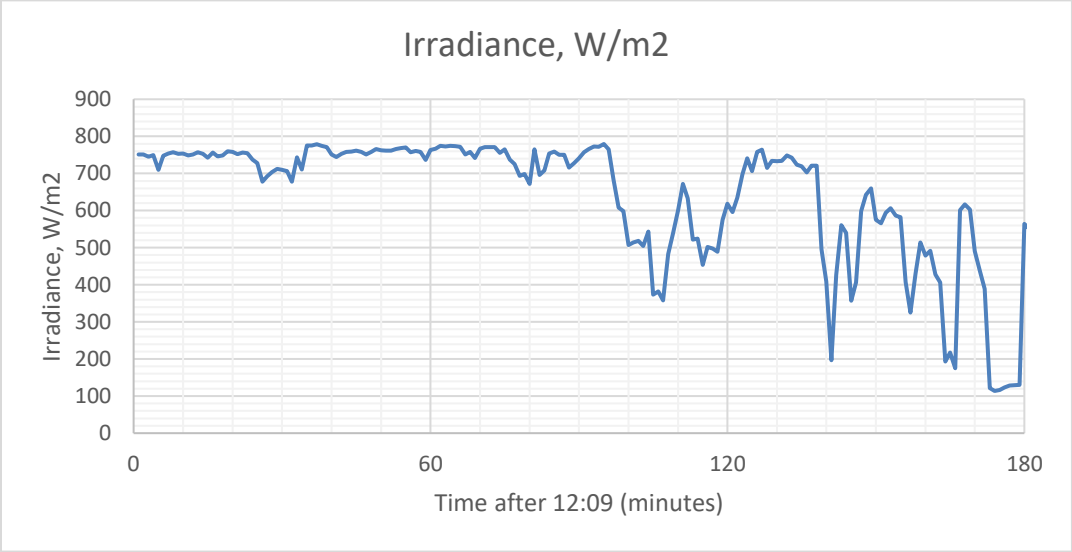
Red and blue: large granite ware pot with Haines reflector #1. Purple and green: Haines Dutch oven with reflector #2.
The wide granite pot heated faster, up until 85 deg. C, then it leveled off, probably because of steam escaping from the large lid. It has a metal, not a rubber rim.
It heated up faster because it was wider and had a stronger greenhouse effect due to the large glass lid. The irregularities after 90 minutes were due to clouds.



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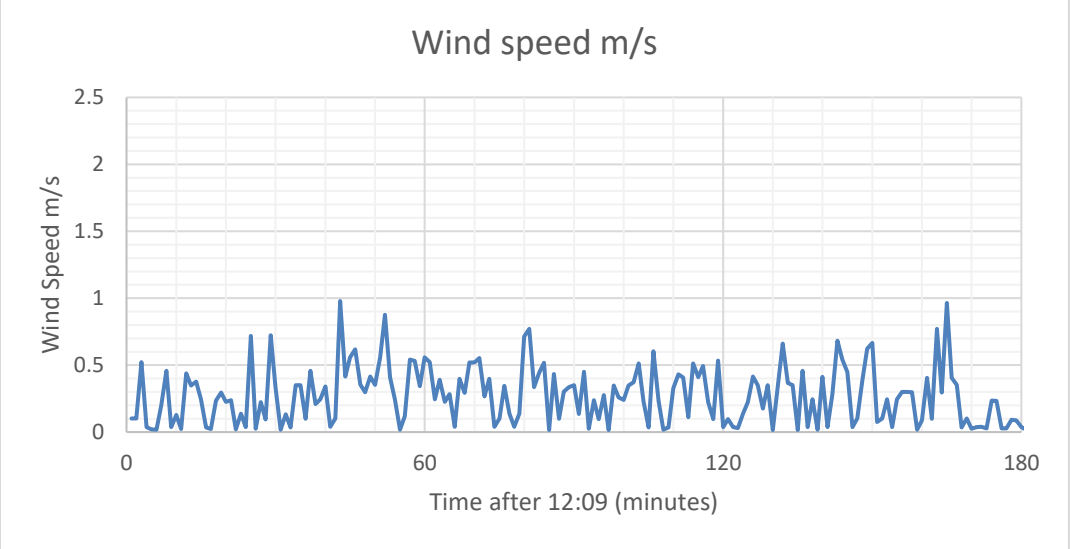

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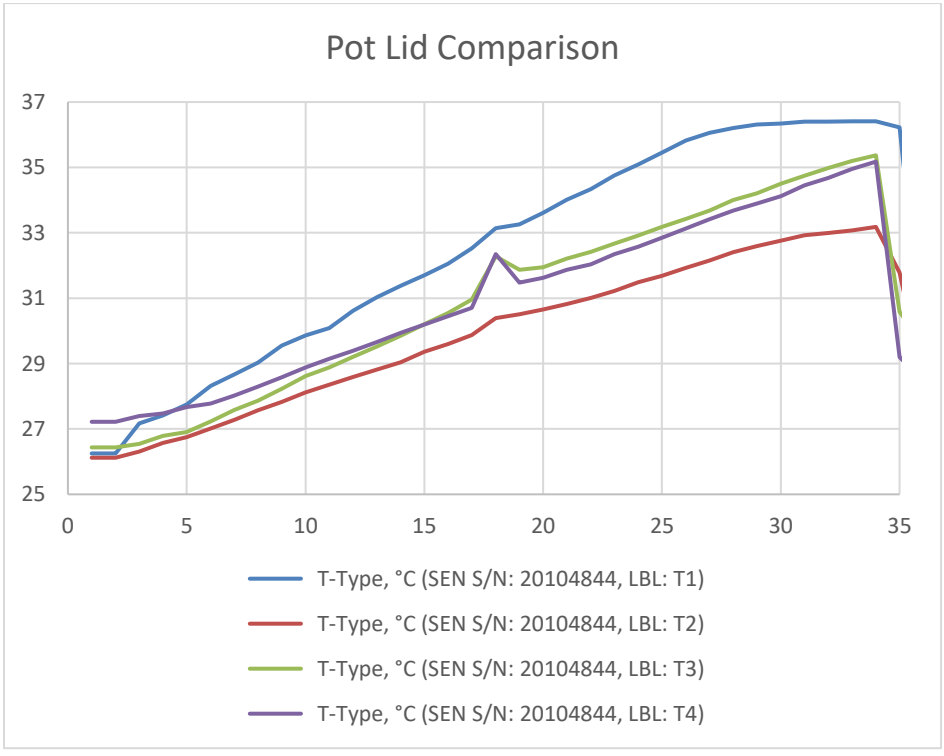


20170927

The question studied here is whether a clear glass lid improves performance. This test compared lid treatments; no reflectors were used. Four Dutch oven pots were used. A four-way comparison was done:
T1 - Haines normal Dutch Oven heated fastest (clear glass top).
T2 - Aluminum foil on outside covered lid - heated slowest.
T3 - Dutch oven with black foil inside cover*
T4 - Dutch oven with lid painted black outside
All pots were shadowed by trees after 35 minutes.

Heating rates:

	10 min	20 min	Amb. Corr.	Diff.	Rate, deg. C / min.	
T1	29.86	33.61	-0.13	3.62	0.362	
T2	28.12	30.65	-0.13	2.4	0.24	
T3	28.62	31.95	-0.13	3.2	0.32	Error*
T4	28.88	31.62	-0.13	2.61	0.261	

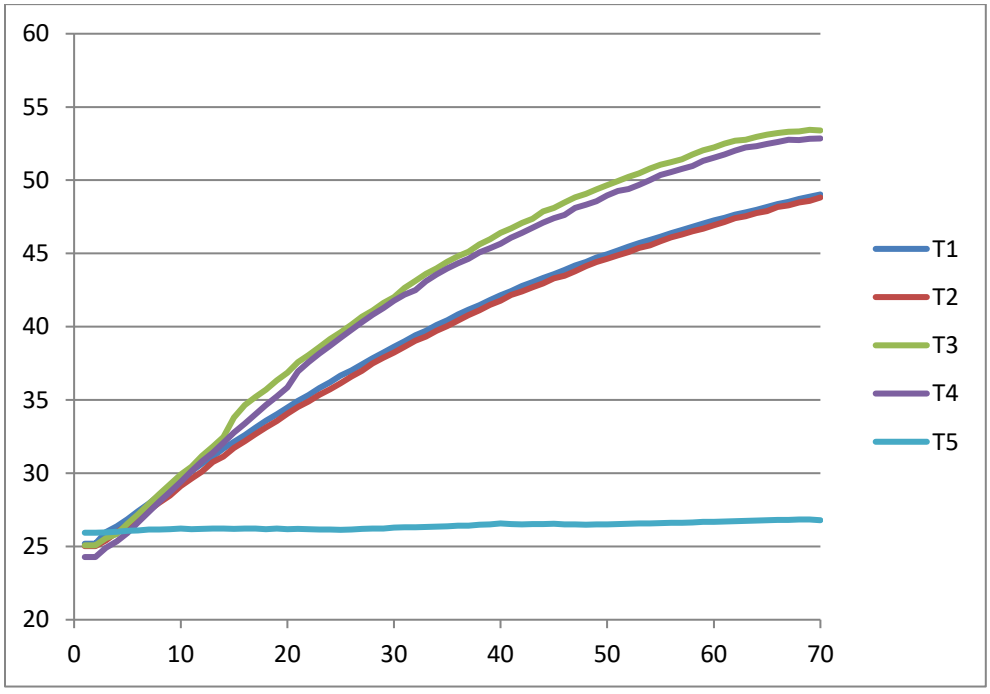
*T3 data (opaque cover) was actually clear because the foil fell off until 17 minutes when it was replaced. Then the heating rate became nearly the same as T4.

This means a painted black lid and an internal black foil behaved the same.

So the clear/opaque heat rate ratio is 1.39, meaning that the heating rate is 39% higher for a clear lid versus a black opaque lid.

Further discussion of these results is given in TR-33.

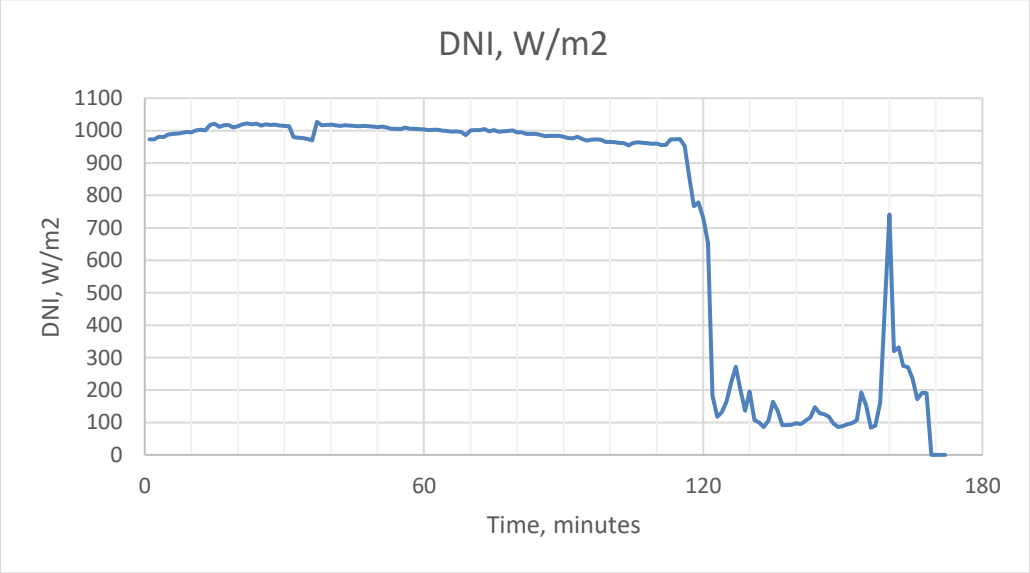
20170928



20170928

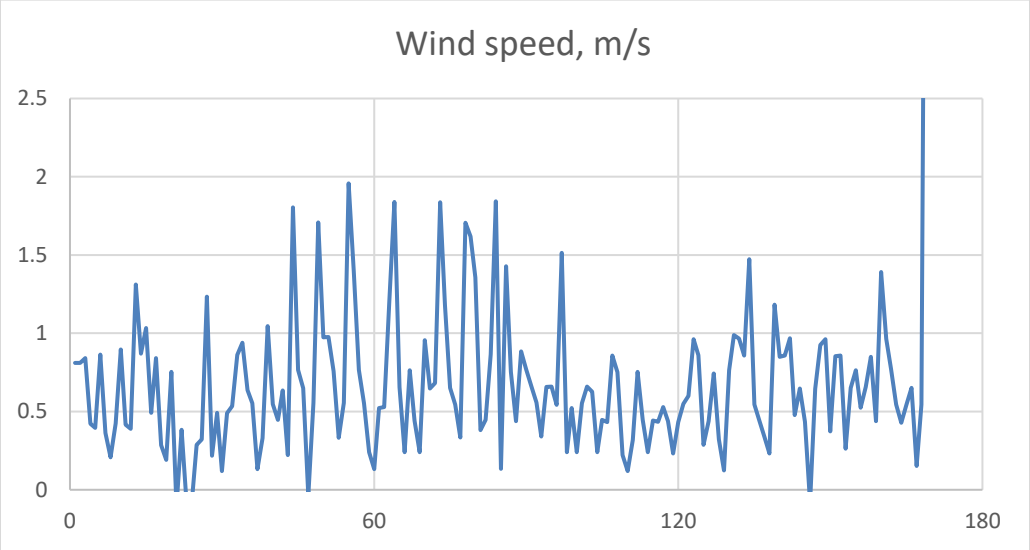
The question studied here is: does a seal on a glass lid make a difference? The comparison is between two identical small speckled enamel pots. One was sealed with aluminum tape (green and purple). The other was left unsealed (red and blue). The

ambient temperature is light blue. Reflectors were not used. Both pots were sitting on insulated pads on the ground. The result showed that the sealed pot was 5 degrees C hotter after one hour than the unsealed pot. This is consistent with our previous observations regarding the importance of good seals or gaskets on pot lids.



20170928

Direct Normal Irradiance (DNI) data for this experiment were acquired with the pyranometer mounted on a solar tracker (see TR-31).



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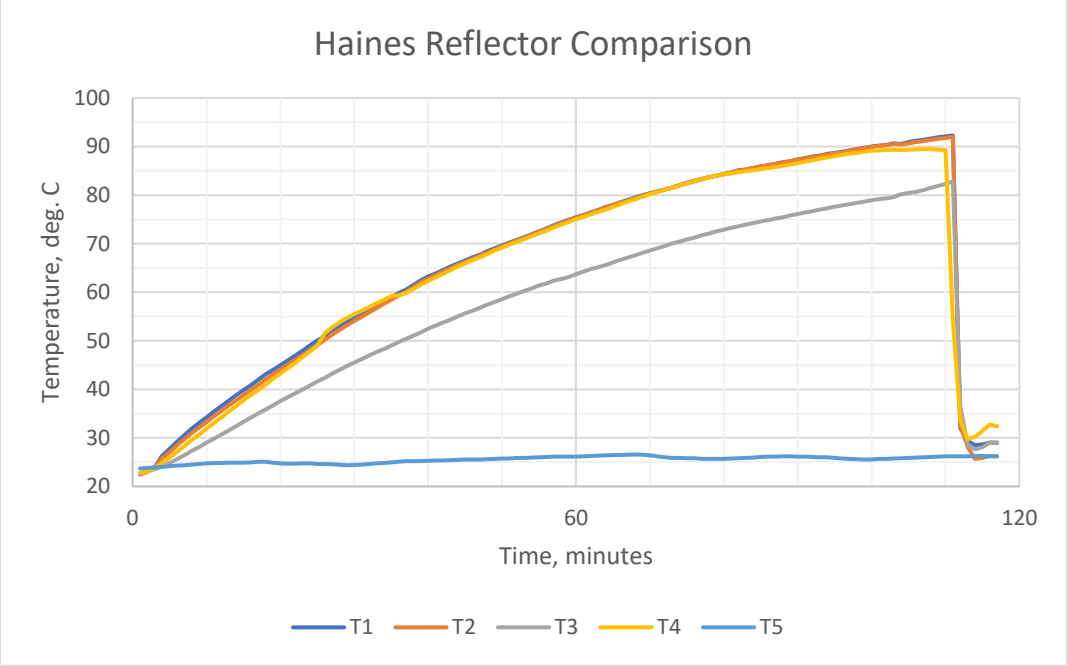
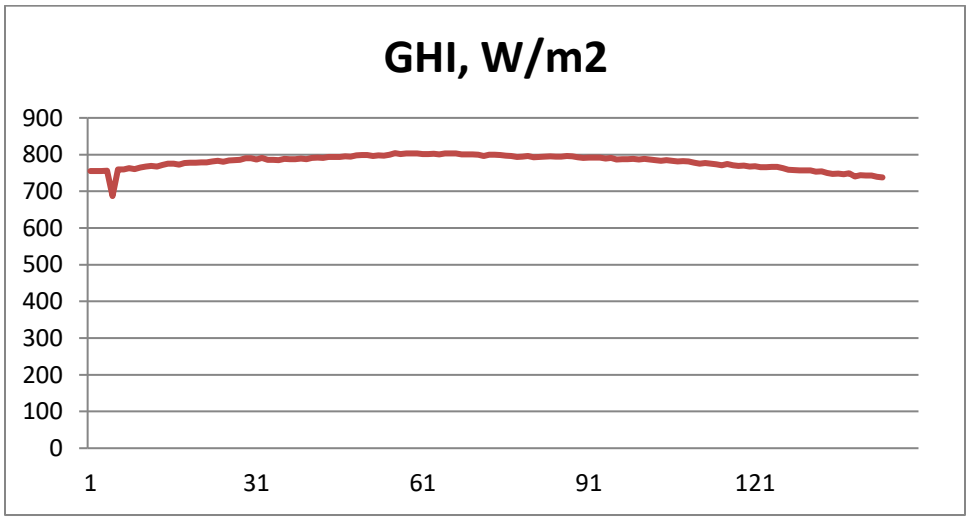
Further discussion of these results is given in TR-33.

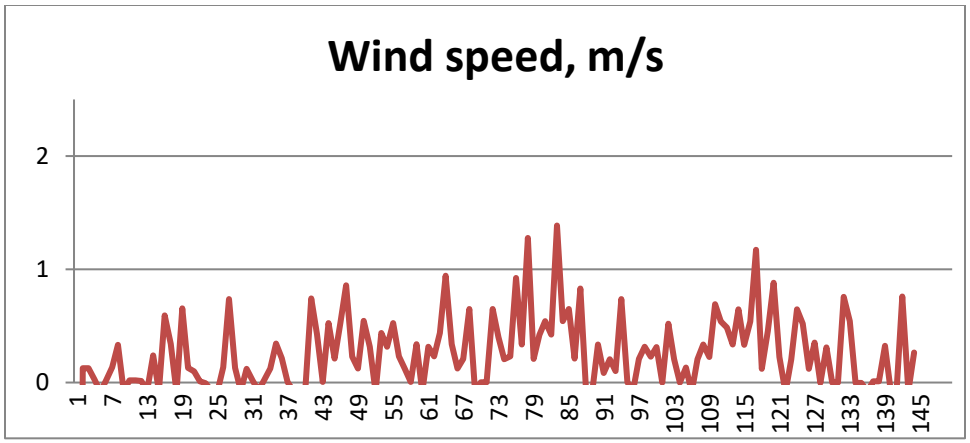


20171002

This was a 3-way comparison between three different Haines cooker reflectors. Each had a Dutch oven pot with 1 liter of water. The T3 data are for Pot #2 with reflector #2. Reflector #3 (T4) had smooth curved reflectors from Sharon Clausson's Copenhagen solar cooker, with a backing of palm leaf matting. The placement of Pot#2 was further forward in the reflector, which may have accounted for its lower performance. It is very important to set the pot at the optimum position; this ought to be marked on the reflector to provide a guide for the user.

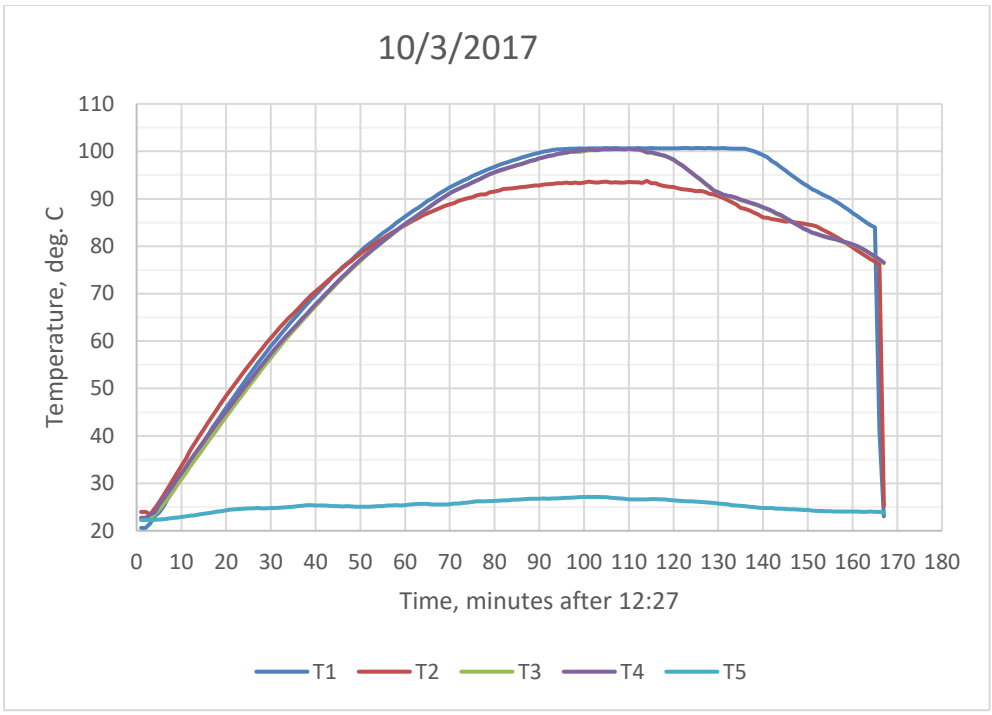


20171002

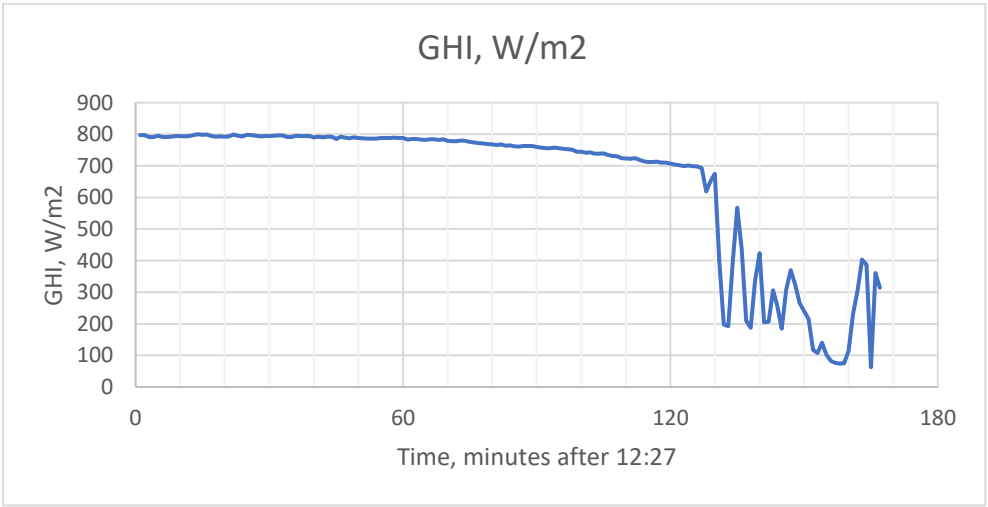


20171002

20171003



T1 = Sealed small Italian pot with Haines reflector #1
T2 = Large unsealed Italian pot with Haines refl. #2
T3 & T4 = Haines Dutch oven with refl. #3
T5 = ambient. All pots had 1 liter of water as a load.
So the sealed pots T1 & T3-4 were about the same. The unsealed pot, though bigger, never quite came to a boil. I could see steam escaping from the lid gap and made a photo. Temperatures dropped after 120 minutes due to shading by trees.
T1 reached 95 at 76 minutes.
T3-4 reached 95 at 79 minutes.
T2 never reached 95.



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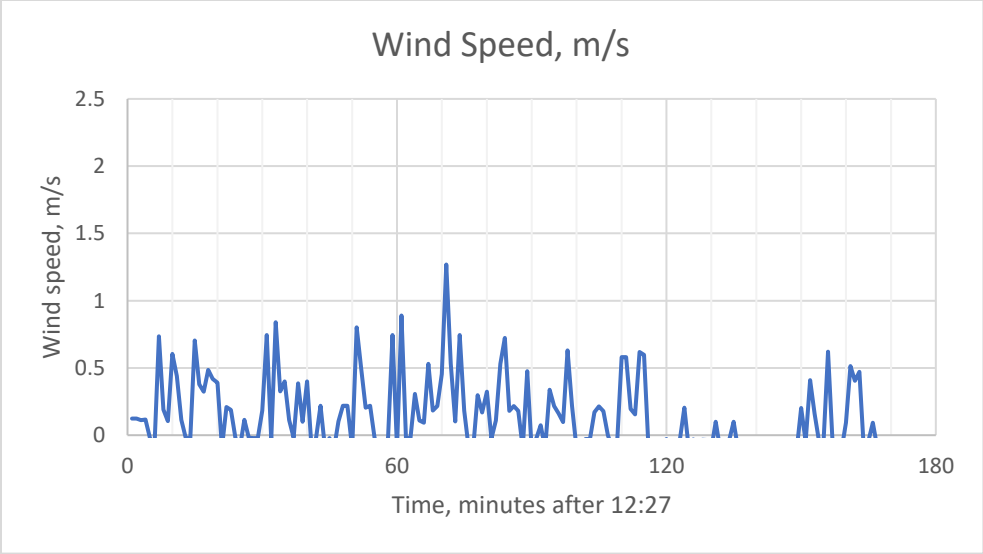

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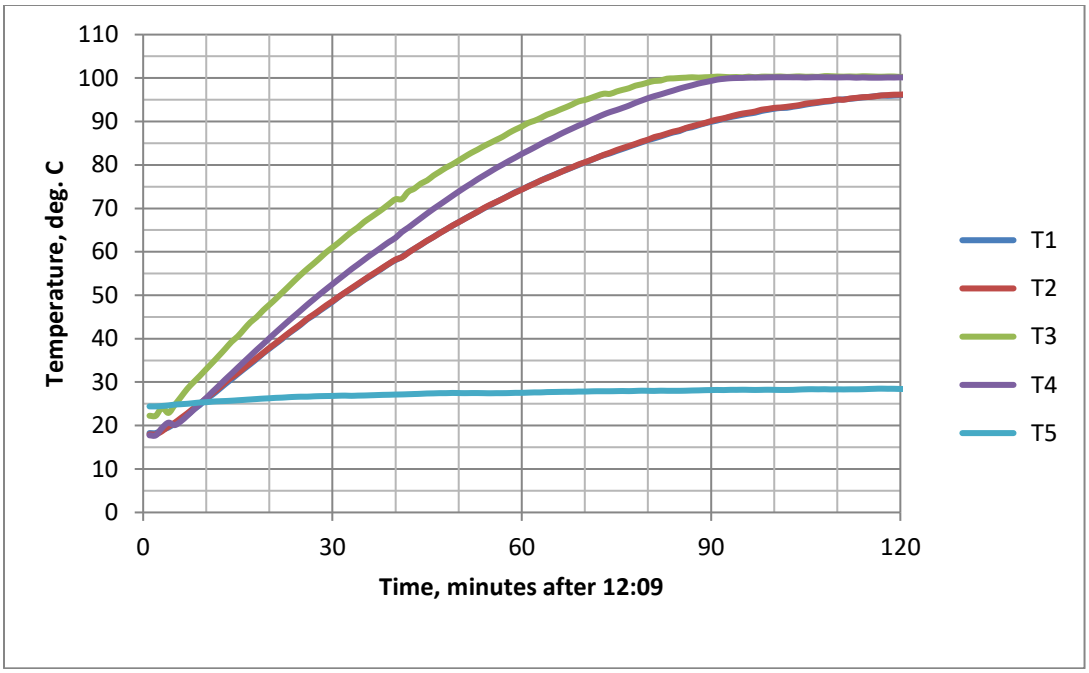
20171004



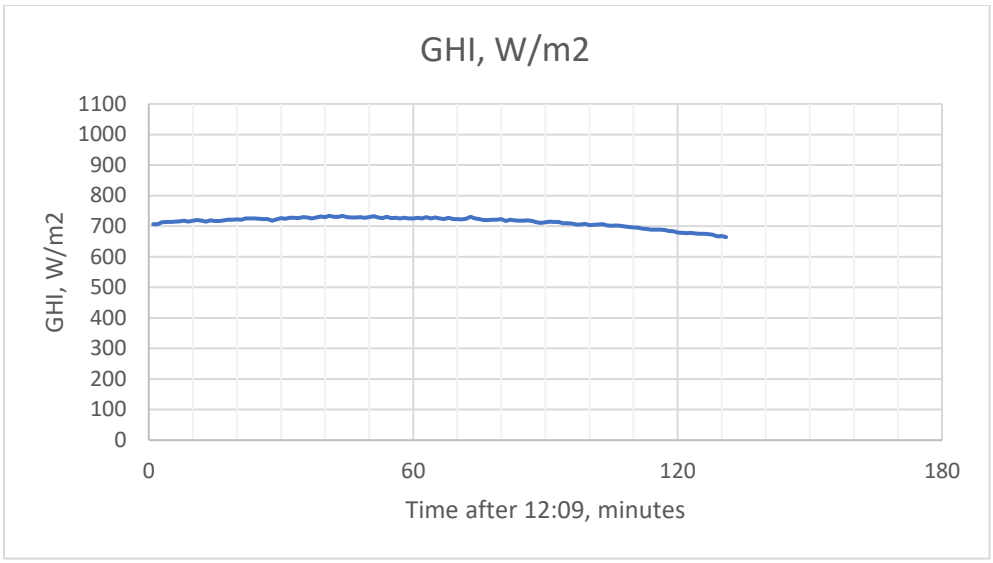
20171004

T1 & T2 = Blue Duracera pot with Haines #1 lid in reflector #1
T3 = Large Italian pot, sealed with tape, in reflector #2
T4 = Haines D.o. #3 in reflector #3
(Note: red covers up blue; both are nearly identical.)
All pots have a 1 liter water load.

The Italian pot got a bit of a head start, but it reached 95 deg. at 71 minutes.
The T4 pot (Haines) reached 95 at 80 minutes.
The blue Duracera pot reached 95 at 110 minutes.

So with a good watertight seal, the Italian pot can beat the Haines pot, barely.
But the Italian pot is not black all over the inside and outside. That would help.

Nice day!



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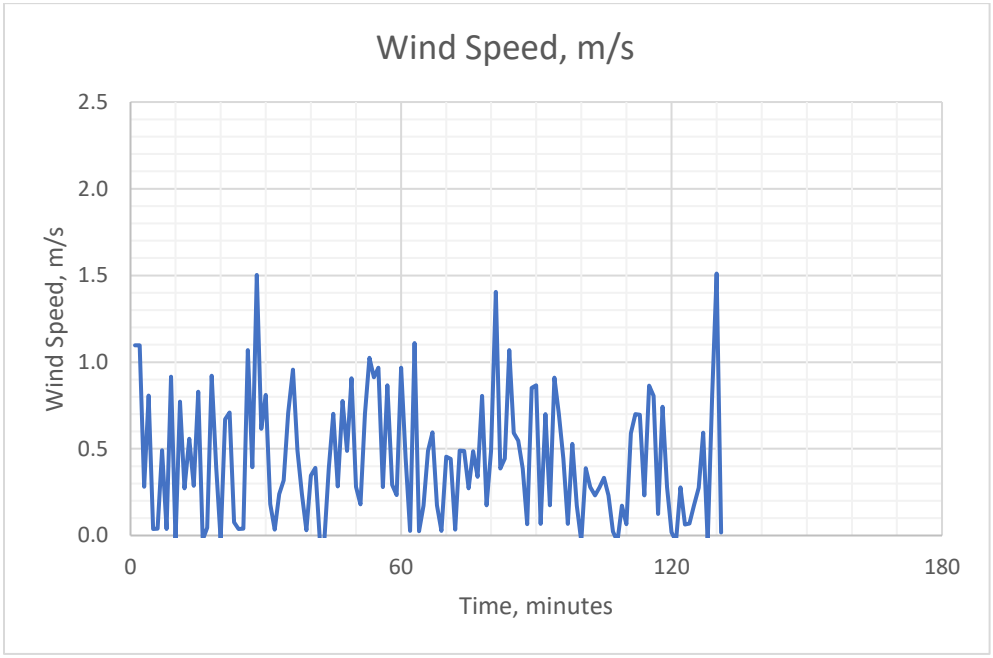

20171004

End of data for 2017.