

# Use of Solar Energy for Household Energy Needs

Experiments, 2018 and 2019

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# It takes a lot of energy to support a family, even in the developing world

- For cooking
- Water heating
- Space heating (depending on climate)
- Boiling drinking water (frequently not done due to lack of energy)
- Drying grain or firewood
- Generating a little electricity
- Other needs

# Johnson and Bryden studied fuel use in detail in a village in Mali

(Energy supply and use in a rural West African village, Nathan G. Johnson and Kenneth M. Bryden, Energy 43 (2012) pp. 283-292.)

- Water and space heating accounted for 22.2% and 19.1% of energy use, respectively.
- Nearly all respondents bathed in hot water once per day.
- 15-30 liter cooking pots were placed on outdoor 3-stone fires.
- Space heating is seasonal, but can account for 20+ kg of wood per day per family burned indoor fires.
- And further, I note that a lot of Africa is about a mile above sea level, and the nights are cool.

# Collecting wood takes a lot of time



Buying wood or charcoal takes a lot of money



Burning wood can be dangerous.....



.....for many reasons. Tending a fire takes a lot of work, too.



# What can that big nuclear reactor in the sky do to help us?

- Part 1: A general purpose heater and drier, very inexpensive and versatile



Put down 5 cm of loose insulation such as straw, then black plastic



Use large buckets, full or partly full, for wash water. Jerry cans work too.



For space heating use many buckets then bring them indoors



# Cover with clear or translucent plastic



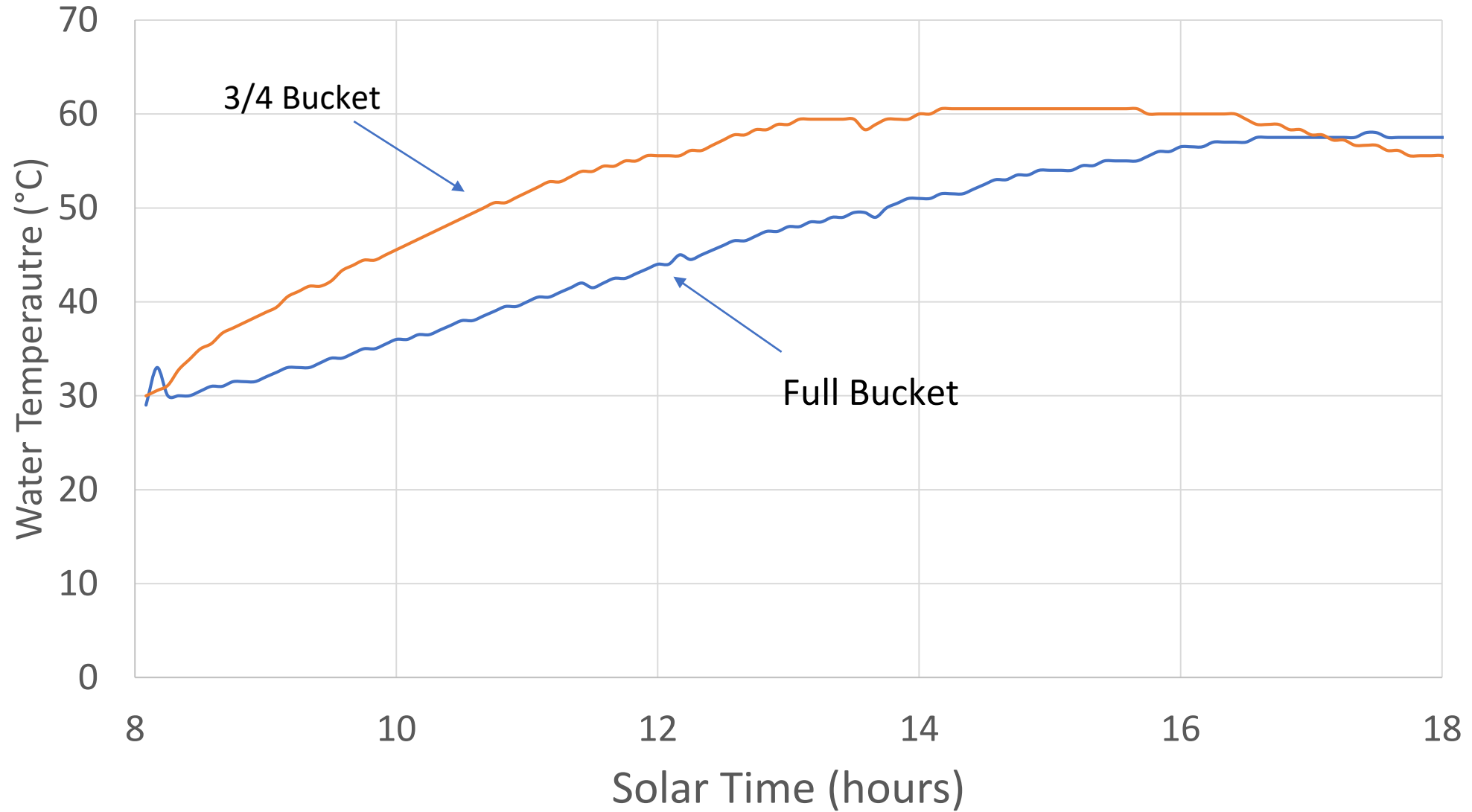
# Video showing application of clear plastic layer



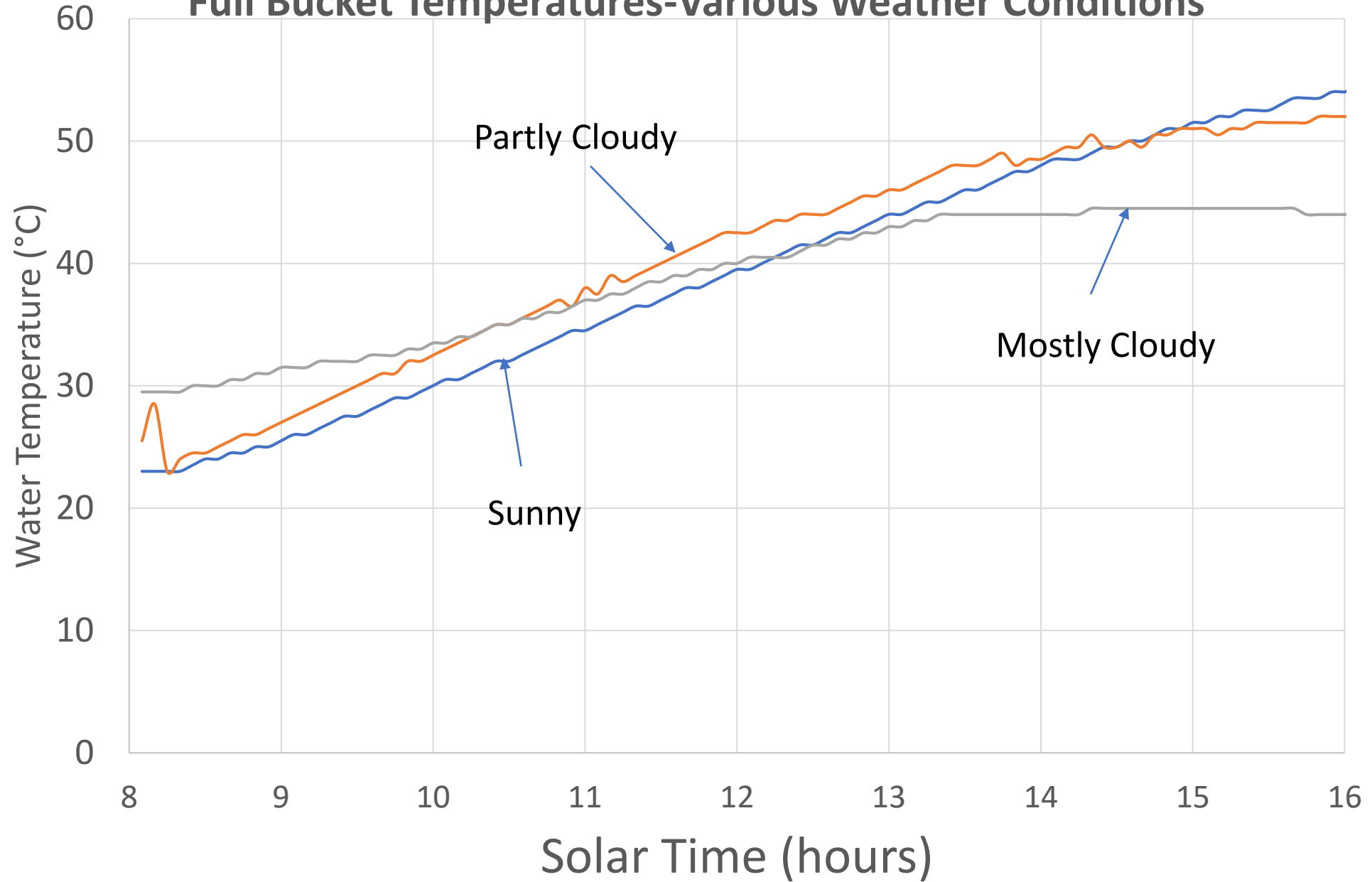
# Water for washing or space heating

- Perhaps 1 or 2 buckets for washing, heated to 50-60 C.
- Perhaps 6-12 buckets for space heating, heated to 45 C.
- Or heat water in jerrycans, heated to 50 C.

# Sunny Day, June 30, 2018



# Full Bucket Temperatures-Variou Weather Conditions



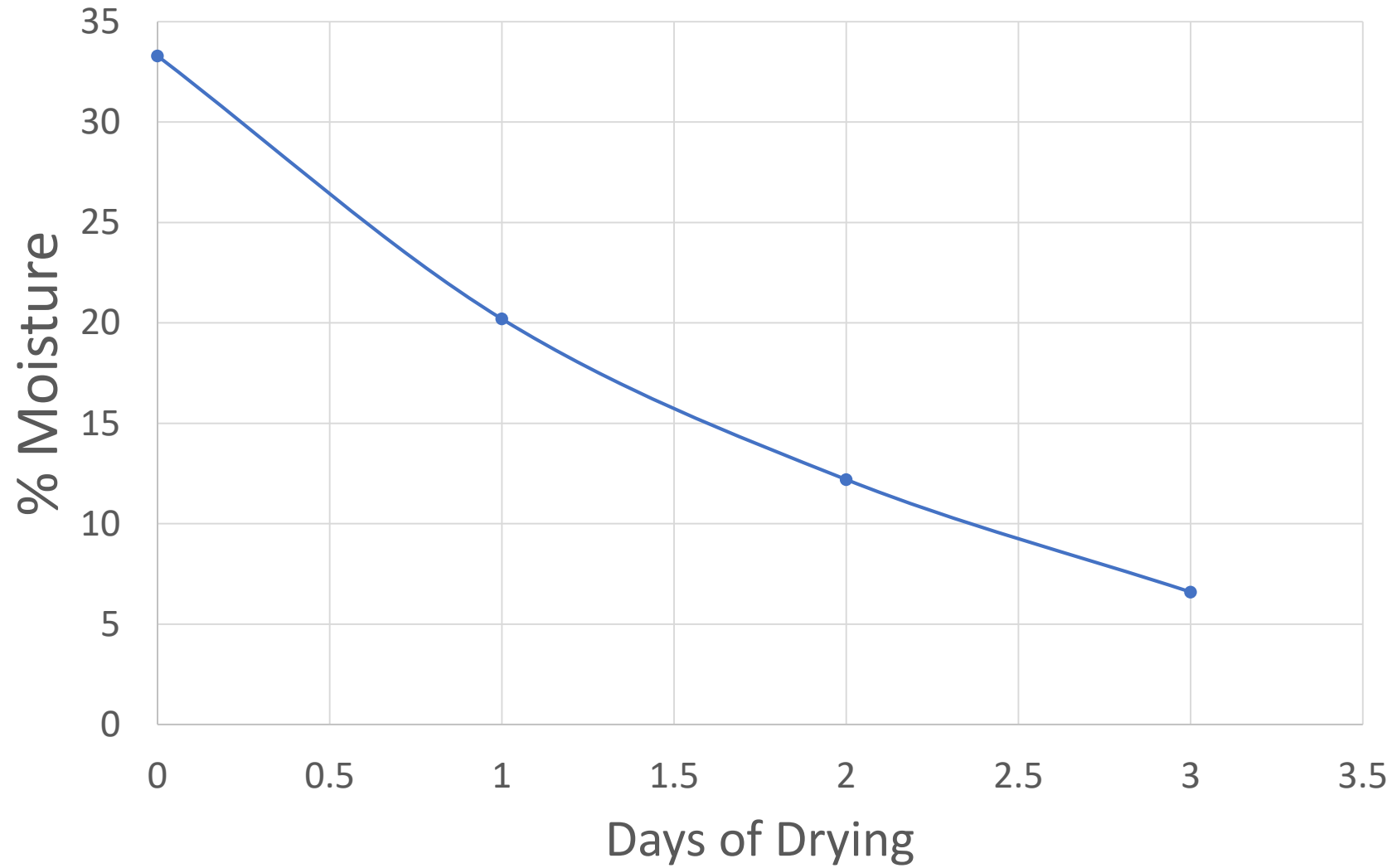


# Dry corn or other grain



3 kg of corn,  
layer is about 1  
cm deep

# Corn Drying

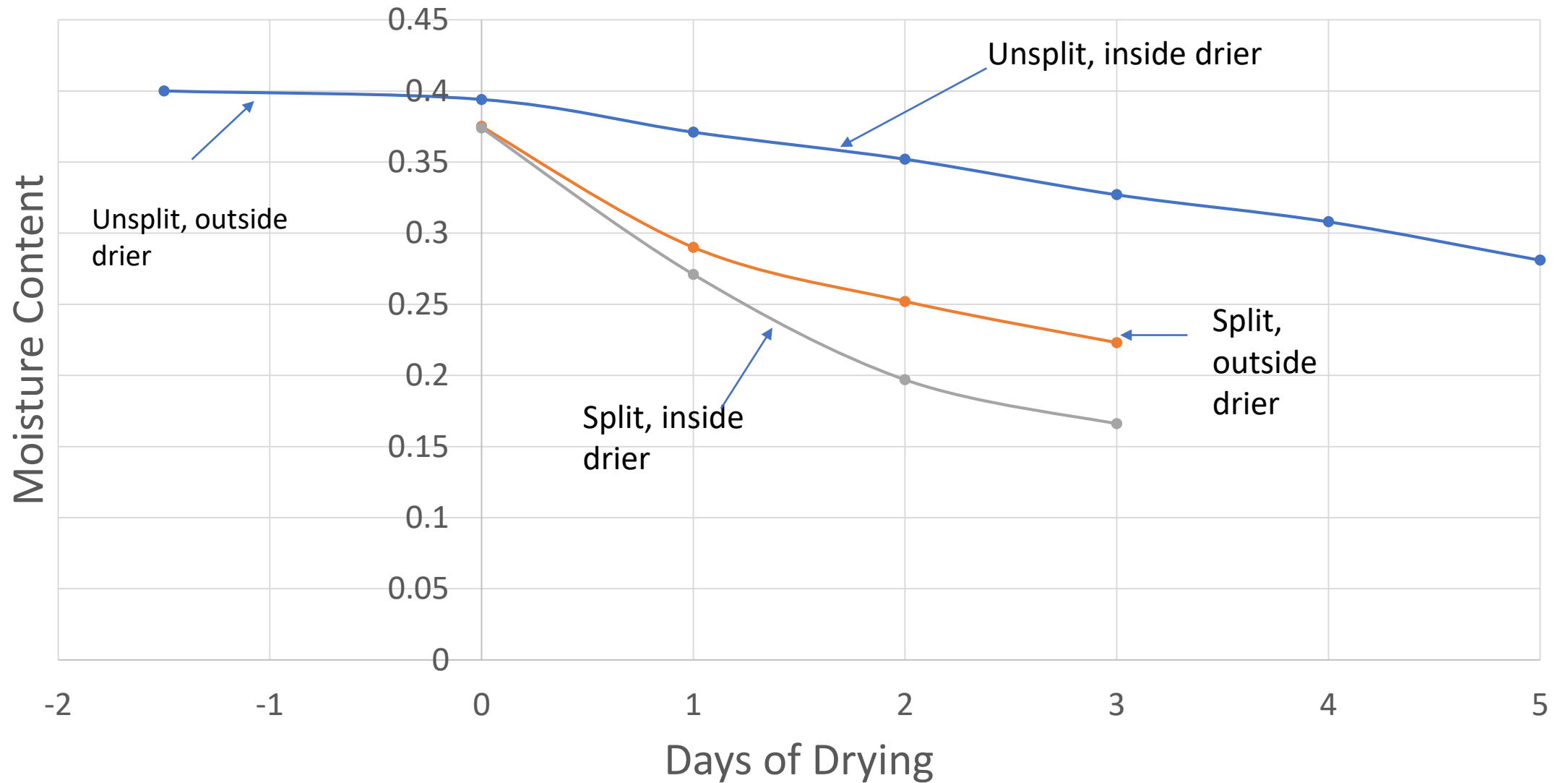


# Dry firewood to make a less smoky fire

(rather than invent a better stove, invent a better way to dry wood?)



# Wood Drying, about 60 mm diameter



# Key points regarding wood drying

- Unsplit wood dries really slowly
- In the drier, it dries less slowly, about 5 times faster
- Split wood dries much faster, even without the drier
- Using the drier might make it unnecessary to split the wood, saving work

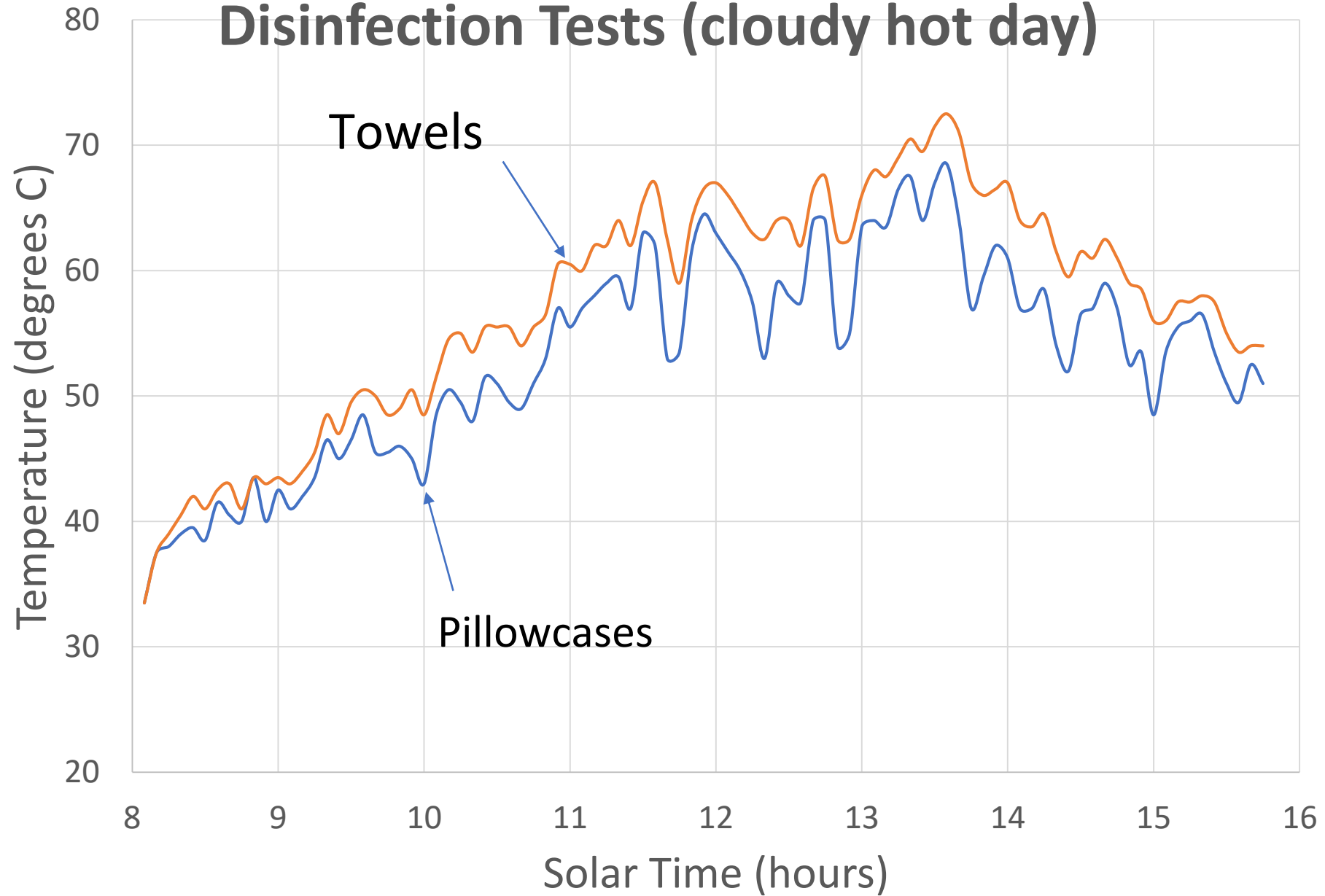
# Insect Egg Disinfection

- In some places, putzi flies lay eggs in wet laundry.
- The laundry dries, people put on the clothes.
- The eggs hatch, and flies bite the people.
- One solution is to iron every stitch of clothing, which is time and energy intensive.
- Temperature needed is about 55°C for 30 minutes.
- Bedbugs are similar.

3 layers of pillowcases or towels



# Disinfection Tests (cloudy hot day)

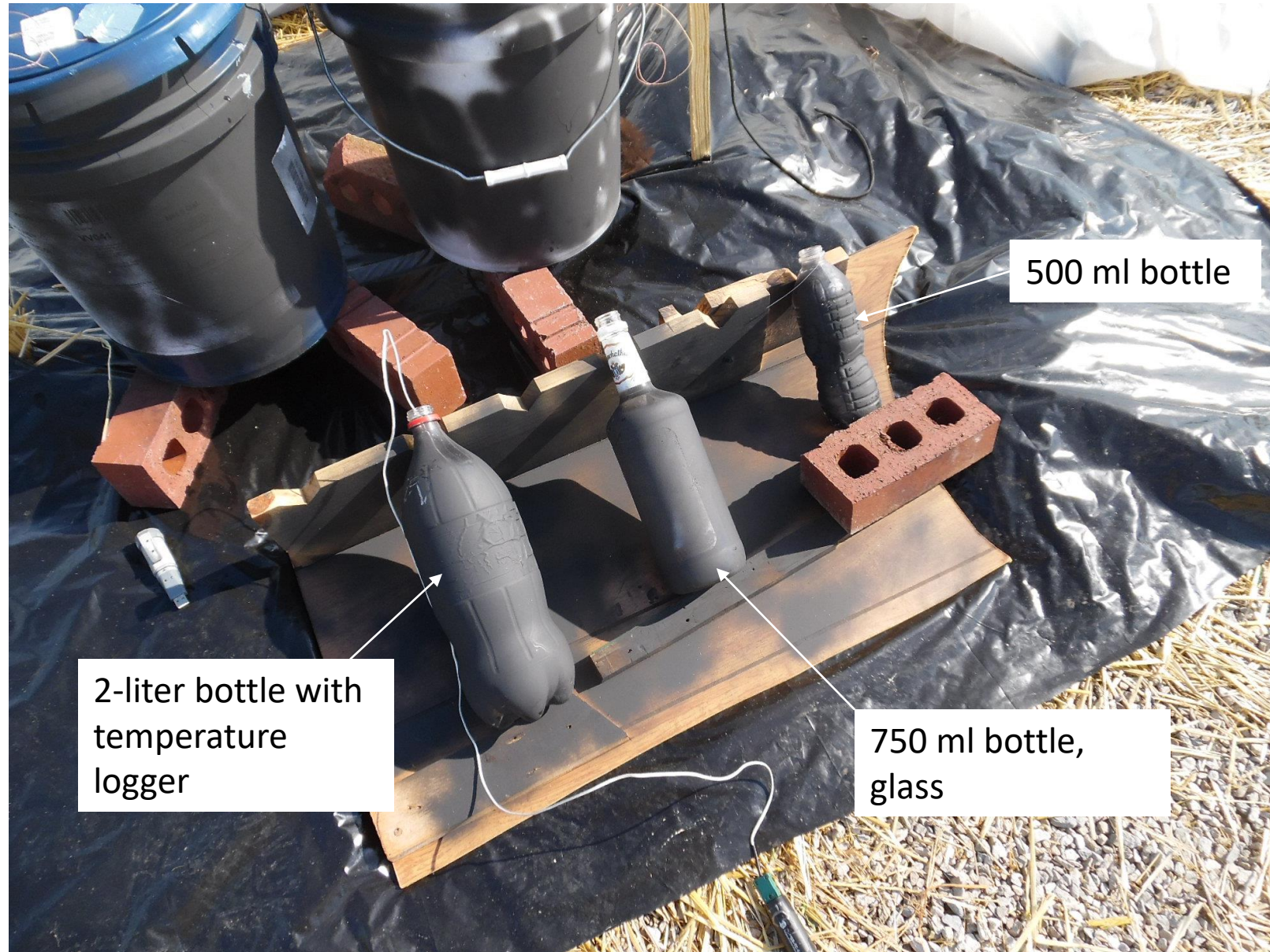




# Basics of Pasteurization

- Pasteurization is the heating of a food or beverage to temperatures sufficient to kill all pathogens.
- For water, 65 C for a few minutes, or 60 C for 30 minutes is sufficient.
- This can be achieved with vessels up to 2 liters.
- It is NOT necessary to boil the water, as many people believe.

Pasteurize water in vessels up to 2 liters. Narrow neck on vessel helps prevent recontamination.



500 ml bottle

2-liter bottle with temperature logger

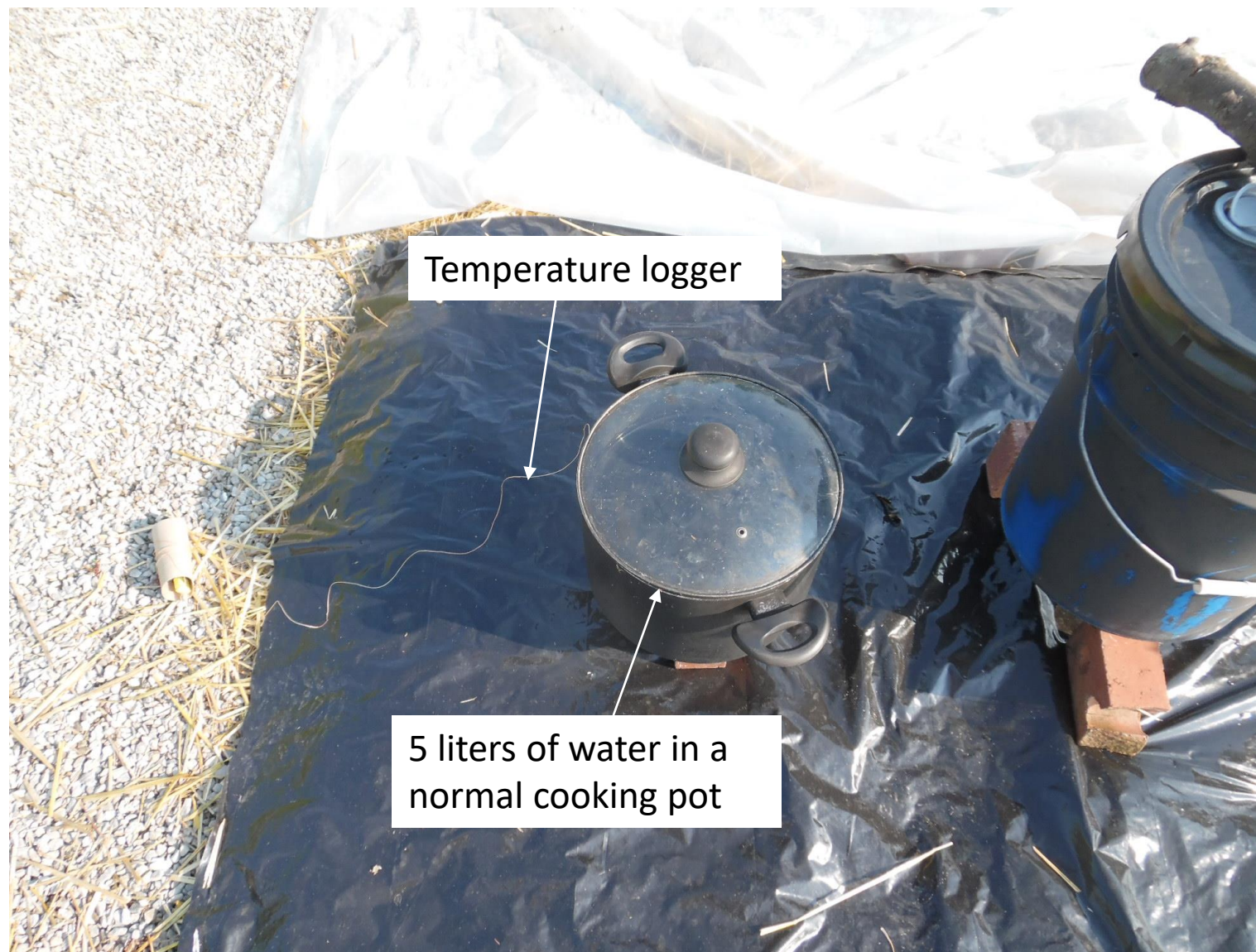
750 ml bottle, glass

# In some areas, boiling is common

- About 1 billion people boil their drinking water.
- If 2 liters per person per day, with wood stoves of typical efficiency, this is about 100 million (metric) tons of wood per year, producing 147 million tons of carbon dioxide. This is about 0.5% of the fossil fuel carbon dioxide footprint.

# Preheat cooking water up to 70 C in the cookpot itself.

(Instead of a better stove, invent a better way to preheat water?)



Other applications: This unit is in Kenya being used to heat bathing water and dry banana peels.



But the neighborhood tall guys don't seem to care much.....



# Some possible shortcuts

- Best is to paint buckets black, but other colors work almost as well.
- Best is to have black plastic on top of straw, but black plastic can be omitted with small performance penalty.
- Best is to have buckets open on top except for top layer of plastic as in Slide 12 (that is, lids on the buckets are bad while heating). Best to get sun down into the bucket.
- For heating pots, best is with clear lid on pot. Opaque lids also work, but not as well.
- Best is to use clear plastic, but translucent white works essentially as well.

Part 2: Inexpensive solar water heaters for people who have piped cold water. If you don't want to spend \$1150 for something like this.....





# Use a low cost solar water heater

- Several types under development, but work is very early.
- Most advanced version shown in the following slides.
- Cost is around \$100, can pay for itself in months with saved electricity costs.

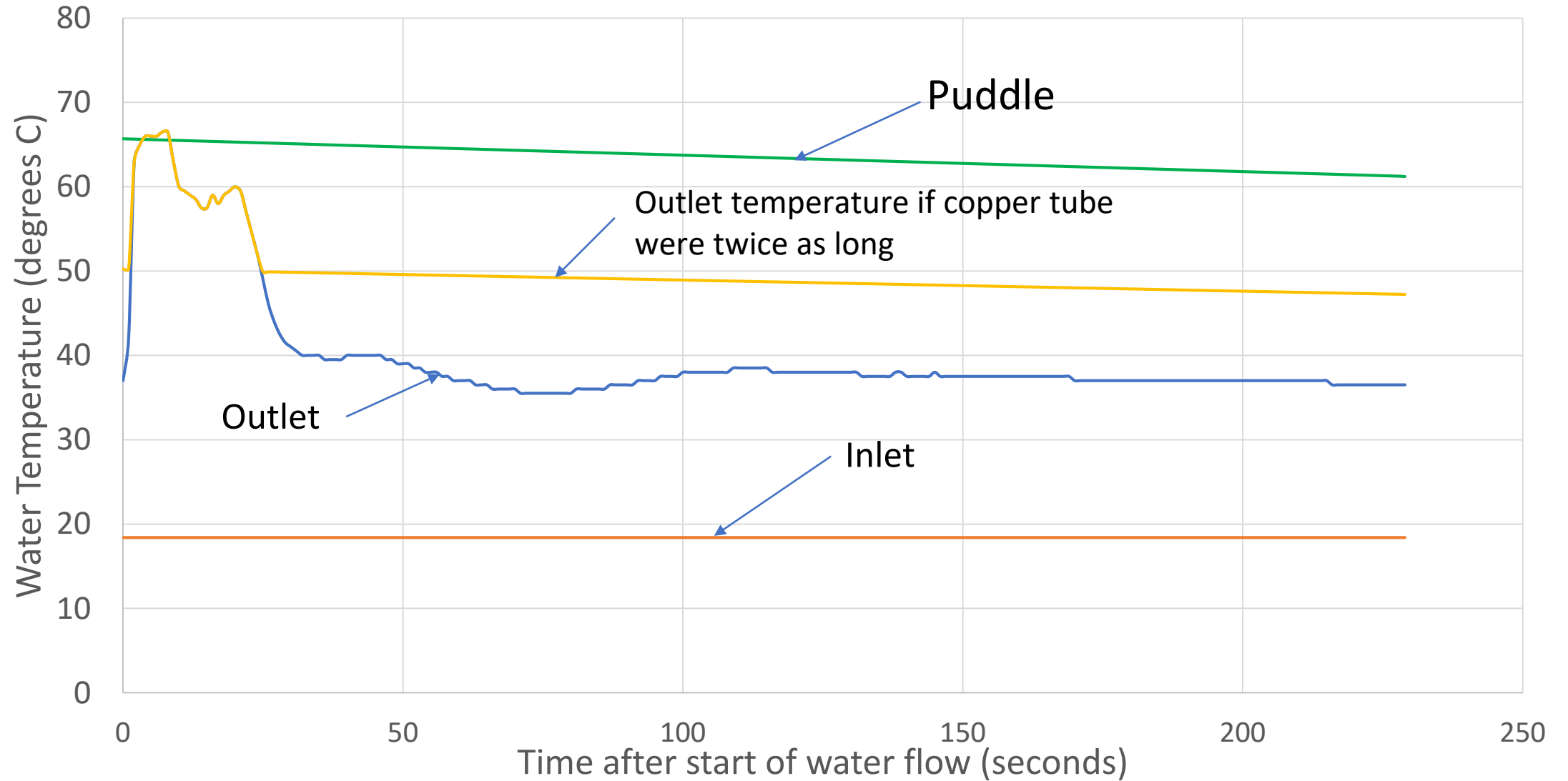
This is the working part of a “solar puddle”, a low cost energy collection and storage method



Complete solar puddle with top layers of clear plastic, forming an insulating air gap.



31 liters of hot water produced in 4 minutes. Outlet temperature remaining steady.



# Notes on durability

- The plastic, especially the top layer, will break down over time under the action of Ultra-violet rays from the sun, and heat.
- Ordinary plastic of 2-3 mil thickness (0.002-0.003 inches, or 0.08-0.12 mm) lasts about 3 months.
- UV stabilized plastic lasts about a year in the tropical sun, longer at more temperate latitudes.
- Thin plastic, less than 1 mil, breaks down in a month.

# For more information

- Video at <https://youtu.be/6Z6snha3uHE>
- Contact Dale Andreatta [dandreatta@sealimited.com](mailto:dandreatta@sealimited.com)