

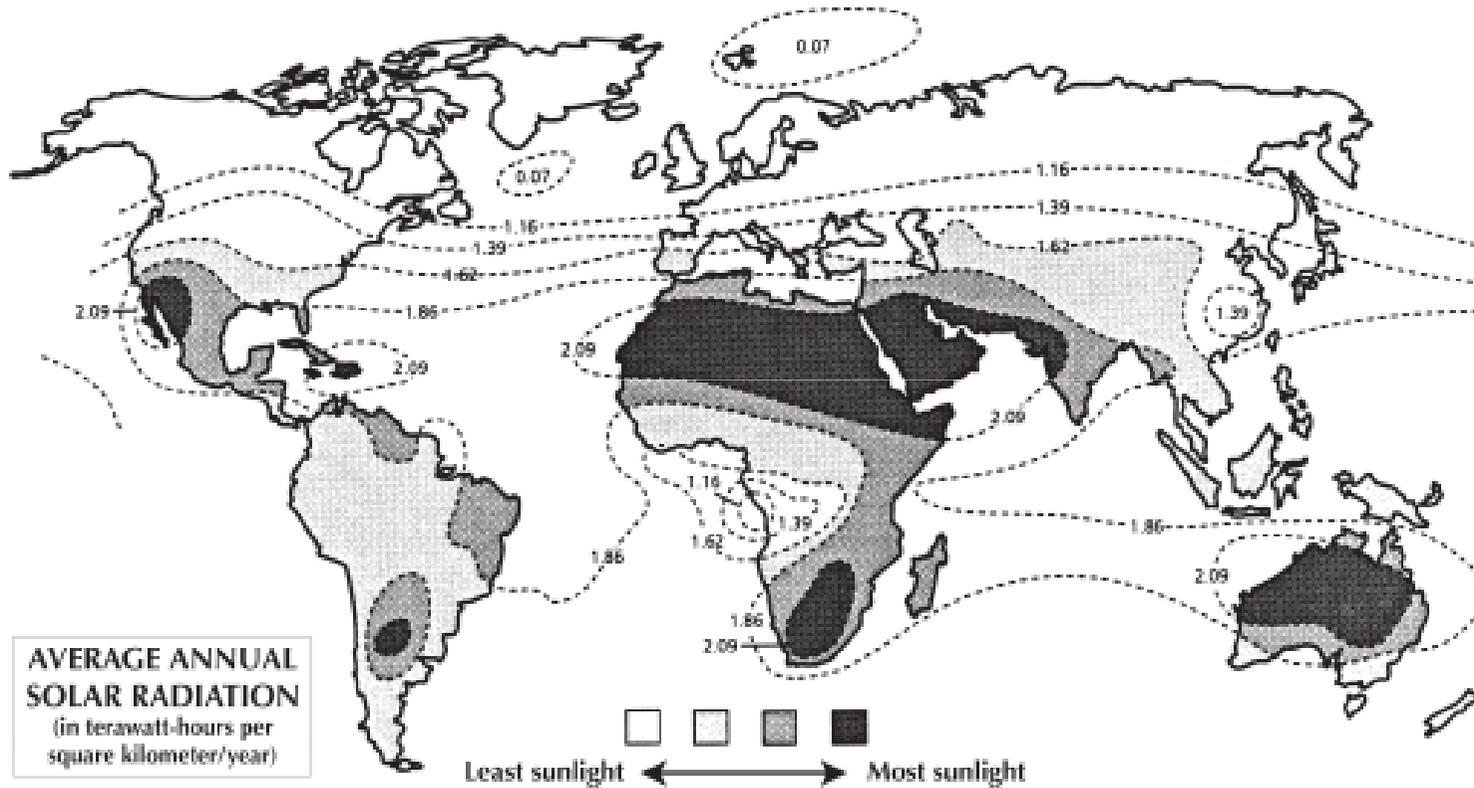
Solutions for Solar Cooking at a Latitude of 54 deg N

Presentation for SolarZentrum

Engineer: Seggy T Segaran

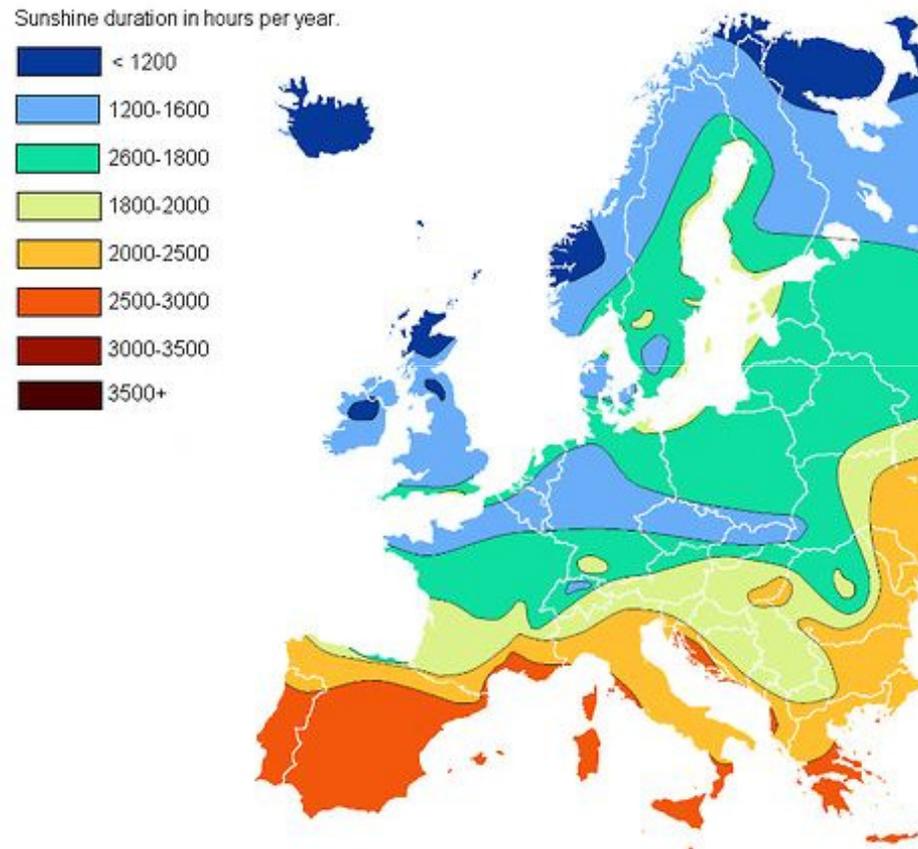
Chef: Jane Segaran

Solar Cooking Potential - Global



Graphic from SCI

Solar Cooking Potential - Europe



Where we live – York – 54 deg N

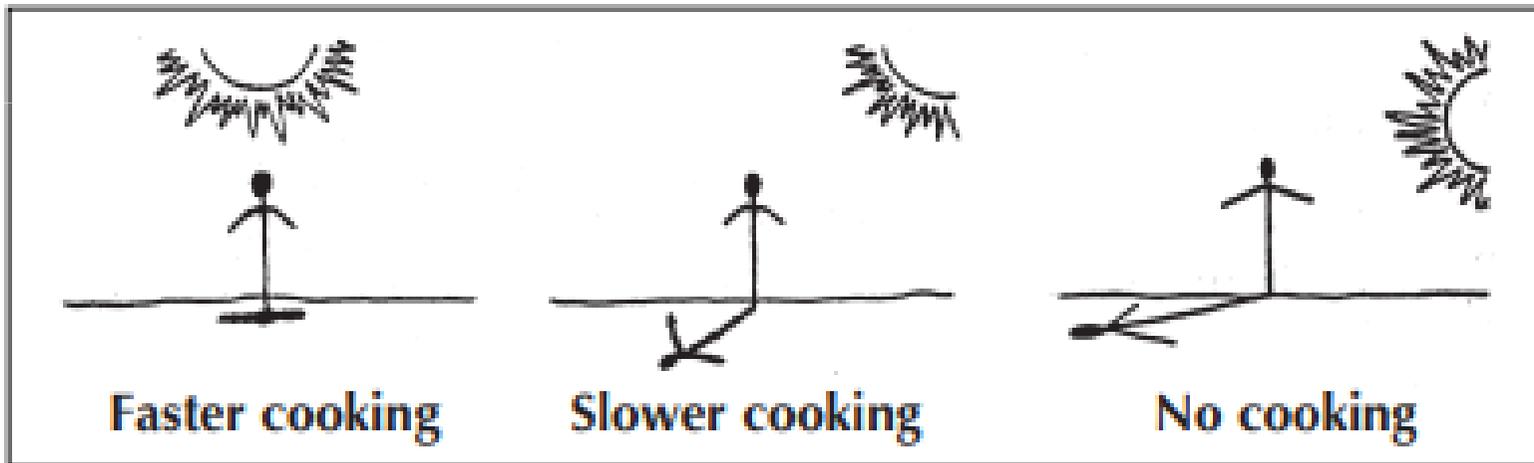


Where we live



Challenges of Solar Cooking in York

- Low sun angle in winter



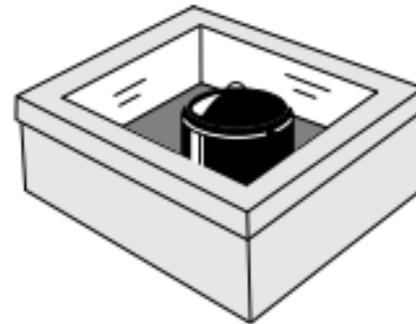
Graphic from SCI

Challenges of Solar Cooking in York

- Outside air temperature is low
- Heat gained from the sun can be lost
- Days with clear blue skies mixed with clouds

Challenges of Solar Cooking in York

- Glass allows short wave radiation from the sun through
- Glass blocks long wave radiation from bodies heated up by the sun



Challenges of Solar Cooking in York

- Heat loss by convection and conduction must also be prevented
- Good insulation is key to retaining collected heat

Enter the vacuum tube solar cooker



Slick SM70 cooker

Using the Slick SM70



Food cooked in the Slick in UK Latitude of 54 deg North



Baking baguettes in January



Another Solar Cooking solution

- For cloudy or rainy days
- Use in the evenings
- For use indoors

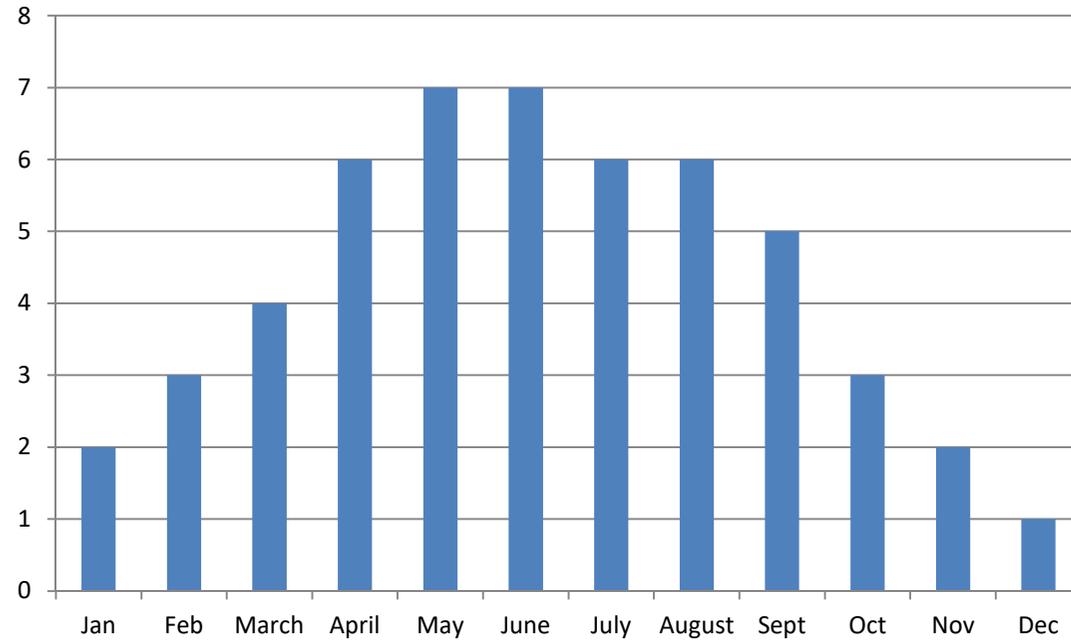
Cooking with stored solar energy

- Harnessing Solar Energy
 - Photo Voltaic (PV) Panel
 - Solar Charge Controller
 - Battery
- Cooking with a battery
 - Heating Pad
 - Insulated Box
 - Temperature Control
 - Timer

Cooking with stored solar energy

- Is this efficient?
- Is it Solar Cooking?
- Does it work?

Average hours of sunshine per day in the UK



Harnessing solar energy

- 100 W Photo Voltaic (PV) Panel
- Average energy harvested per day (in the UK):
 - Summer is 50 Watts over 6 hours = 300 Watt hours
 - Winter is 50 Watts over 2 hours = 100 Watts hours



Battery to store energy

- 110 Ah Leisure Battery
- Total stored energy 110 Ah x 12V
 - 1320 Watt hours
- Usable energy (50%)
 - 660 Watt hours



Charge Controller

- Interfaces between the PV panel, the battery and the load.
- Prevents the battery over-charging and over-discharging.
- Will protect battery from total discharge
- Lengthens battery life of Lead Acid battery.



Connecting up



Cooking with a Battery

- 120 Watt heating element
- These are designed for 3D printer heating beds, but are ideal for our cooker.
- 12V operation
- Waterproof
- Will stand temperatures up to 200 deg C
- Easy to wire up
- Low cost and widely available



5.5 hours of cooking time using 1 leisure battery

Charging and cooking times

PV size (Watts)	100	200	200
Battery Capacity (Ah)	110	110	220
Energy (Watt Hours)	660	660	1320
Time to charge (hours)	13	6.5	13
Cooking time (hours)	5.5	5.5	11

Making your own 12 V Slow Cooker

- Heating element
- Insulated Box
- Conventional Slow Cooker consumes around 500 Watts
- 12 V Slow Cooker only takes 120 Watts
- So its possible to power from a Solar charged battery

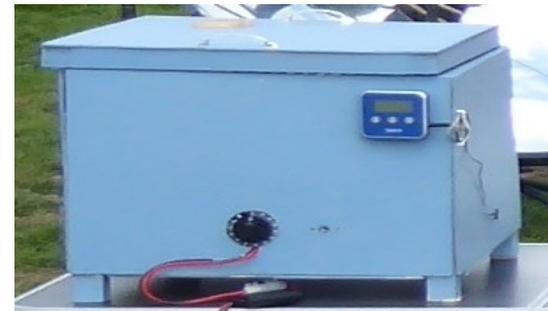
Insulated Box – Mark 1

- Made with cardboard box
- Kingspan Insulation
- Lined with cardboard on the inside
- Covered with aluminium foil.



Insulated Box – Mark 2

- Made with wood
- Rockwool insulation
- Stock pot set into the box
- Metal lid with insulation on top



Insulated Box – Mark 3

- Made with wood
- Rockwool insulation
- Metal box for cooking in
- Hinged door



Hints and Tips

- Keeping the heating pad in contact with the cooking pot
 - Will maximise heat transfer and cooking power
- Using a Dutch Oven
 - Nice even cooking
 - Makes baking easier



Hints and Tips

- Always have a thermal load on the heating pad when it is on
- For example a dutch oven
- This stops it from overheating
- This is the same as turning on an empty microwave!
- This will extend the life of the heating pad

Hints and Tips

- Adding a timer control
 - Will prevent the battery draining by accident
- Adding a thermometer
 - Monitor cooking temperature



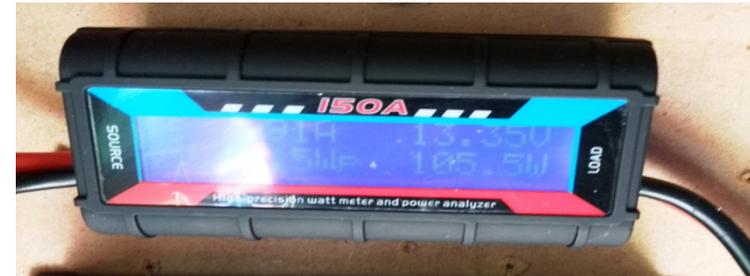
Hints and Tips

- Using a Watt Meter
- Allows you to monitor battery status and power consumption
- If you have 2:
 - Add one between PV and charge controller
 - Another between charge controller and heating pad



On a sunny day

- Solar power into battery
 - 105 Watts
- Cooking power out of battery
 - 122 Watts
- Nett power from battery
 - Only 17 Watts



Cost of basic system

• 100 W Photo Voltaic (PV) Panel	£100	
• 110 Ah Lead Acid Leisure Battery	£120	
– (5.5 hours cooking time)		
• 10 Amp Charge Controller	£10	
• 120 Watt heating element		£10
• Insulated Box		£10
• Miscellaneous items		£10
• Total Cost	£230	£30

Solar Cookers – cooking power

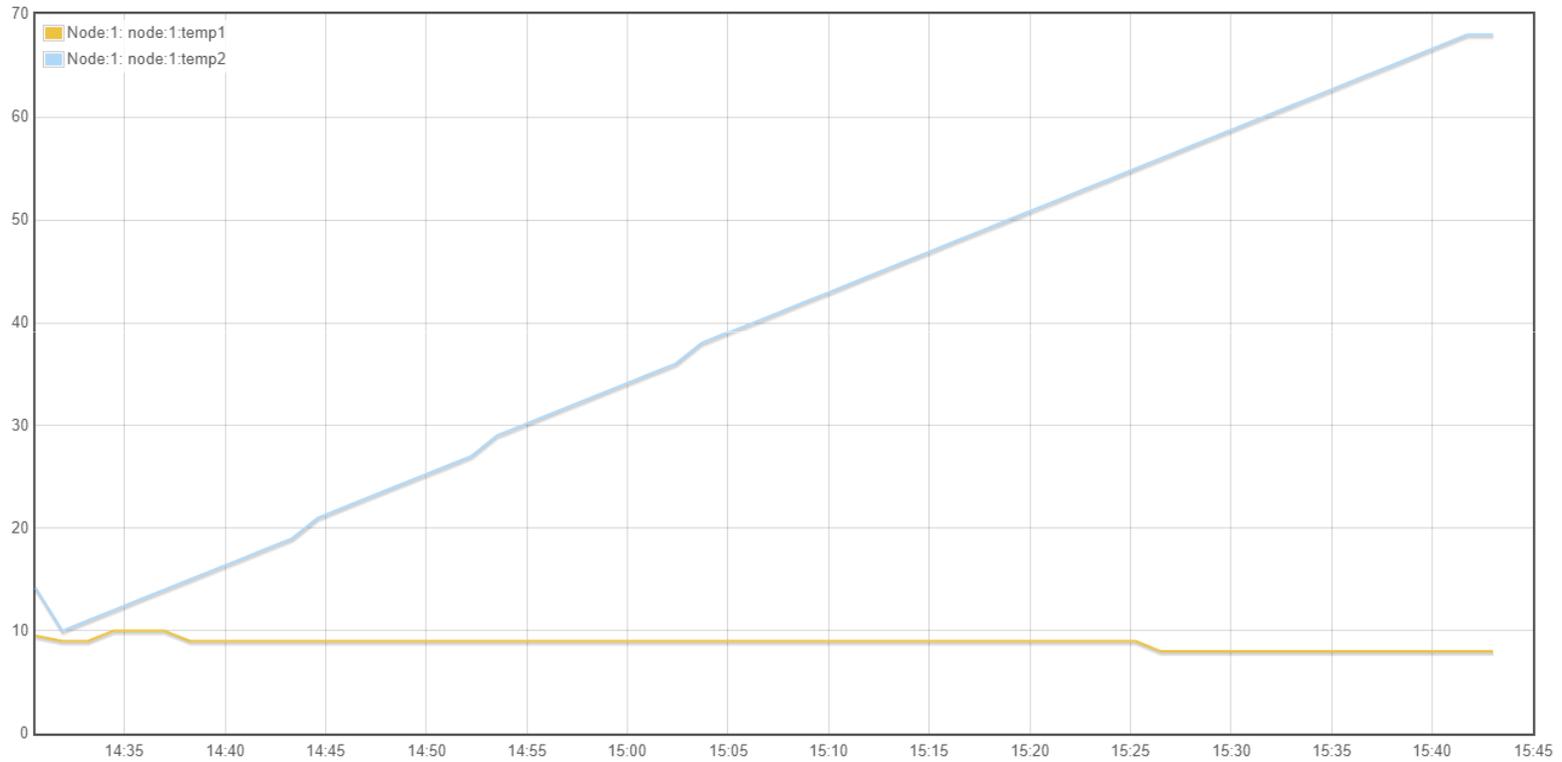


Solar Box Cooker and Panel Cookers have a cooking power of about 50 to 60 Watts

Measuring cooking power

- Water heating test (Dave Oxford shortcut method)
- Heat 1 litre of water in cooker
- Monitor water and ambient temperature
- When temperature differential is greater than 50 deg C
- Monitor temperature rise over 10 minutes
- Cooking power = temperature rise in 10 minutes multiplied by 7

Cooking with a 100 watt heating pad



Cooking power of 12 V Cooker

- Powered from 12V Battery – power measured as between 90 and 110 Watts
- Power at 66 deg C: Temperature rise of 8 deg over 10 minutes – so 56 Watts
- Power at 50 deg C: Temperature rise of 8 deg over 10 minutes – so 56 Watts
- Outside temperature = 15 deg C
- So cooking power is 56 Watts

What can you cook?

- Rice
- Stews
- Curries
- Bread
- Cakes and scones
- Biscuits



Cooking rice

- Use 25% less water
 - 1.5 cups of water to 1 cup of rice
- Heat water up for 30 to 45 minutes
- Then add washed rice
- Cook for 2 hours



Baking bread - results



Bread dough recipe

- 250 gms bread flour
- 1 tsp salt
- 1 tsp sugar
- 2 tsp quick yeast
- 1 tbsp oil
- Mix into dough using warm water
- Form into bread loaf
- Leave to rise until double in size

Baking bread



Baking bread - method

- Pre-heat cooker for 30 to 45 minutes
- The dough goes on non-stick paper
- Use a trivet to raise the dough off the base of the pan
 - If the bread touches the base it can burn
- Cook for 1.5 to 2 hours
- Check if cooked by knocking the base – it will sound hollow when ready.

Bean Stew

- Add chopped onions and crushed garlic to some oil and heat in pan for around half an hour
- Meanwhile, chop available vegetables (carrot, courgette, pepper, sweet potato, aubergine) into 1 cm cubes.
- Add chopped vegetables, stock, small tin of beans, tomato puree and seasoning to the onions and cook for around 2 to 3 hours.

Bean Stew

- Vegetables cut small will cook quicker
- Make sure that liquid level is below the vegetables
 - Always use less water than normal



Commercial 12V cookers

- Roadpro
- Moulded plastic construction on the outside
- Moulded metal on the inside
- Power consumption 70 to 100 Watts
- Cooking power 56W
- Looks like made in China
- Circa £50



Dishes cooked in the Roadpro

- Stewed fruit
- Pineapple upside down cake



Commercial 12V cookers

- Travel Buddy Marine Oven
- Stainless steel construction
- Power consumption 100 Watts
- Timer control
- Temperature control
- Cooking power < 20 Watts
- Mainly for warming up
- Made in Australia
- Circa £200



Benefits of cooking with stored solar energy

- Technology is here and now
- Parts are widely available and prices are coming down fast
- Easily understood and maintained
- Can cook indoors, on cloudy days and in evenings
- Modest cost
- Can be made in most parts of the world locally
- Doubles up as a 'haybox cooker'

12 V Slow Cooker as Haybox Cooker



Wrap the pot in a blanket and leave in 12 V Slow Cooker.
It will carry on cooking and stay hot for hours.

Solar Powered Slow Cooker / Oven at the Green Gathering 2019, Wales

