Cooking for a Healthy Climate

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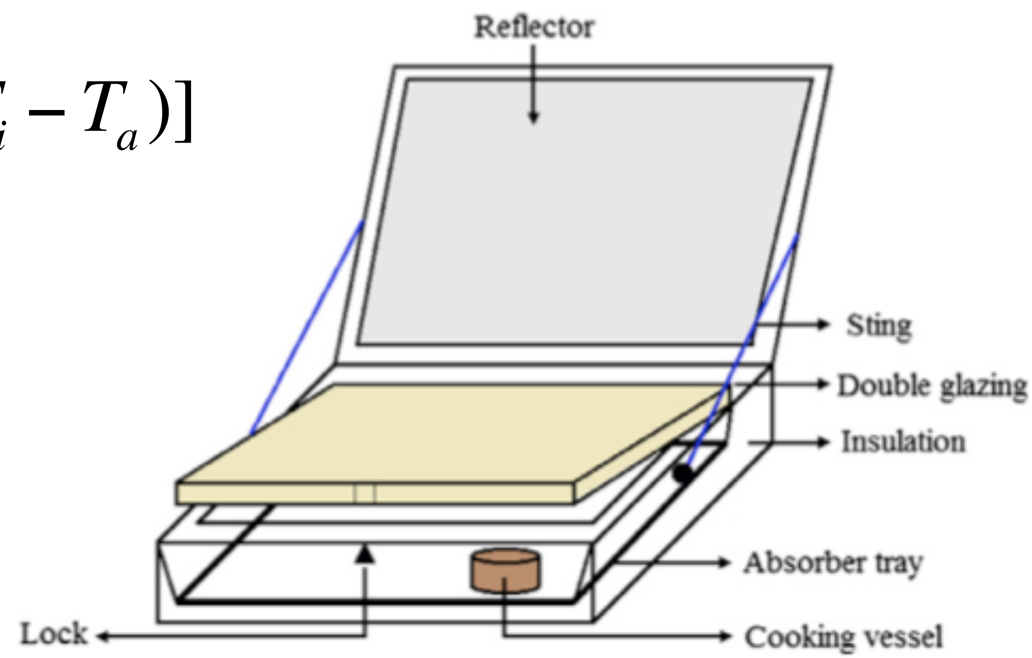
Biomass Cooking Reinforces Poverty

- Over 2 billion people around the world cook with biomass fuel (i.e. wood, dung, crop residues)
- Contributes to massive deforestation, respiratory ailments, and anthropogenic climate change
- Time/money spent gathering fuel contributes to inequality

The Solution: Solar Cookers

Hottel-Whillier-Bliss Equation:

$$Q_u = FA[I\tau\alpha - U_L(T_i - T_a)]$$



- Boils 1L water in 1 hour
- Cooks family meal in 2-4hrs
- No fuel
- **No greenhouse gases**
- **Cost ≈ $100: prohibitive**

Carbon Credits?

Emissions Savings Calculations

1. Find reduction in fuel consumption

2. Calculate greenhouse gas emissions per amount of fuel
    – *Carbon Balance Method*

3. Adjust for fuel renewability

Carbon Balance Method

$$\Delta m = \Delta C / f_C$$

$$\Delta C \approx C_{CO_2} + C_{CH_4} + C_{TNMHC} + C_{TSP} + C_{CO}$$

$$\frac{\Delta C}{C_{CO_2}} \approx 1 + \frac{C_{CH_4}}{C_{CO_2}} + \frac{C_{TNMHC}}{C_{CO_2}} + \frac{C_{TSP}}{C_{CO_2}} + \frac{C_{CO}}{C_{CO_2}}$$

Measure *ratios* of each emission to carbon dioxide, normalize to total amount of carbon lost

Normalize to global warming potential (GWP) of carbon dioxide:

CO_2 = 1
CO ≈ 1.9
CH_4 = 23
TNMHC = 4.1
TSP = ? (potentially large)

Adjust for fuel renewability

- Some carbon released during combustion is offset by new plant growth

$$GWP_{renewable} = GWP_{non-renewable} - GWP_{CO_2}$$

- Renewability determined by supply vs. demand
  - Demand = household consumption
  - Supply = ecological productivity

UN Simplification…

1. Emissions = Consumption x 29.9 tCO_2/MJ fuel

   assumption 1

2. Consumption = Solar energy produced x fuel energy content

   assumption 2

3. Solar energy produced = Standard power output x time used

   assumption 3

…or is it *Simply fiction?*

Measuring "Standard Power"

- Monitor temperature every 10min. as water heats up in oven from 40°C–90°C

$$P_s = \frac{m_w C_w \Delta T}{600s} \bullet \frac{700W / m_2}{I}$$

- Subtract from ambient temperature, take linear regression at $\Delta T = 50°C$
- **Conditions:** wind speed ≤ 1m/s,
  ambient temperature = 20-35°C,
  solar irradiance = 400-1100W/m^2,
  m_w = 7kg/m^2 intercept area,
  one black metal pot

Accurate model of real world?

Room for Improvement

- Great need for simple emissions calculation more accurate than UN method
  - Possible to determine power following cooking practices?
- Summer in Nicaragua!