Efficient Solar Electric Cookstoves for the Developing World

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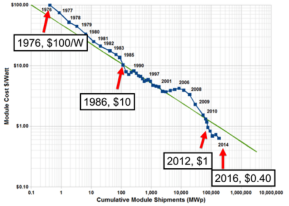
Problem

Photo taken in Uganda depicting the traditional three stone, biomass cookstove

- Three billion people cook using open-fire stoves fueled by biomass or coal [1]
- Four million people die each year from illnesses attributable to indoor cooking pollution [1]
- Exposure is highest among women and children
- Deforestation, GHG emissions of soot and CO_2, financial cost, violence from fuel gathering

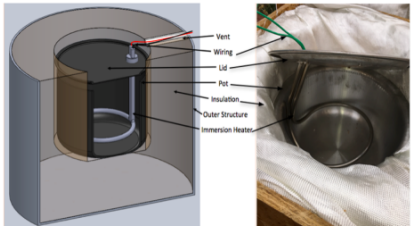
Solar Solution



Log graph illustrating the decreasing cost of photovoltaics from 1976 to 2016.

- The cost of photovoltaic (PV) solar panels is cut in half every five years [2]
- High power, solar electric cooking will ultimately be the preferred cooking for the poor but is currently too expensive
- Low power insulated cooking is *already* cost competitive

Design



CAD image (left) and actual design prototype (right) of an immersion heater ISEC.[3]

Insulated Solar Electric Cookstoves (ISEC) consist of three crucial components:

- Low power PV solar panel (~ 100 W)
- Electric Heating Element
- Thermal insulation (reduces heat loss)

Collaborators

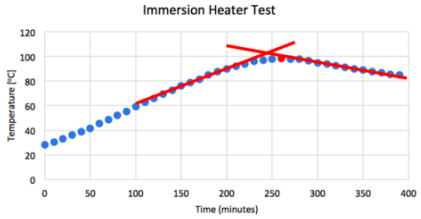
Beacon of Hope Secondary School, boarding and serving over 700 of Uganda's "most vulnerable youth"

- Newly formed cooking technology club
- Consistent email communication

Aid Africa Ugandan non-Profit with 13 years experience enhancing half a million lives with cooking technology, fruit trees, and clean water

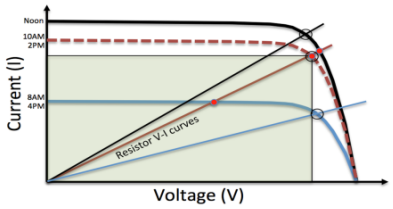
- Collaborative ISEC implementation with villages
- Subsequent monitoring of ISEC performance and use
- Certified with UN CO_2 Market

Data



Temperature data collected from an ISEC cook test our team performed to cook 2.7 kg of stew.[3]

- Solar panel specifications: Power = 100 W, Working Voltage = 18 V, Working Current = 5.6 A
- 2.7 kg of stew boils in 260 minutes, Powers off at red data point
- Calculate thermal power at 90 °C:
  - Heating:19.2 °C /hr corresponds to 60 W absorbed power
  - Cooling: 6.7 °C /hr corresponds to 21 W thermal loss
  - Total power = 81 W, corresponds to heating efficiency of 74%



Available current from our solar panel changes during the day depending on the angle of the Sun. To maximize heat from our electric heater, we must match the resistance to account for optimal and nonoptimal conditions.

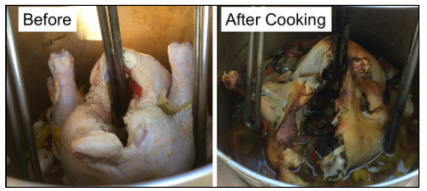
- Power optimization requires different heater resistance (straight lines) for different solar conditions
- Two filaments allows for 4 different resistances covering a wide range of solar conditions

Implementation

Shows ISEC recipient, Rose, with her ISEC 3 weeks after the initial implementation (left). Photo taken at ISEC implementation, Uganda 2016 (right).

- 2016 research trip with collaborative design and building
- Using locally available materials,120 Watt ISEC cost $110

2018 Plans



Before and after cooking in ISEC in California.

- Practice cooking with ISEC in California
- Implement ~200 ISECs and large ¼ ton capacity at BOH
- Establish education programs
- Follow up implementation with technical support and surveys
- Exploring design improvements around:
  - Device charging capabilities when stove is not being used for cooking

Bibliography

1. Household air pollution and health. (n.d.). Retrieved August 09, 2017, from http://www.who.int/mediacentre/factsheets/fs292/en/
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3. Insulated Solar Electric Cooking – Tomorrow's healthy affordable stoves? (2017). Retrieved August 16, 2017, from http://www.sciencedirect.com/science/article/pii/S2352728516300653