Bridging the Affordability Gap: Enabling Rural Malawian Ownship of Off-grid Solar-electric Cooking Systems

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Bridging the Affordability Gap:

Enabling Rural Malawian Ownship of Off-grid Solar-electric Cooking Systems

Robert Van Buskirk, Ph.D.: https://solar4africa.org

Kachione Timeline

2015 – Kuyere! Founded for solar lighting

2017 – Solar lighting systems training – Rachel & Christina attend

2018 – RVB starts import of solar pump & irrigation

2019 – 120 data loggers for ISEC monitoring, 90 150 W solar panels, and 1000kg of phase change material purchased.

Malawian-made (ISEC) Solar Electric Cooking - TRIID Challenge Fund project

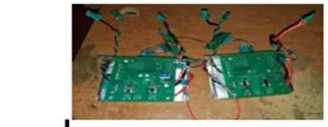
2020 – Breakthroughs
1. Battery work starts
2. MECS award for solar home systems with cooking
3. Solar pump systems break even

2021 – The first, of 15, solar shops is built and starts selling, Lundu

Cooking demos start

Solar tuktuk arrives

24 cooker systems sold, 50 PV panels delivered (Lundu)



Rebranded as Solar 4 Africa

2022 – LTO battery work begins in earnest – Stamford student, Skylar Selvin, designs circuit

Solar battery cooking tests

Rachel and Christina establish shop deliveries

Additional MECS funding for women's empowerment

M'bangombe village shop

2023 – Solar cooked food business model trials

July 2023 -200 women's groups bought $20,000 of solar panels, aiming for 600 groups by November

November 2023 – 16 solar shops

January - 1800 DC EPCs arrive!

2024 – **Affordable Solar for Villages** - NGO to support expansion

April, Malawi MoE endorse distribution of 15,000 off grid solar systems

19 August 2024 – the import costs of 650Wp direct-use cooking system is $160

Production run of 400 batteries planned for November/ December

Publication: **Hot diodes! Dirt Cheap Cooking and Electricity for the Global Poor?**

Publication: **Removing barriers and promoting demand-side energy efficiency in households in Sub-Saharan Africa: A case study in Ghana**

Publication: **Estimating the "Willingness to Invest" in Solar Home Systems with Cookers for Rural Households in Malawi**

Publication: **Customising Malawi-made solar electric cooking technology and business models to provide access to very low income villages**

Publication: **A simplified method for calculating the levelized cost of energy (LCOE) using amortization factors**

Publication: **How to Make Off-Grid Solar Electric Cooking Cheaper Than Wood-Based Cooking**

Publication: **Empowering Efficiency: Distributing off-grid solar electric cooking systems using women-lead organizing in rural Malawi**

Our Base Solar Cooking System has 3 Components

$80 Bulk Procurement Cost

One 655W Solar Panel

+

Maximum Power Point Tracking (MPPT) 600W Controller

$30 Bulk Procurement Cost

+

$40 Bulk Procurement Cost

DC Insulated Electric Pressure Cooker

Cooking System Bulk Procurement Cost as low as $150

Delivered Cost of about $300

Outline

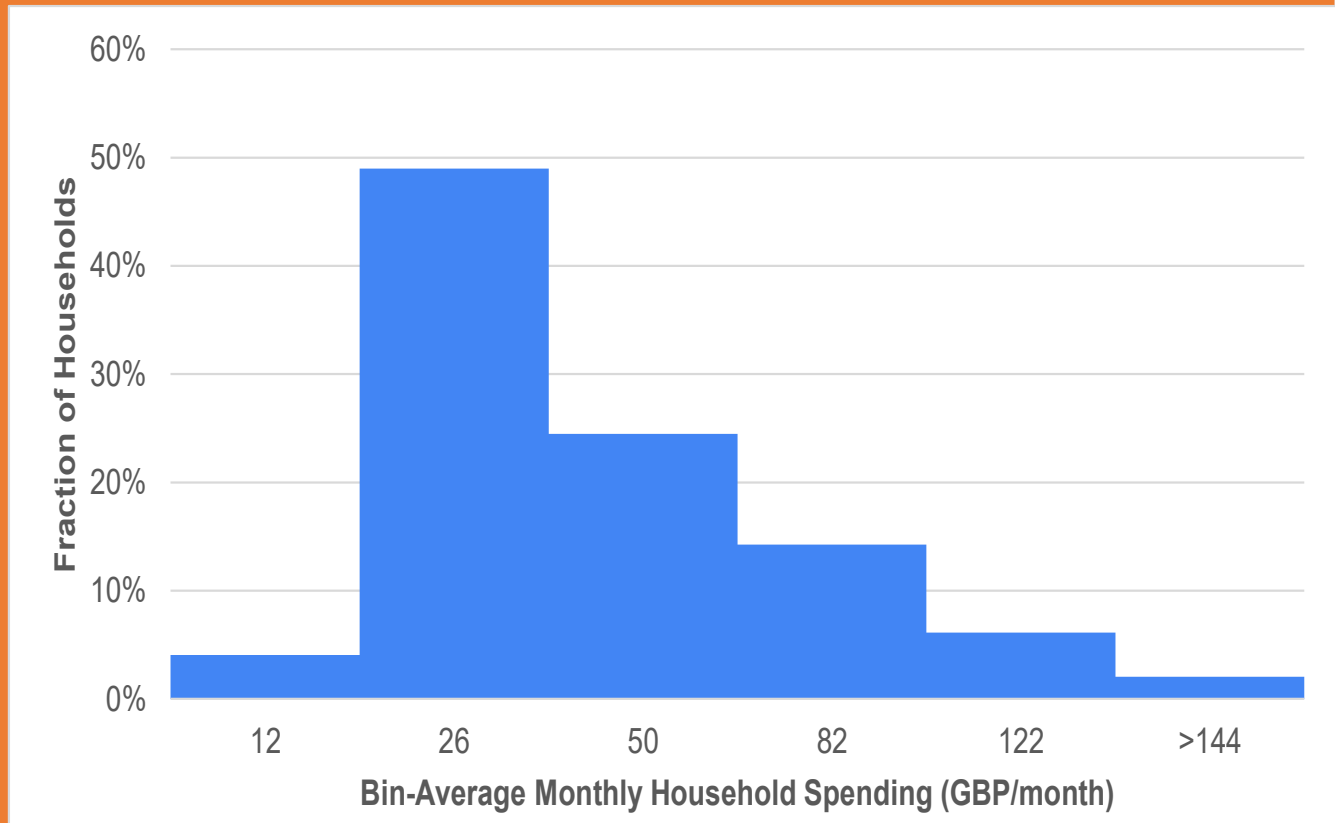
- Household economics
- Diet and cooking
- Energy intensity of cooking
- Sales & pricing
- Field performance
- System upgrade options
- Options for bridging the gap
  - “Efficient” subsidies
  - Serving urban customers
  - Cross-subsidizing
- Questions we hope to answer

Household Economics: VERY Low Cash Spending

Most rural customers are subsistence farmers who grow 70% of the food that they eat.

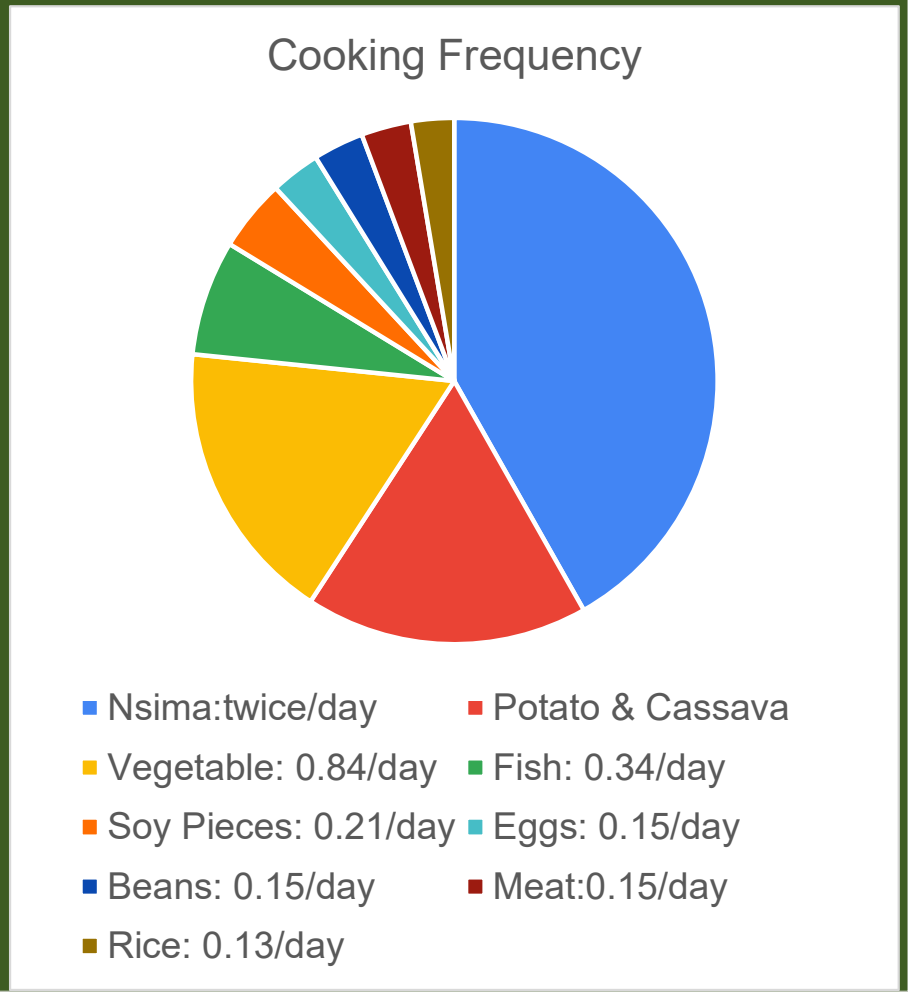
They typically have an annual harvest in April to June and may wait until August to December to sell their harvest for cash.

They invest after selling their harvest



80% of Food Cooked is Starches and Vegetables

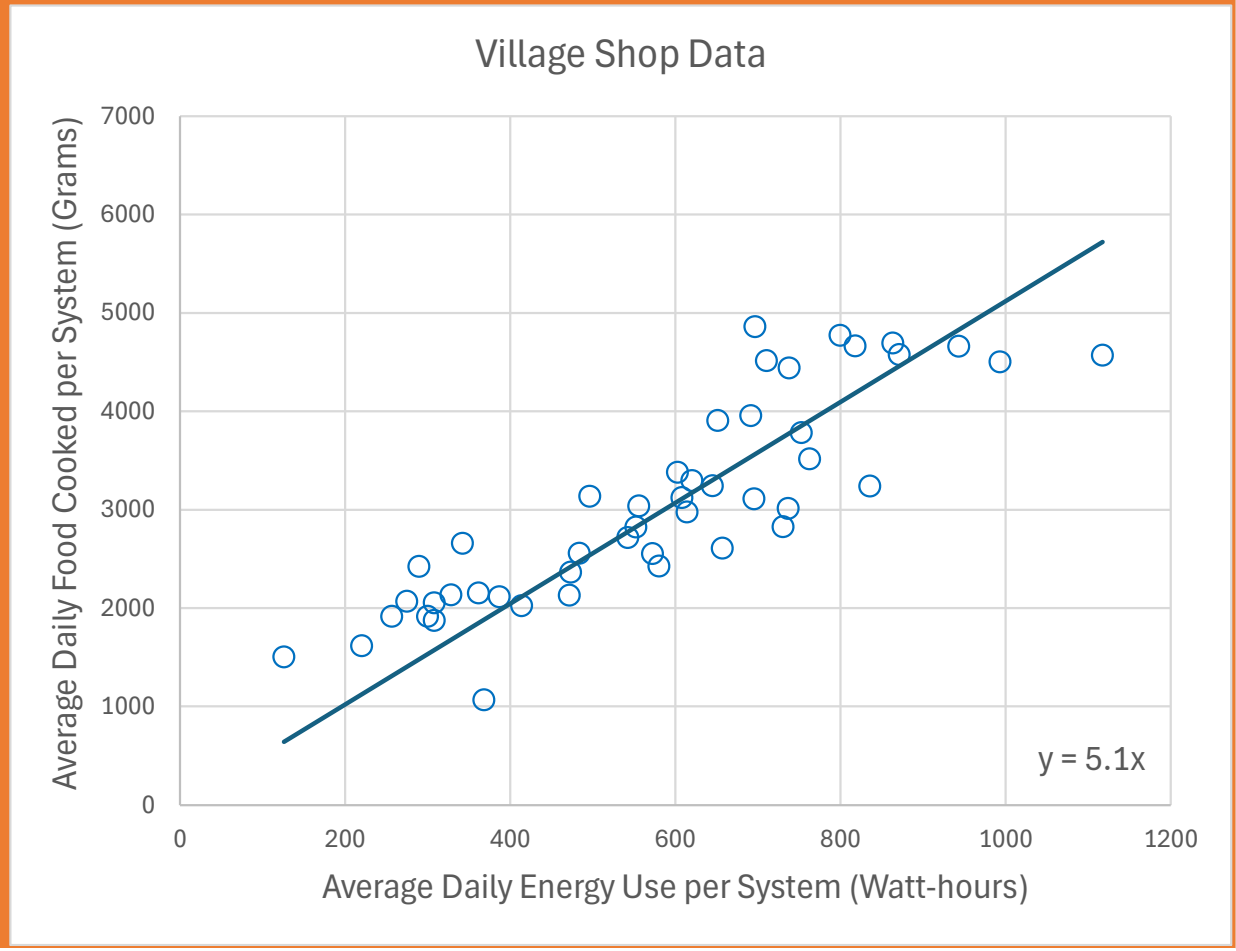
1. Almost half of food cooked is Nsima/Ugali
2. Beans are expensive, so are cooked only once per week on average
3. Because of Lake Malawi, fish is commonly eaten with Nsima
4. Sweet potatoes are also s very common part of the Malawi diet
5. Total cooking is about 5 to 6 dishes per day



Energy Intensity of Cooking is about 5g/Wh

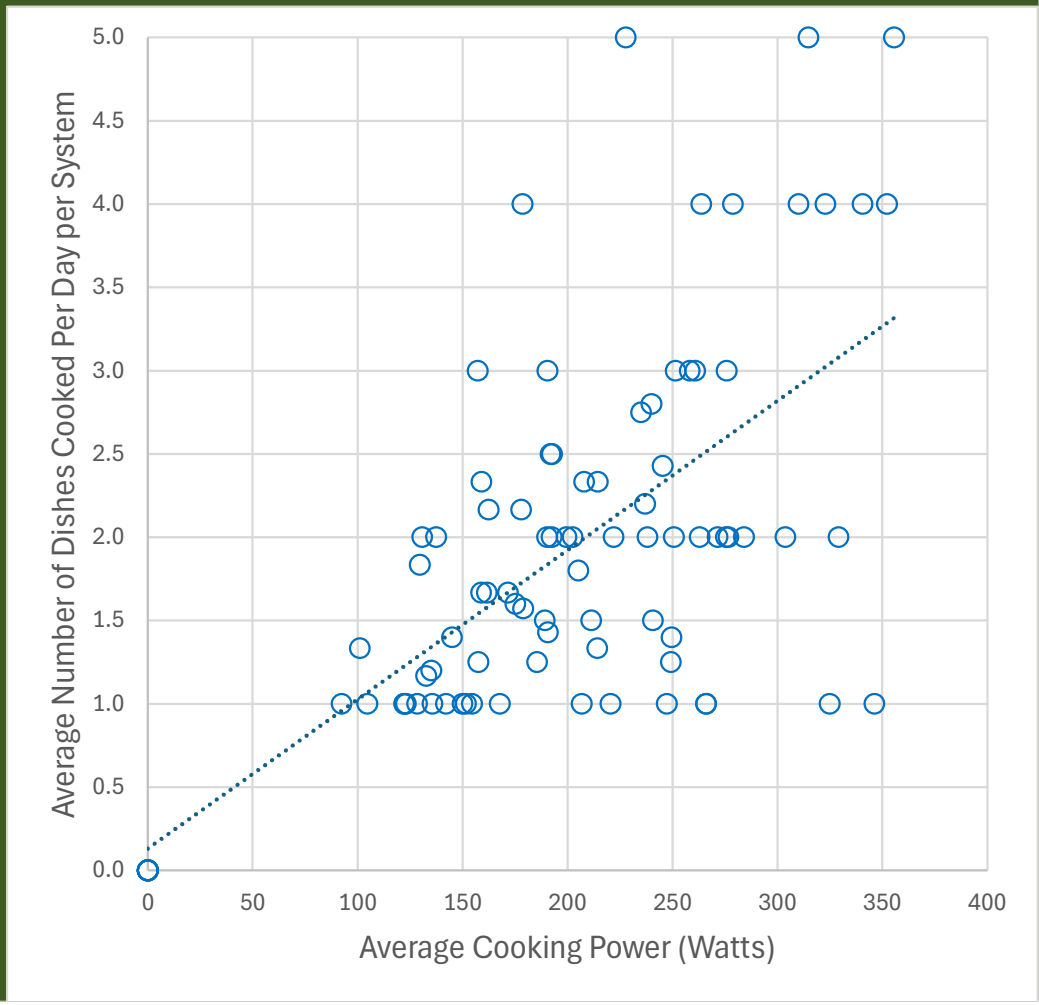
The 5g/Wh measurement is for rather efficient cooks. Less efficient cooks may be at about 3g/Wh.

Malawi food has about 1 calorie (i.e. 4 kJ) per gram, so the daily food requirement of 2000 calories has an energy requirement of about 400 Wh per capita



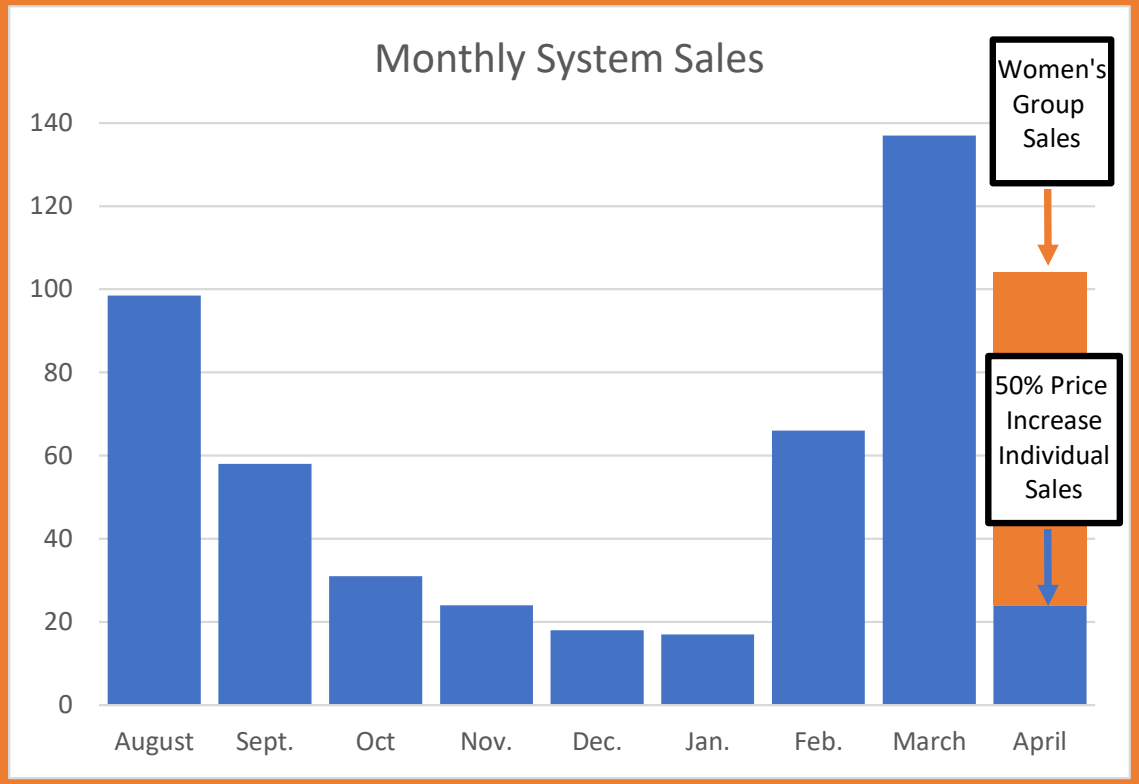
One 300W Direct-use Cooker Cooks 2 - 3 Dishes/day

- The data on the right is for cookers with about 350W of panel
- A 500W cooker with a 655W panel runs at about 300W on average.
- 2 - 3 dishes per day (at about 2 kg/dish) is about half of the cooking requirements of a typical household
- These numbers will be refined with field data from our current study.



Solar System Sales Depend on Season & Price

- Demand for off-grid solar-electric cooking systems is highly elastic and seasonal.
- An announced price increase leads to a rush of sales before the increase and a drop in sales afterwards.
- Women's groups use the systems better than individuals but require about an 80% subsidy for affordability

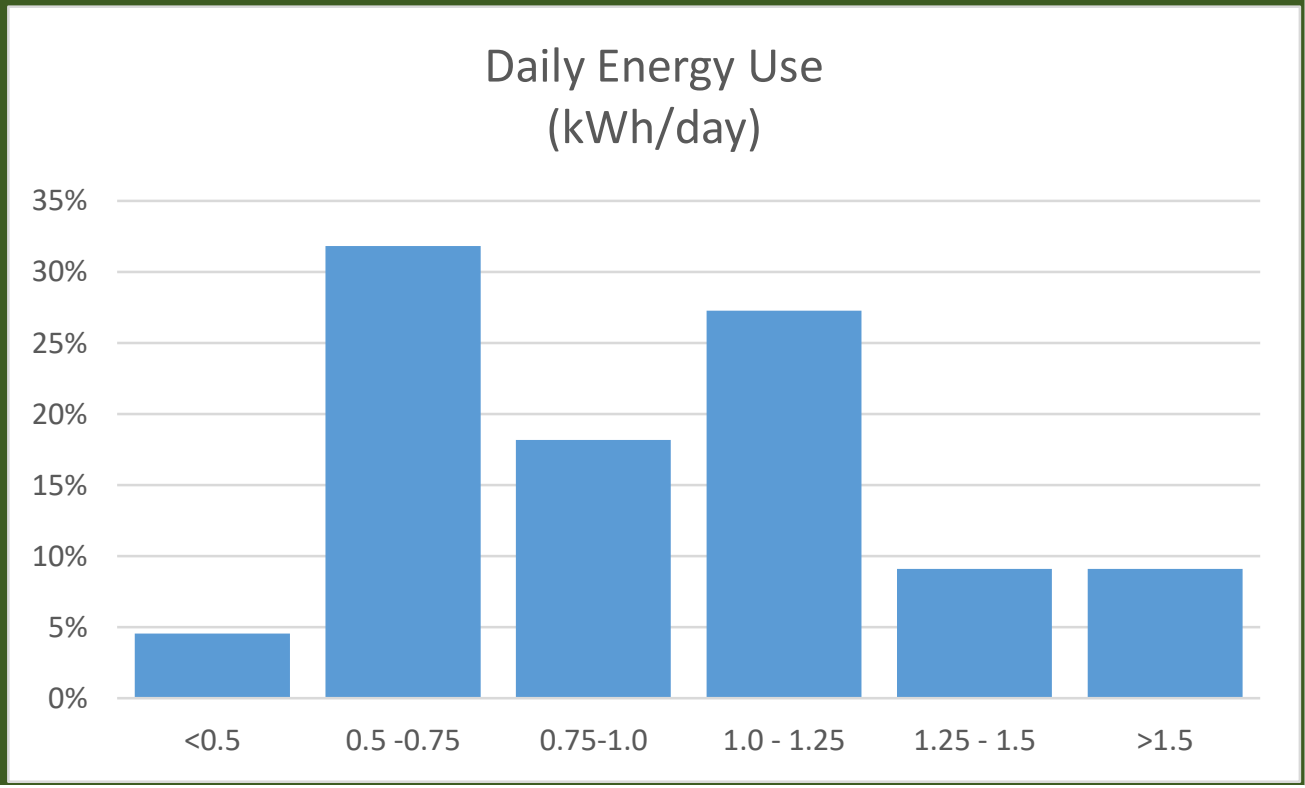


Women's Group Cooking System Utilization

Organized and motivated "women's group" customers initially appear to utilize the cooking systems very well at ~1 kWh/day for a 655Wp system.

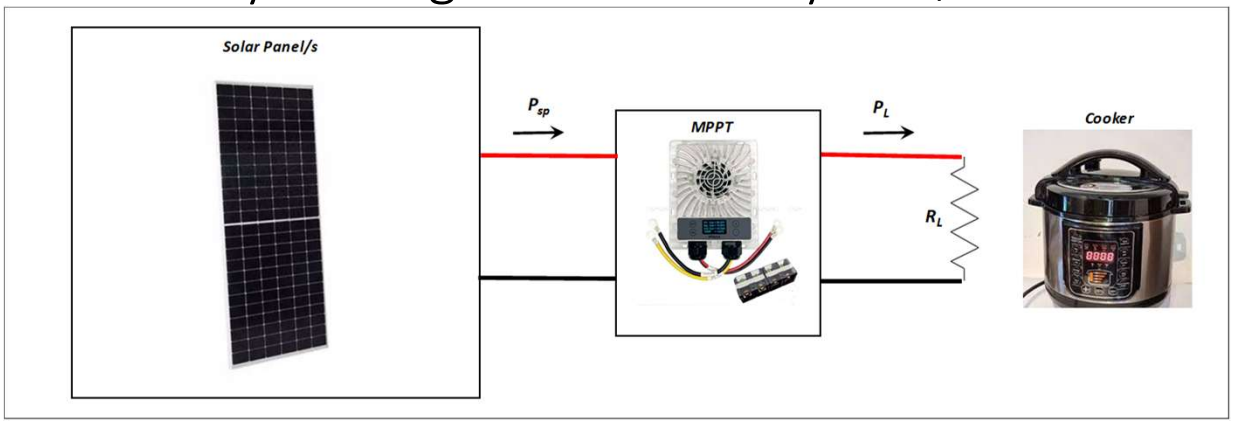
Visits to individual customers has revealed "spotty" utilization.

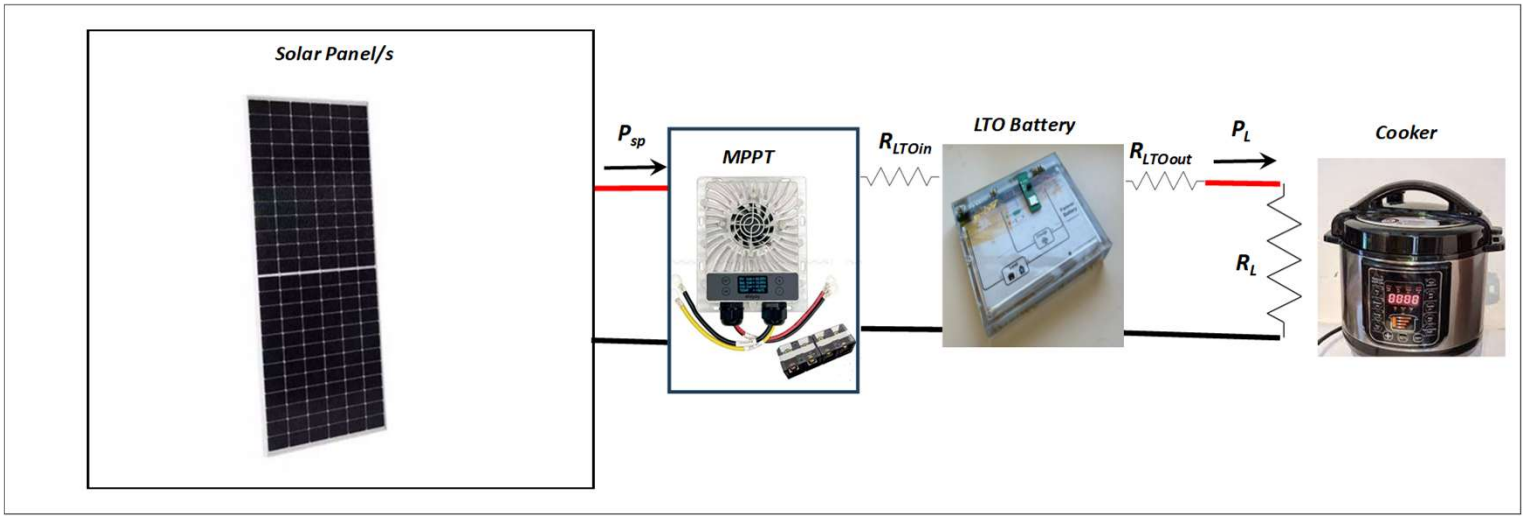
Many individuals appear to buy subsidized cooker systems because they want large solar panels for a low price.



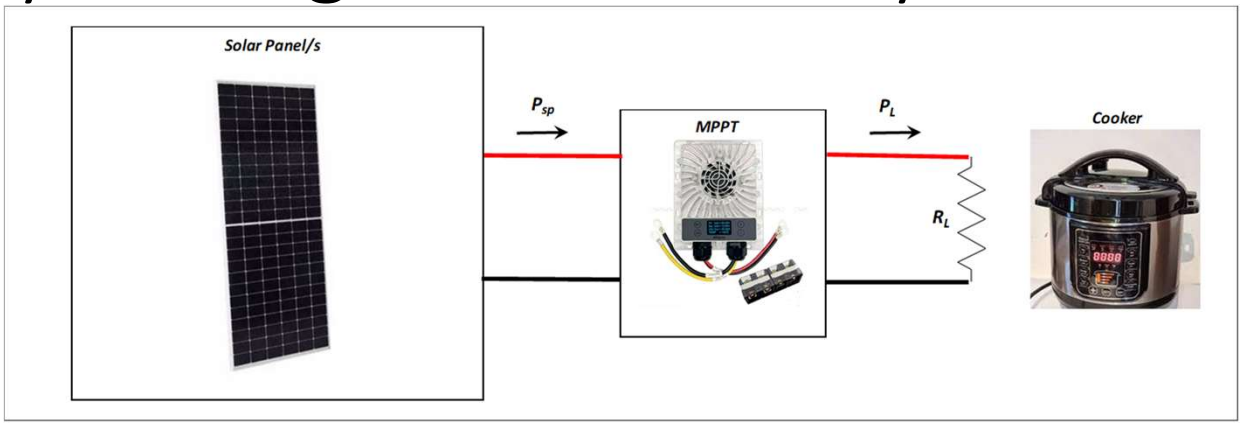
How do we increase use?:

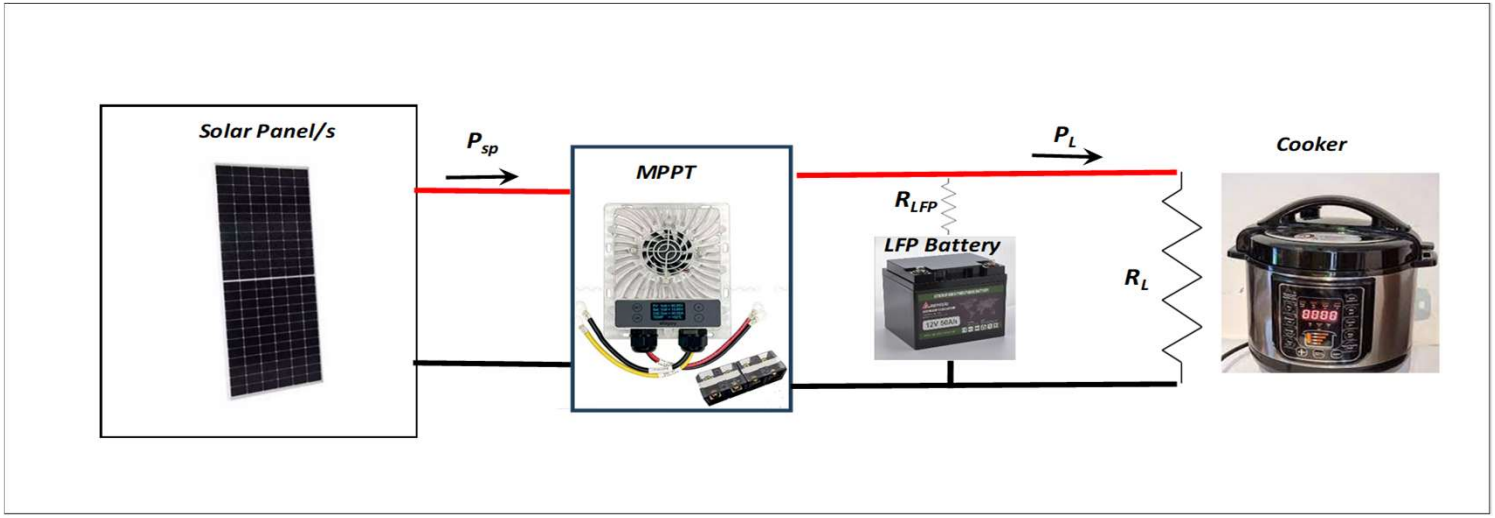
We can Upgrade the Base System by Adding an LTO Battery for $100



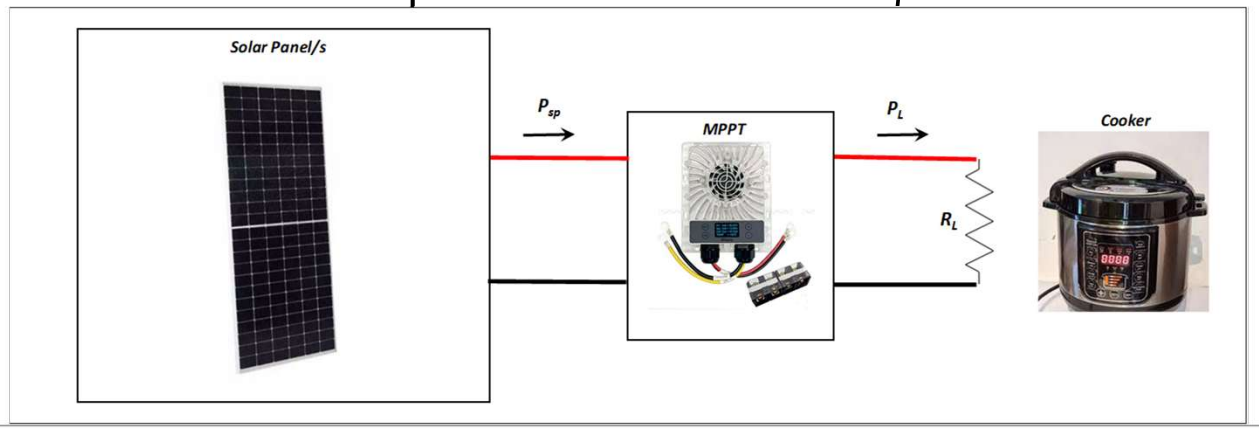


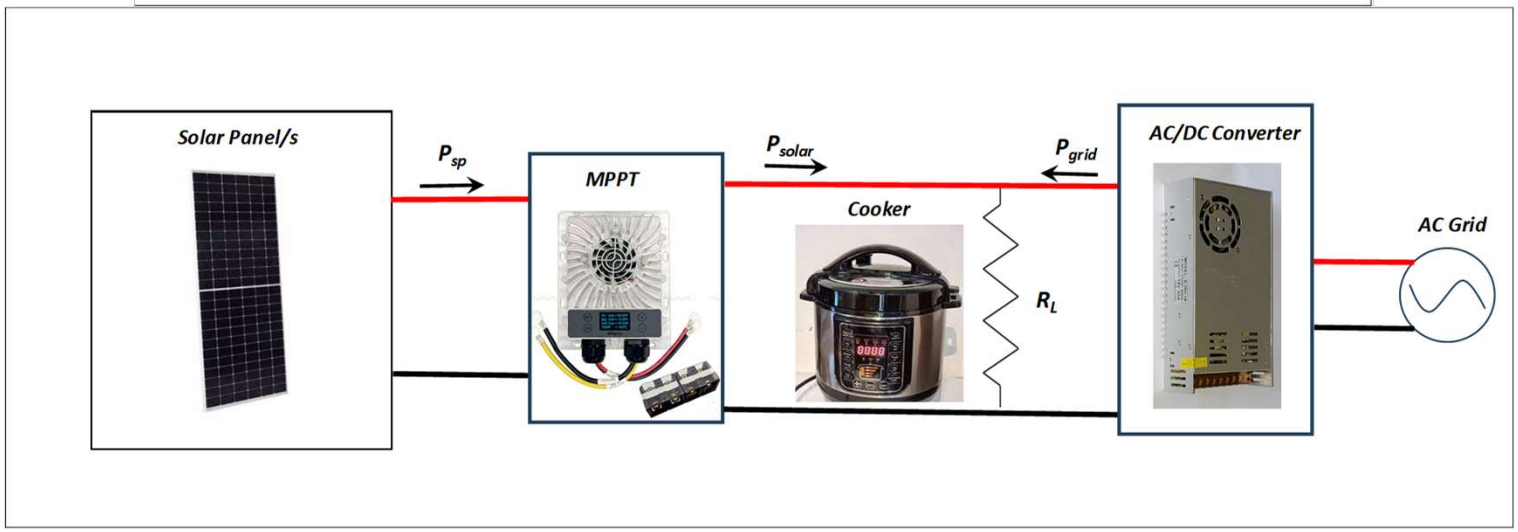
We can Upgrade the Base System by Adding an LFP Battery for $200





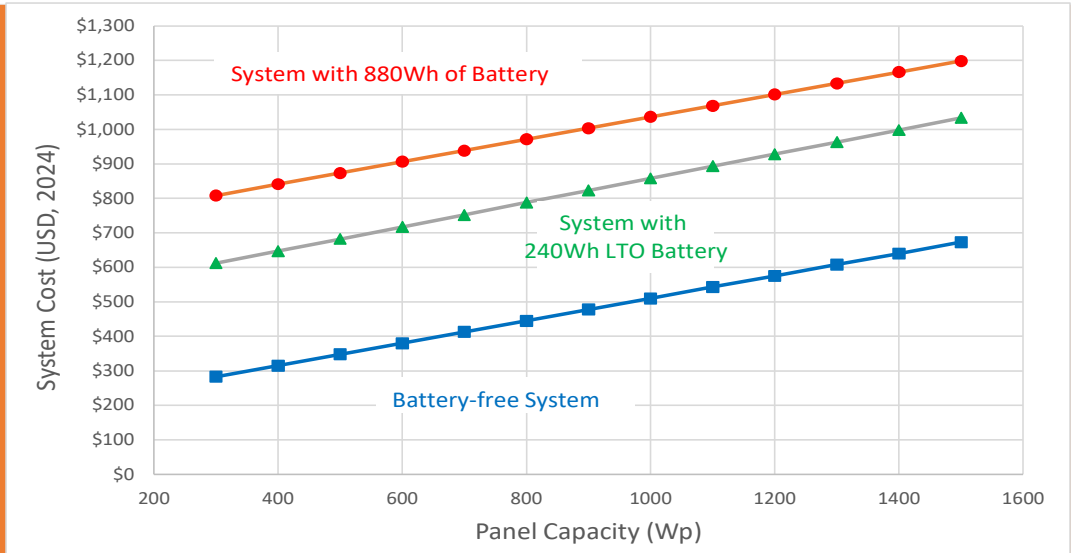
Or we can Upgrade the Base System
by Connecting to the Grid for $30,
or add more panels for about $100 each

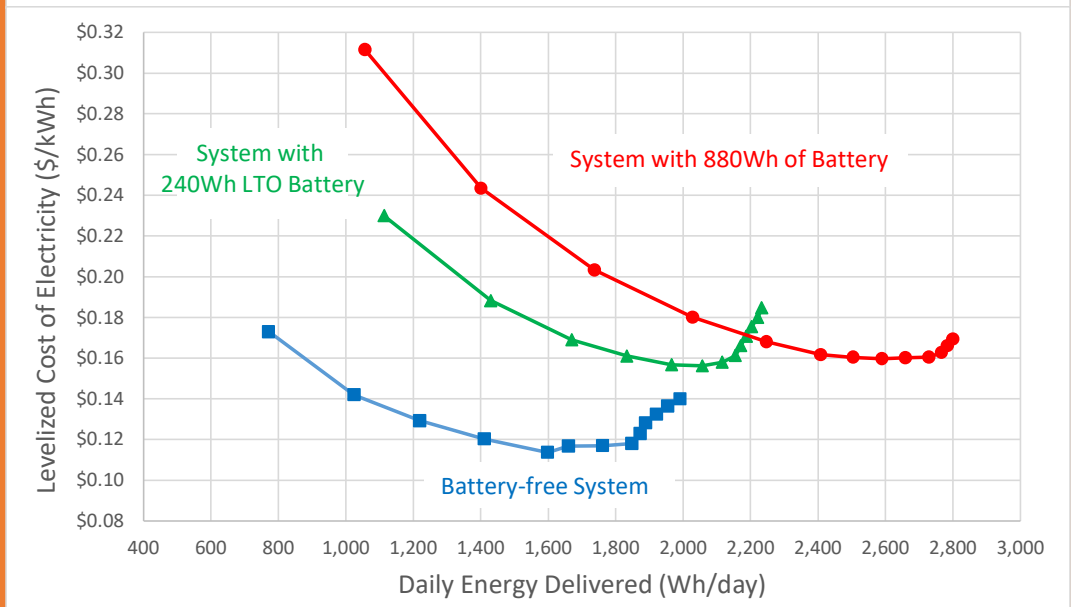




Costs for Different Systems

- The lowest-cost system is $300 to $400.
- The cheapest unit cost of cooking electricity is about $0.12/kWh.
- But people will want to add a battery, especially if they can get a discount.
- Cost of grid electricity in Malawi is $0.07/kWh.





We are now testing upgrades for select customer systems with a “loaned” LTO battery

To test the idea of doing system upgrades that can be subsidized with results-based finance, we are providing upgrade equipment “on loan”

After 6 to 12 months, the customer can buy the equipment at a discount based on use

Possibilities of an “Affordability Bridge”

1. A “$1 of subsidy for $10 of benefit” may be able to finance an “efficient” subsidy at about $0.10/kWh of use
2. System equipment “loans” and system upgrade discounts can be potentially financed with verified “efficient subsidies”
3. Or grid-connected systems may be reliable and inexpensive enough to be sold to wealthier urban customers without subsidy