CAPTURING THE EXPERIENCE OF ELECTRIC COOKING WITH ETHNO-ENGINEERING

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FUNDERS & PARTNERS

LOW COST TECHNOLOGIES

ECOOK MARKET ASSESSMENTS

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OUTLINE

- eCook, the ethno-engineering approach & why we need think INSIDE the box!
- The cooking diaries methodology
- Key learning points from:
  - Kenya, Zambia, Myanmar & Tanzania

COOKING WITH ELECTRICITY IN AFRICA & ASIA

COOKING WITH ELECTRICITY WILL SOON BE A COST EFFECTIVE OPTION FOR THE POOR.

EMISSIONS FROM BIOMASS ACCOUNT FOR 5% OF TOTAL GLOBAL WARMING

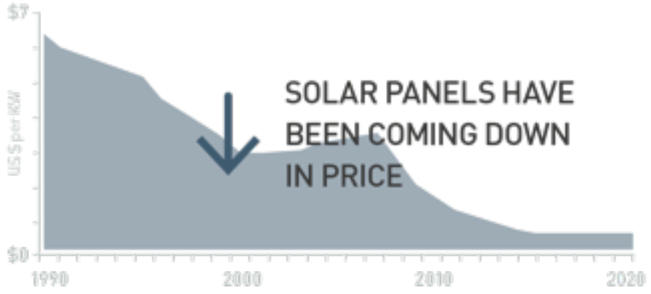
Gamos

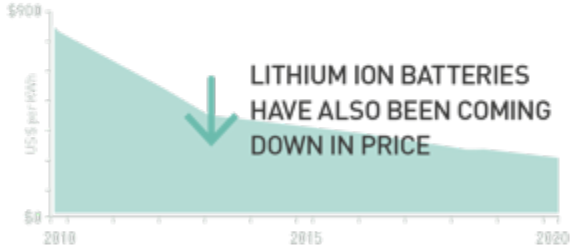
Batchelor (2013, 2015a)

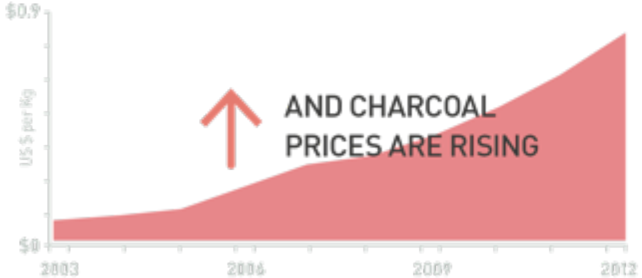
3 BILLION
COOK WITH BIOMASS WORLDWIDE

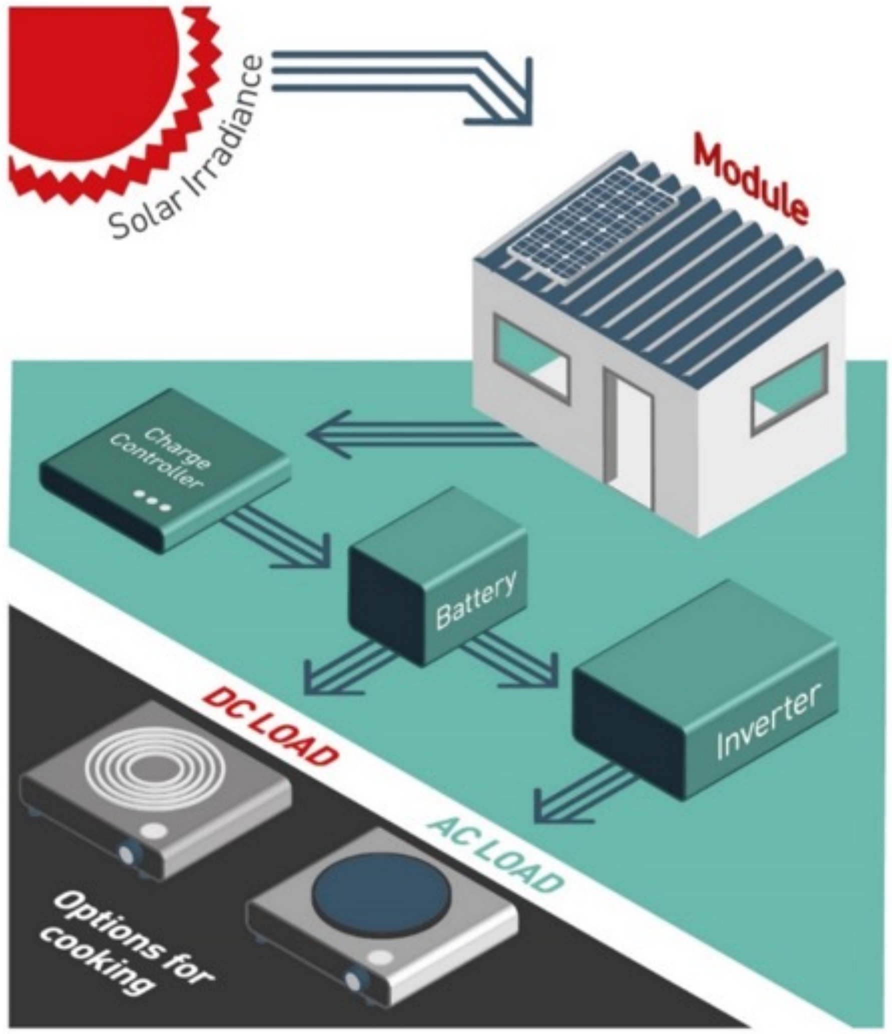
1.5 BILLION
PAY MORE THAN $10 PER MONTH TO COOK WITH BIOMASS

4 MILLION
PREMATURE DEATHS PER YEAR FROM ACUTE RESPIRATORY INFECTION AS A RESULT OF COOKING OVER WOOD AND BIOMASS







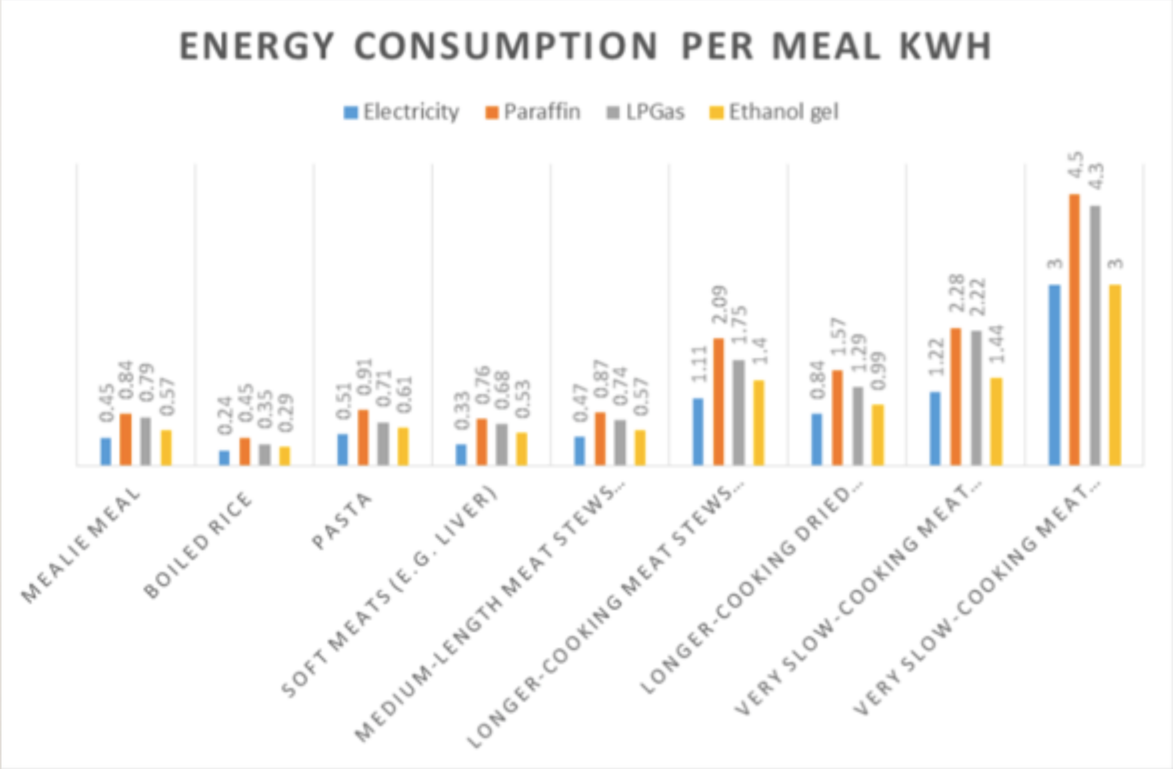


ETHNO-ENGINEERING

- Ethnography + engineering = ethno-engineering
  - Ethnography offers valuable insight into culturally distinctive processes of domestication of new technologies
  - Engineering reveals how they physically function
- Integrating the 2 disciplinary approaches can offer a more holistic & culturally informed understanding of technical solutions to social problems resulting in more effective interventions to alleviate poverty (Nye, 1990)
- Understanding and applying culturaly distinctive skills and practices in a participatory development process, carefully observing the resulting changes in community practices (Bastholm & Henning, 2014; Drackl√© & W. Krauss, 2011)

COWAN (2008)

- Identification of urban energy best practices
- Imizamo Yethu - informal settlement in South Africa
- "…at the present time there is a clear overall advantage in using electricity, where available. It is cheaper to use, safer and more controllable – from a householder's perspective, at current energy prices."
- "Imizamo Yethu Energy Cookbook"



NERINI, RAY & BOULKAID (2017)

- Levelised Cost of Cooking a Meal (LCCM)

$$\mathrm{LCCM}_t = \mathrm{LCCM}_{\mathrm{fuel}} + \mathrm{LCCM}_{\mathrm{stove}} = \frac{F_{\mathrm{ct}} * E_m}{\eta_s} + \frac{\sum_{t=1}^{n} \frac{I_t + O\&M_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{\mathrm{Ml}_t}{(1+r)^t}}$$

where:

- F_{ct} is the fuel cost in USD/MJ at the time t.
- E_m the final energy required for cooking a meal in MJ.
- η_s the stove efficiency [%].
- I_t is the stove investment cost.
- $O\&M_t$ are the stove operation and maintenance costs.
- Ml_t are the amount of meals cooked in the time unit (1 year).
- n is the stove lifetime [years].
- r is the discount rate [%].

NERINI, RAY & BOULKAID (2017)

- Nyeri County, Kenya

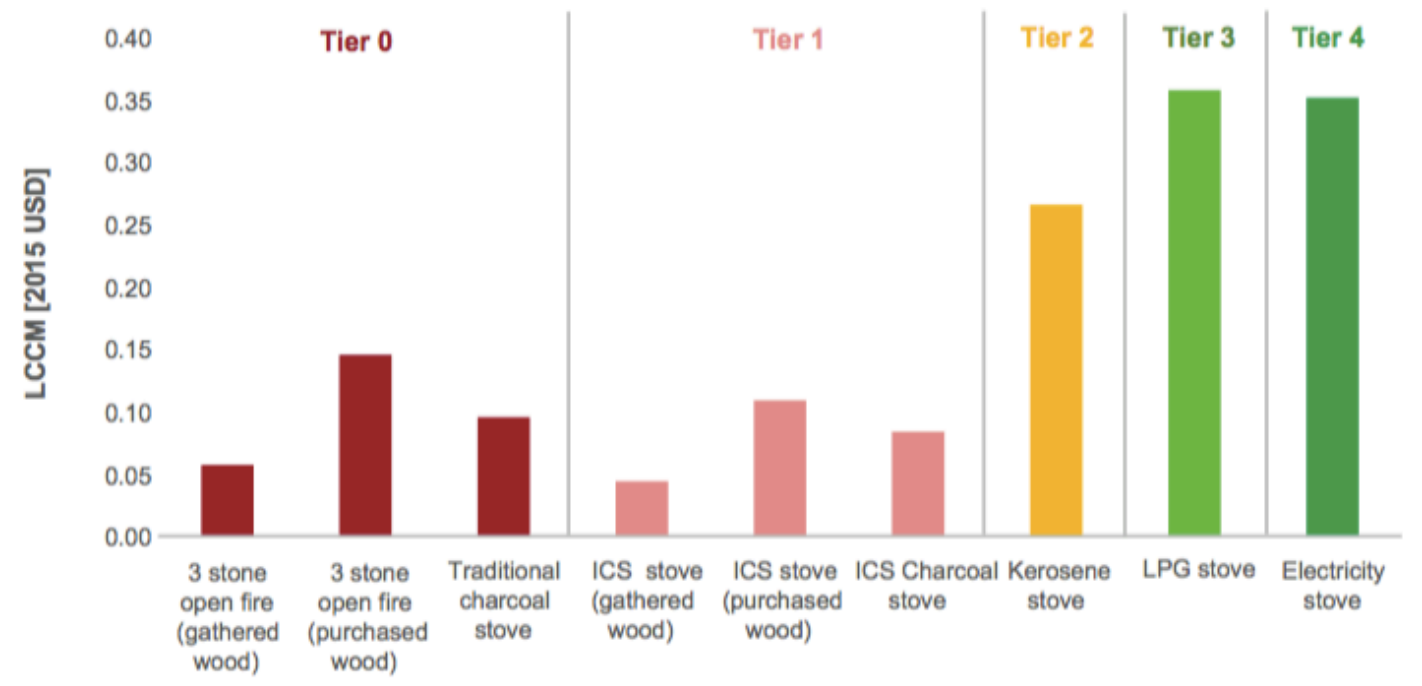


Figure 3. LCCM in the Nyeri County with selected technologies and for reaching different IWA tiers of cooking energy access.

NERINI, RAY & BOULKAID (2017)

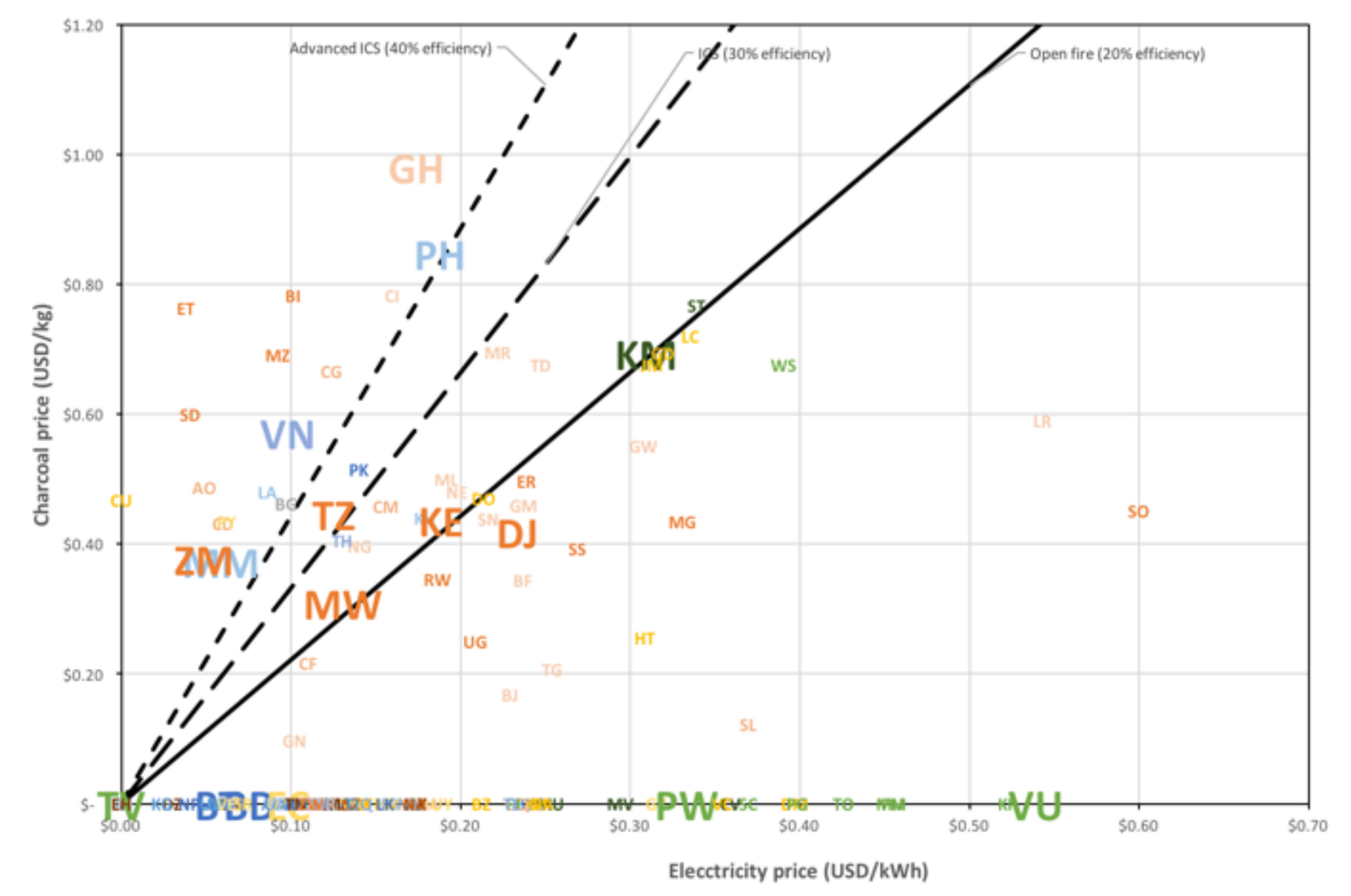
- Key variables for electric cooking:
  - Unit cost of electricity
    - 0.25USD/kWh
  - Efficiency of stove
    - Heat transfer into the pot

Table A. 1 Stove model parameters, elaboration of the authors from field observation and (Kshirsagar and Kalamkar 2014)(Jetter *et al* 2012) (MacCarty *et al* 2010)(Global Alliance for Clean Cookstoves 2016)

	Capital cost (Kenyan shillings)	Capital cost (USD)	Efficiency (%)	Stove Lifetime (years)
3 stones open fire	-	-	14	-
Traditional charcoal stove (Jiko)	300	3	26	4
ICS firewood stove	1000	11	19	6
ICS charcoal stove	1000	11	30	6
Kerosene Stove	550	6	37	5
LPG Stove	1800	20	53	5
Electrical stove	4000	44	70	5

GLOBAL MARKET ASSESSMENT

- Variable efficiency for ICS
- Single 70% value used for electric hotplate
- Urban charcoal prices

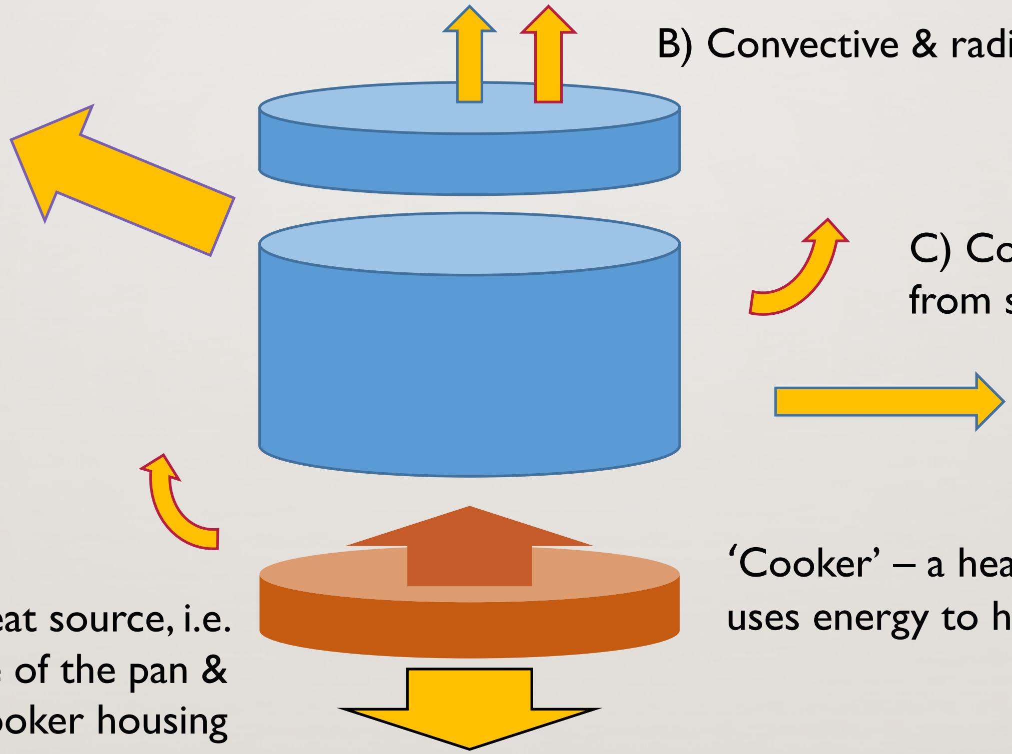


ENERGY EFFICIENT APPLIANCES

LED VS. INCANDESCENT
90% REDUCTION

WHAT IS THE '*LED OF SOLAR ELECTRIC COOKING*'?

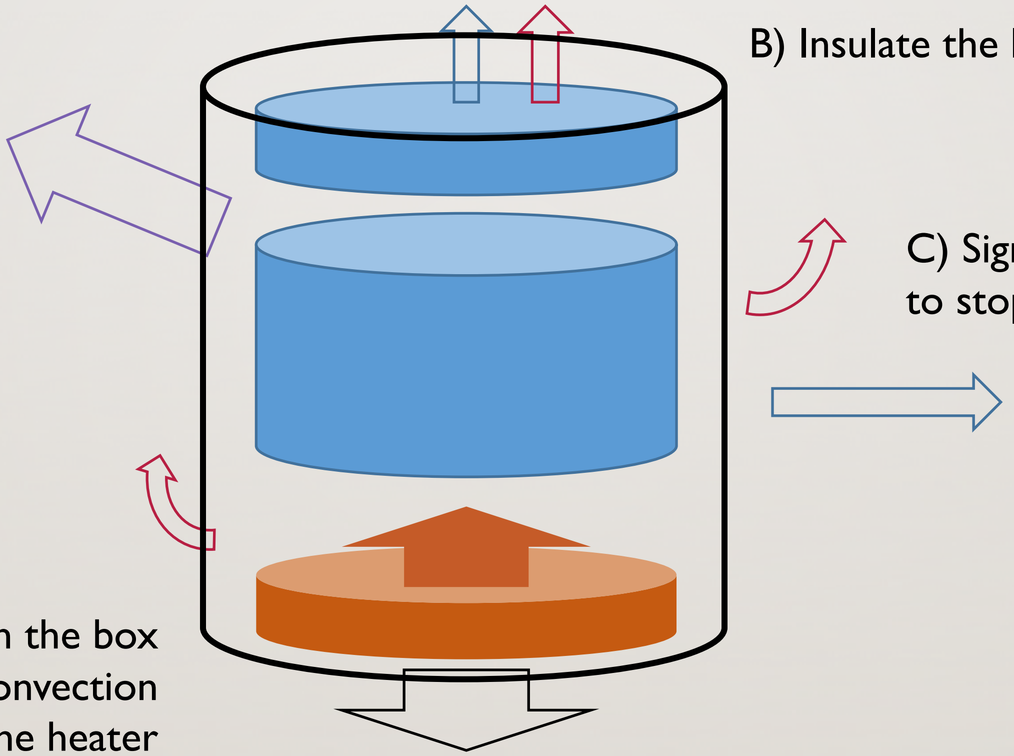
HEAT TRANSFER OUT OF THE POT IS AS IMPORTANT AS HEAT TRANSFER INTO IT!



THINK **INSIDE** THE BOX

D) Minimise evaporation losses by having a lid and a thermostat to stop excessive conversion of water to steam.

B) Insulate the lid too!



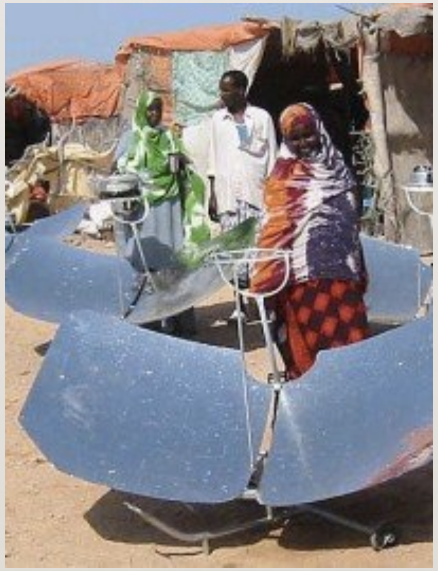
C) Significant insulation on the side to stop radiant & convection losses

A) Encase the heater in the box to stop conduction & convection losses from the heater

BEHAVIOURAL CHANGE

SOLAR COOKER

- Must cook outside
- Must keep dish aligned with sun
- Fuel still required for evening/morning & cloudy days



WONDERBAG

- Cook anywhere
- Fuel still required for initial heating
- No frying

THE COOKING DIARIES METHODOLOGY

AIMS

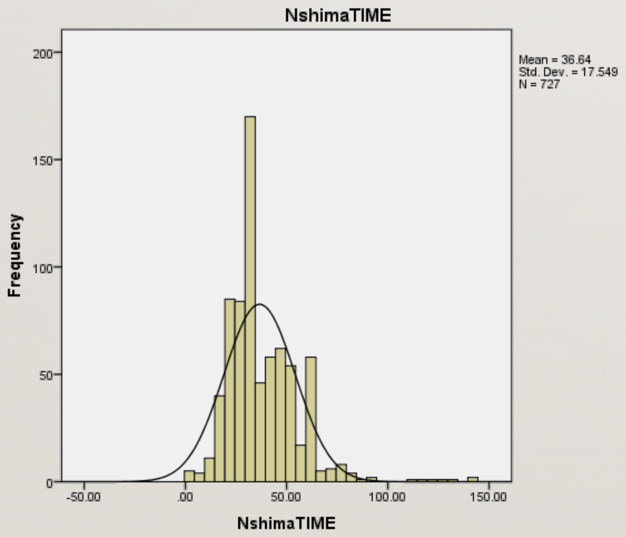
- To evaluate the trade-offs between energy efficiency and behavioural change
- To capture the user experience of transitioning to electricity for cooking
  - To assess the compatibility of different electric cooking appliances with culturally distinct cooking practices
- To quantify the amount of electricity required to cook
  - To characterise the range of load profiles for future eCook systems
  - To compare the relative costs of cooking on electricity and other key fuels

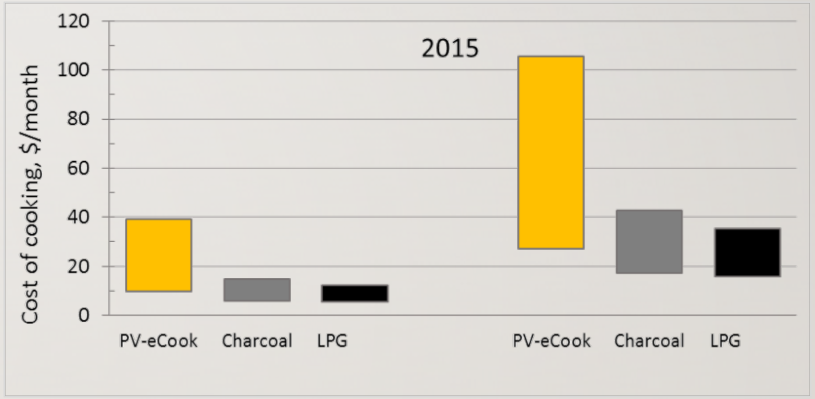
DATA COLLECTION

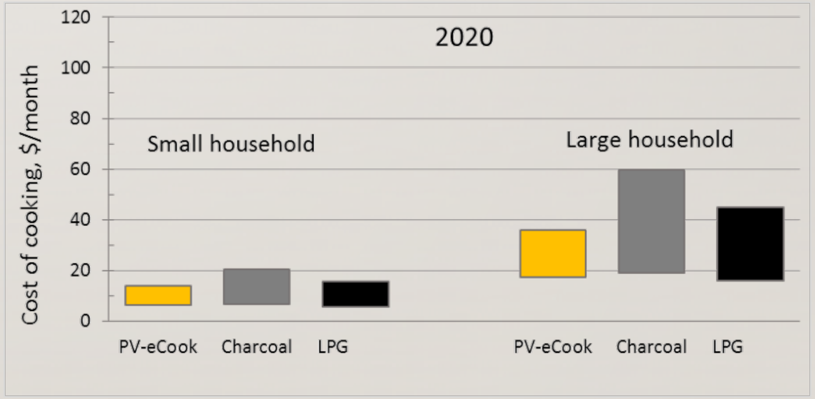
- 20 HHs in each country
- 6 weeks of data collection
  - 2 weeks baseline
  - 4 weeks transitioning to electricity
- Recording what is cooked, how it is cooked and how much energy it uses
- Meal-level resolution
- Registration & exit surveys to capture user experiences
  - eCooking challenges

DATA ANALYSIS

- Excel -> SPSS
  - Economic modelling (Leach & Oduro, 2015)
  - eCookBook



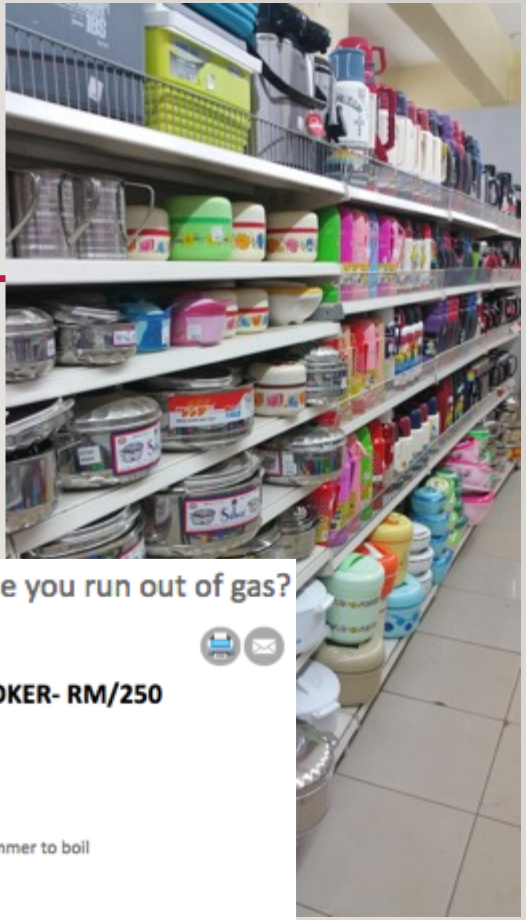




KEY LEARNING POINTS FROM KENYA

KEY LEARNING POINTS FROM KENYA

- Simple hotplates are not competitive in contexts where gas is cheap and widely available
  - No participants still regularly using hotplates after study
- Insulated storage containers and uninsulated stove-top pressure cookers widely available



THE MULTI-COOKER

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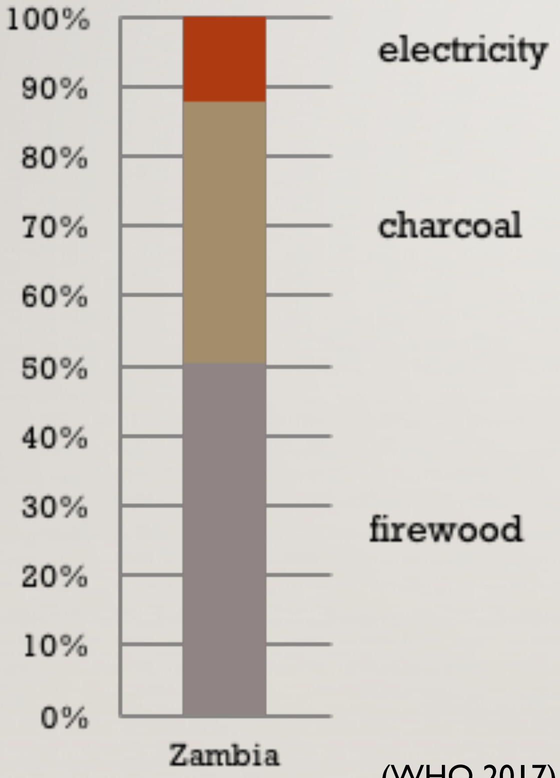
KEY LEARNING POINTS FROM ZAMBIA

CHARCOAL & ELECTRICITY



(WHO 2017)

- 37% of Zambians (6 million) cook primarily on charcoal
  - Kerosene & LPG use minimal
- 5 million Zambians are grid connected (World Bank 2017)
- 2 million Zambians already cook with grid electricity as their primary fuel (WHO 2017)
  - Electricity is the aspirational fuel for most people
- Load shedding dramatically increased charcoal use (Dlamini et al. 2016)

KEY LEARNING POINTS FROM ZAMBIA

- Multi-cooker & hotplate for each household
- Energy meters with a live readout can empower users to adapt their cooking practices around energy consumption

THE BEAN BOILING CHALLENGE

- 1 cup of beans, including sauce, with the least energy possible
- Energy saving techniques employed included:
  - Soaking the beans overnight (in salty water)
  - Pressure cooking beans with the sauces at the start (tomatoes, onions, chilies, spices, salt and oil)
  - Choosing quicker cooking varieties of beans
  - Avoid depressurizing the pressure cooker while cooking
  - Starting with hot water

RANK	UNITS (kWh)
1	0.094
2	0.140
3	0.143
4	0.147
5	0.166
6	0.175
7	0.185
8	0.190
9	0.237
10	0.243
11	0.265
12	0.268
13	0.380
14	0.409
15	0.412
16	1.001
17	1.12
18	2.0
19	Unavailable
20	Unavailable

KEY LEARNING POINTS FROM MYANMAR

THE RICE COOKER

- Induction stoves can save energy, but not as much as insulated appliances
  - Even 100% efficient heat transfer into the pot is no use if all the heat escapes!
- Rice cookers don't just cook rice
- DC rice cookers are already being mass-produced in China

RICE-eCOOK

		PV-eCook	Grid-eCook
Key equipment specification	Battery	0.26kWh	
	PV	0.08kW	-
	Controller	5.3A	-
	Capital cost	$116	$58
eCook monthly cost	3yr repayment	$4/month	$2/month
	5 yr repayment	$3/month	$1/month
	Utility (20yr)	$2/month	$1/month

- Entry level system
- Lowest possible cost

THE THERMO-POT

- Insulated pots traditionally used to keep tea warm
- Thermo-pot is a modern evolution
  - Kettle plus thermos flask
  - Reduces energy usage during initial cooking/heating & for reheating
  - Charge controller could switch it on when batteries fully charged

KEY LEARNING POINTS FROM TANZANIA

POSITIVE RESPONSE TO ALL INSULATED APPLIANCES

- It is possible to cook ugali in a rice cooker
  - Green light means stir, instead of ready
- BUT hotplates still heavily used as only 2 appliances per household
- Behavioral change still challenging for initial adoption of multi-cookers, however:
  - Strong motivation for sustained use beyond energy saving, as pressure cookers offer a quicker & more convenient cooking experience

KEY BEHAVIOURAL CHANGE BARRIERS

Slow

Single pot only

Many complicated buttons

Restricted access to pot whilst cooking

Flat bottomed pots only

Steel pots only

Water boiling only

Requires other stove for initial heating

KEY DRIVERS FOR SUSTAINED ADOPTION

ENERGY SAVING POTENTIAL

CONCLUSION

- Think INSIDE the box!
    - The efficiency of heat transfer out of the pot is as important as the efficiency of heat transfer into it
- The multi-cooker could well be the *'LED of solar electric cooking'*,
    - **BUT**… only when combined with energy efficient cooking practices
- Electrical appliances & training on energy efficient cooking practices are much cheaper than batteries

PV-ECOOK.ORG

STAY TUNED FOR RESULTS OF THE QUANTITAVE ANALYSIS

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