Workshop Report

IMPROVED COOKSTOVES: NEXT GENERATION IDEAS

An activity of the Low Cost Technologies Project

HELD IN NAIROBI ON 3RD-4TH OCTOBER 2016

The project team is led by the Open University (UK) and the consortium includes the following partners:-

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Executive Summary

This report summarizes the discussions that took place at The Improved Cookstoves: Next generation ideas workshop organized by the African Centre for Technology Studies (ACTS) in Kenya on 3-4 October 2016.

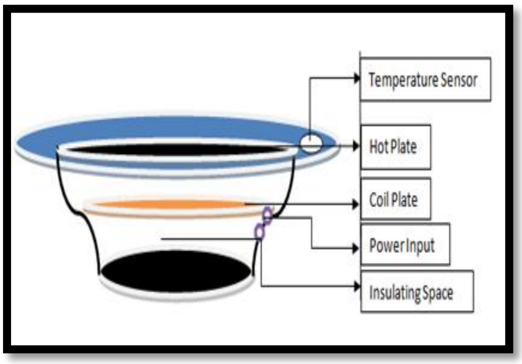
This is one of the outputs to be documented under "The Next Generation of Low-cost Energy-efficient Products for the Bottom of the Pyramid, (LCT project)" in 2016. The LCT project is a three-year project funded by EPSRC/DFID, with the objectives of:

(i) Understanding the types of low-cost energy efficient appliances that are demanded in low-income communities of Kenya;
(ii) Developing 2 to 3 technologies based on the articulated demands of consumers for low-cost energy efficient appliances in Kenya;
(iii) Developing one or more innovation hubs in Kenya that will sustain the project and access to these appliances long term and;
(iv) Assessing the effectiveness of the project through the appliances it promotes.

The workshop brought together 25 participants; technicians, facilitators and organizers. Amongst our project partners present were Gamos Ltd UK and United International University, Bangladesh. The full programme and list of participants is available in the appendix. Invitees were a mixture of those involved with improved cookstoves and those involved with Solar Lighting.

The report describes the various presentations in brief. Opening remarks were made by Dr Rebbeca Hanlin who described the history of ACTS and its role over the last decade or more in promoting improved cookstoves and renewable energy. Dr Simon Batchelor then gave the keynote address. His key point was that Solar PV technology has and continues to become cheaper, as do Lithium batteries. By looking into the short term future, if trends continue, the monthly discounted price for a solar PV battery cooking system could become about $12 per month by 2020. This is about the same as many households pay for charcoal for cooking. He told the participants that this iis an emerging landscape of new territory. While it has been a struggle to get solar lighting to scale, virtually no one is looking ahead and talking about solar PV based cooking. He explained some recent research looking into this, and said that the workshop would be the first place two solar PV prototype cookers would be exhibited. Dr Batchelor also said that the battery cooker combination had some potential to strengthen the National Grid in Kenya by demand side management, and that without the battery, cooking with electricity would create even higher peak loads causing more load shedding.

Dr Scott presented the results of a choice modelling survey that the project had undertaken. This methodology was able to document some features respondents wanted to see in clean stoves and to provide some insight into their willingness to pay for such features.



The workshop then proceeded with demonstrations of equipment. These included the Gamos Prototype for Solar PV cooking, UIU (Bangladesh) Prototype for Solar cooking, an induction stove from the market, UIU (Bangladesh) forced draft gasification stove, the rocket stove and the Wonderbag. The Wonderbag is not a stove per se, but it demonstrates how insulation can reduce the overall energy consumption thus making the meal cheaper to cook regardless of fuel. In the second day the sets of equipment were used to cook rice, and a simple trial of speed and energy consumption was conducted – for demonstration more than scientific validity.

The participants then discussed the trials and noted the possible drivers and barriers to the uptake of each. In particular, moderated by Dr. Ann Kingiri, the groups considered the enabling environment – what would government and private sector have to do to enable these technologies to come onto the market.

In conclusion, the workshop successfully introduced new stove designs to technicians working in the field in Kenya. At the same time, it started a dialogue with regards to the future of improved cooking and clean cooking options. The LCT project team received good feedback from the participants which will be utilized to enhance the design of the project activities moving forward. By the end of the workshop, there appeared to be considerable interest from participants to take some of the ideas presented forward. Not least one NGO participant took away the Wonderbag so that her constituency of women's groups might consider their viability in Kenya – this seems to be a simple and easy win for the project. The ACTS team in Nairobi will now work with interested participants as they work through business plans to take any of the technologies forward.

BACKGROUND

Improved cookstoves have been promoted in Kenya since the 1960s with the first 'ceramic jiko'. These were promoted as a means of reducing firewood requirements and over time newer designs have focused on a potential to reduce harmful emissions from smoke. Improved stoves are therefore seen as important from a natural resources management perspective and from a health perspective.

It is a source of poor health with many deaths occurring as a result of smoke inhalation across the country. Women and young children have greatest exposure to the resulting indoor air pollution because of the amount of their time spent cooking and being in and around the home. As a result women and children face the greatest health risks. The resulting deforestation also has several environmental outcomes. Currently Kenya is estimated to be losing tree cover at a high rate for use as firewood every year. This not only harms the environment and agricultural potential through loss of biomass, but it also contributes to greenhouse gas emissions and climate change not only by direct CO_2 contribution but by the absence of biomass that mitigates the presence of CO_2.

Key facts from World Health Organisation 2016

Around 3 billion people cook and heat their homes using open fires and simple stoves burning biomass (wood, animal dung and crop waste) and coal.

Over 4 million people die prematurely from illness attributable to the household air pollution from cooking with solid fuels.

More than 50% of premature deaths due to pneumonia among children under 5 are caused by the particulate matter (soot) inhaled from household air pollution.

3.8 million premature deaths annually from noncommunicable diseases including stroke, ischaemic heart disease, chronic obstructive pulmonary disease (COPD) and lung cancer are attributed to exposure to household air pollution.

Despite their promotion by numerous organisations for the benefits of health and the environment, improved cookstoves have not widely been taken up in Kenya. Some argue that this is due to the lack of attention placed on the importance of understanding socio-cultural and behavioural use of cookstoves while others blame their high cost, lack of reliability, lack of knowledge by users and lack of relevant regulation.

The result is that although Kenya has a well established improved cookstove market, uptake levels remain low. There are numerous companies producing a range of relatively similar products to a market of buyers that have cooking habits that don't always fit the products available.

At the same time, new energy solutions are being promoted in other areas. Modern energy encompasses both LPG and electricity, and yet while the current cost of electricity in grid connected areas might suggest a role for cooking with electricity, the presence of load shedding and weak infrastructure means that cooking with electricity is not widespread even among the urban elite. In this workshop the LCT project has considered the role of modern energy for cooking, and presents an additional strategy to the improved charcoal cookstove. This is with the intention of supporting Sustainable Development Goal 7 (and contributing to SDGs 1, 3, 5, 8, 9, 11, 12, and 13)

Sustainable Development Goal Energy -
GOAL 7 TARGETS

7.1 By 2030, ensure universal access to affordable, reliable and modern energy services

7.2 By 2030, increase substantially the share of renewable energy in the global energy mix

7.3 By 2030, double the global rate of improvement in energy efficiency

7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology

7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support

Within a few years emerging technology could change the landscape of cooking in Kenya, creating new opportunities for demand side management on the grid, and providing a gateway for access in rural areas. If achievable this would potentially prevent thousands of deaths and lessen the deforestation with consequent mitigation of greenhouse gases, climate change and even improved agriculture.

THE OBJECTIVES OF THE WORKSHOP

The workshop held in Nairobi in October 2016 was convened to:

1. Facilitate exchange of information on product design: what has worked well in the past and what is likely to work well in the future? What lessons can be drawn from the engineering problems encountered in the past?
2. Facilitate linkages between engineers working in the field of improved cookstoves and associated technologies to encourage the development of new cookstove designs and prototypes.
3. Develop an action plan for the continued promotion of linkages and information exchange between engineers from the UK, Bangladesh and Kenya

Workshop deliberations

What follows is an outline of the activities that took place at the workshop and the discussions that resulted.

Day 1

Each participant was given an opportunity to share a brief profile of their work, background and details of their latest or improved cookstoves they have at the moment, or in the case of Solar technicians their current solar packages.. Most of the participants were the relevant and expected target stakeholders being technicians or those responsible for innovation and engineering in their companies.

Figure 1: Dr. Rebecca Hanlin, project introduction

Introduction remarks were made by Dr. Rebecca Hanlin, an innovation and development specialist at African Centre for Technology Studies (ACTS). In her highlights she gave a brief history of ACTS and mentioned that ACTS has a pioneering role in enhancing policy dialogue in the area of biofuels, improved cookstoves and lighting in Africa (as a result of technology brokering activities) and that ACTS has been influential in ensuring policy dialogue and debate on issues from land reform to climate change to biotech regulation. Dr. Hanlin also briefed the participants on the Low-cost energy-efficient (LCT) project mentioning the partners on board with in the project; The Open University, The Nairobi Women's Hospital, Gamos Ltd, United International University, Institute for Globally Transformative Technologies at [Lawrence Berkeley National Lab] (LIGTT) and ACTS being the lead in-country partner in Kenya. She mentioned the project specific objectives being; new social research, new technical research, Products to benefit the poor and Capacity building. she also gave an overview of the major project activities that have been completed and others ongoing. She also warned the participants that the workshop would be very practical and hands-on and expected them to scrutinise existing designs on the market through interaction with a range of new ideas from engineers from the UK and Bangladesh who were present in the workshop.

On the workshop expectations, she emphasized that the lessons from the project would be widely disseminated across the sector and that it was expected that workshop participants would be provided with an opportunity to increase their level of networking among themselves, collaborate and find new business opportunities.

Simon Batchelor gave a presentation to kick start the discussion and activities of the day; essentially asking the participants to consider 'why do we need innovations in cooking?'. One idea being championed due to the current and expected trends in the energy sector, is that the next generation cookstoves will be cooking with solar PV systems. It might take three years or so for this to occur as the prices of batteries and panels need to reduce further but all indications are that this will happen.

Figure 2: Simon making his presentation

In the near future a solar PV system discounted into a monthly cost, will become cheaper than biomass fuels if the charcoal or wood is purchased (eg in urban, peri urban areas or small towns). In particular, there are emerging opportunities to be explored by the advances being made in lithium and sodium batteries. For example, a game park in Kenya is already using sodium batteries to power its facilities.

He spoke about the way cooking was done i.e. cooking habits. He said that only one study has been identified which looked at the cost of cooking. Cowan 2008 undertook trials documenting in terms of what energy source was used and how the cooking was conducted. It turns out a lot of energy use is determined by the level of controllability of the energy source (you can regulate LPG but you can't so easily regulate a wood fire). In addition, the amount of energy was also determined by how you cooked e.g. , whether you used lids, and whether the pots were insulated

He told participants that what is needed now is to conduct pilot research projects to work out the key variables, to enhance system design and to consider the potential impact on the local economy of different cooking methods. This is important because in Kenya most people do 'fuel stacking i.e. Use different fuel and cooking technologies for different types of food being cooked or based on the reason the food is being cooked. In addition, research shows that African households often do not use electricity to cook even though they are connected. This he checked by asking participants by show of hands if anyone used electricity and only one participant raised her hand. There are a number of reasons people connected do not cook with electricity. Not least the daily load profile curve for Kenya shows that most households use the most power in the evening till midnight making it the peak of electricity consumption in a day. Encouraging cooking would make the peak higher and lead to increased load shedding – so cooking with electricity is barely mentioned as an alternative to charcoal even though it might make economic sense to a household. The participants noted that the grid in Kenya is not reliable and not able to cope yet with cooking on electricity due to the electrical draw required with current products and designs being promoted. Dr Batchelor suggested that the inclusion of a battery mitigates many of these problems – it would enable trickle charging a battery over night when loads are less and the supply therefore more stable.

Dr Batchelor has been working with a number of colleagues in different projects to explore these ideas and more details can be found in his writings.

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

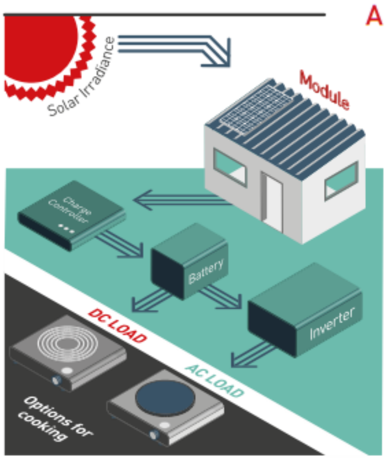
3 BILLION
COOK WITH BIOMASS WORLDWIDE

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

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

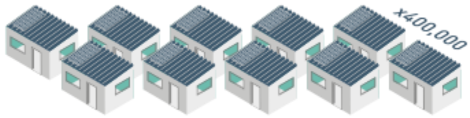
2020 CURRENT TRENDS IN PRICING INDICATE THAT BY 2020 SOLAR PV WILL SUPPLY ELECTRIC COOKING WITH 2-3 YEARS PAYBACK

A SOLUTION



STAND ALONE SOLAR PV SYSTEMS

With full lifetime costings, Solar PV could currently supply 'electric cooking' at an equivalent price ($10pm).

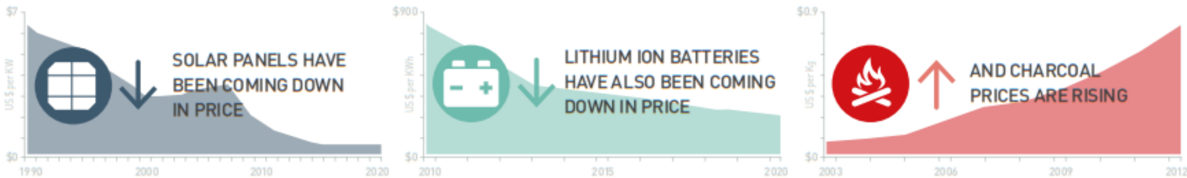


4 MILLION HOUSEHOLDS

would **likely change their cooking appliances** if they were presented with an alternative to biomass at a similar cost per month ($10)

In most of Africa and Asia grid electricity is already cheaper than biomass, but is too unreliable for cooking. Energy storage is a key to **zero emission kitchens.**

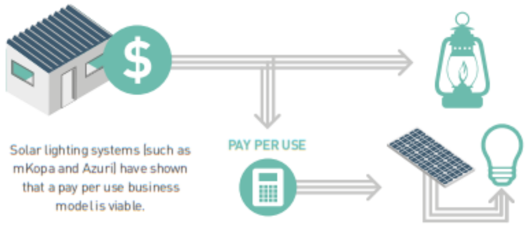
SOME COST DATA AND ASSUMPTIONS



A SUITABLY SIZED SOLAR PHOTOVOLTAIC HOME SYSTEM SIZED FOR COOKING IS AT RETAIL PRICES TODAY APPROXIMATELY $0.52 CENTS PER KWH ($0.6 LEVELISED)

BUSINESS MODELS THAT WORK

Clean lighting systems have gained traction in the last few years because they substitute a monthly expenditure on Kerosene with solar energy.



Solar lighting systems (such as mKopa and Azuri) have shown that a pay per use business model is viable.

Pay per use models have also appeared in other sectors such as Water (Grundfos LIFELINK). Indeed the water industry is championing a shift away from thinking about infrastructure per se to a 'Service Delivery Approach'

Organisations or Private Sector willing to invest in the initial capital could run **Service Delivery Approaches** for cooking from Solar PV Panels at today's prices

RESEARCH REQUIRED

Technically the system is already possible (off the shelf), and price wise it will likely be picked up by the private sector as a product option at least by 2025.

We can accelerate this by:

Some technical research on system design, sizing of battery, heat transfer and safety in connections.

Assuming this went to scale there is policy/market research required:

- Can the global industry provide the panels without a shortage?
- Are there emerging alternatives for energy storage?
- What should countries do to position waste disposal of the batteries?
- What are the foreign exchange implications for a scaled uptake?
- What are the local labour implications for the biomass stove market?
- Are there opportunities here for carbon markets?
- What behaviour change and awareness raising is required?

Gamos

2015. References available on request. For more information contact Research@gamos.org

Questions and discussion that arose:.

1. Have you modeled a hybrid wind and solar yet?

   In any system, whether nano grid, mini grid, micro grid, whether wind and solar, or hydro and solar, or solar alone, then if you size the batteries to enable cooking then you have access to the expenditure of people for cooking. One needs to look at this as a means to access a secure income stream for infrastructure development. Donors are calling for solar to be used for ‘productive energy‘ so that people can afford to pay for their electricity. But in their current expenditure on charcoal we know they have money to spend on energy Lighting has taken off because there is a direct substitution between kerosene cost and solar system cost. But now firms are moving into more value adding services. Mkopa and others are going onto TVs and refrigeration. But TVs are not substituting for another expense and not income generating. Fridges are only income generating for first mover (who sells sodas etc).

   Where you have large systems (Mini grids and micro grids) need useful/ productive use argument for them to become useful/ relevant.

   So, it's not a question of which energy source to use but what money do households have for energy access?

2. What is the payback period?

   Solar PV can last 20 years. Battery lifetimes depends on how it is used and the useful lifecycles. So initial economic models took a 20 years horizon for modeling with replacement of failing components built in. Consider this something like a utility – the household gets provided with the kit and pays a monthly tariff. However, the current solar lighting models are more akin to a ‘product’. The consumer pays a monthly charge and after one or two years owns the equipment. In the model with the assumptions made and the cost of finance (borrowing the money upfront) and profit was 7 years for payback.

   But the real question is whether we could we get an Mkopa-like system where a home gets a system leased to them for 2 years and then option to purchase is there. We are presenting two prototypes – one high powered, the other lower powered. Rezwan’s route (lower power – more on this later) might be less payback time because the technology is different.

   One issue to consider is behavior change… Aspirational nature of technology of electricity might mean the high power version is preferredbut at this point its difficult to say. (We need more market studies of consumer preferences)

3. How can we deal with behavior change? Even the most educated and sensible people still don't understand that once a pot of water is at boiling point you don’t need the same or more energy to keep it boiling. How do we encourage cost effectiveness? What partners are needed to enable benefits to be realized?

   This is a question of the technology that is available. The best route would be automation or the intelligence of the stove built in so it knows how to cook. The key thing – as Rezwan argued – is that it's not energy but the temperature/heat that cooks the food. Hence the design of passive cooking systems such as a the Wonderbag.

Dr. Rezwan Khan, the vice chancellor of United International University (UIU) Bangladesh, made his presentation on his approach to alternative cooking; in so doing introducing his prototypes,. He explained that the losses in a cooking stove - that is conventional cooking stoves

Figure 3: Rezwan during his presentation

– are substantial because they are highly inefficient. There is a lot of loss due to uncontrolled flames, escape of hot air after combustion, there is generation of steam due to boiling water and also a lot of radiation losses.

Rezwan emphasized that the idea behind technologies now should focus on the losses in cooking process. the basic principal of cooking is that it is not energy that cooks but the temperature, and so insulation is the key element.

Rezwan recognises that behaviour change is going to be a problem but there is a solution to that.

Questions and discussion that arose:

1. How long will it take to boil water with Rezwan's stove?

Too long at present probably but depends on what the needs of the household are,

2. Kenyans are keen on esthetic. Need something that looks good and quick to cook. Especially if focus on younger generation.
3. Rural areas – wood stoves mostly – what can they do? Will they change from wood?
   Simon responded by saying that market differentiation will be necessary. It is highly unlikely to change the people who do not pay for wood. Need to focus on urban and peri-urban areas, who are used to paying for wood and charcoal. There is a 2 year programme on behavior change in global alliance of cook stoves.

4. There seems to be resistance to this idea of electric cooking, why?
   This is a new opportunity. Historically the cost of batteries and panels etc. made this prohibitive, and so the the two fields or 'Solar' and 'Improved cookstoves' haven't traditionally come together. This workshop might be one of the first where people working in each sector sit in the same room and explore emerging opportunities.

5. Need behavior change. A solar iron box is possible… Why not a cook stove?
6. What about conversion costs of electricity to heat (temperature)?
   Induction stoves vs electric stoves in Europe argument. With induction it is possible to increase efficiency but too much behavior change is needed (different cooking pans needed and the stove too doesn't heat up in the traditional way). However, Ecuador and Bhutan are introducing induction stoves on a large scale so this might change things.
   .
7. What is the life span of battery and will it break even by the time the battery expires?
8. What about additional functionality? E.g. Phones and calculators, torch functions etc.
9. All possible- Ovens, USB port, water heater etc
   Lithium 6-7 years vs lead acid only 2 years. Sodium is supposed to be about 30 years 10k cycle sheet) also lithium titanate the same. Then there is the waste disposal issue. The economic model includes the disposal of equipment at the end of its life.

Survey results

Dr Nigel Scott made a presentation on the results of a survey done in Kenya in 2015/2016.

Choice modelling methodology was used as the theoretical construct in the consumer surveys, which identified the key characteristics or parameters that each product should have to find a ready acceptance with consumers. An experimental design in a Choice Experiment was used as it is a strict scheme for controlling and presenting hypothetical scenarios, or choice sets to respondents.

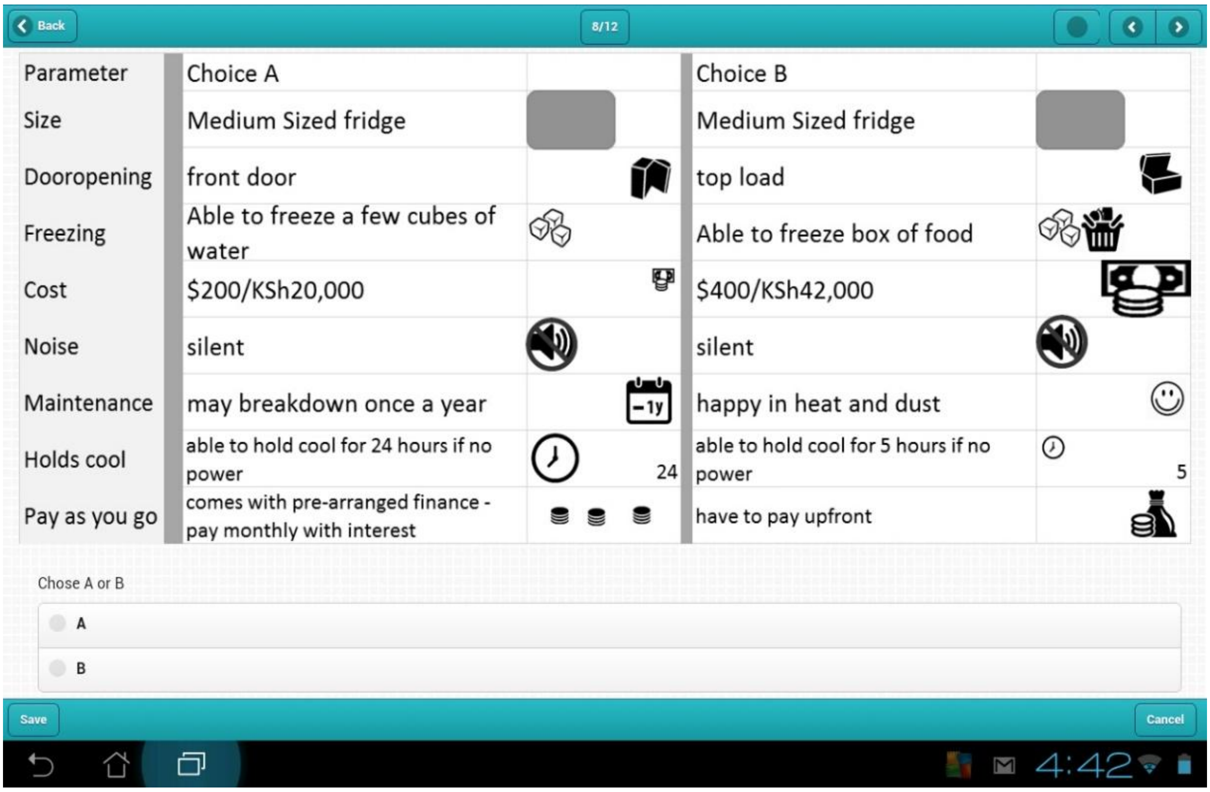


Figure 4: a sample set of choices in the questionnaire

A total of 780 interviews were conducted in 5 regions (Malindi, marsabit, kisumu, Nairobi and Kirinyaga) across Kenya and 58% of the interviewees were the head of household. Most people use charcoal, wood and gas for cooking and a decision on purchasing a cookstove would most commonly be made by the female head of the household, although men would be involved in the decision in many homes. There was a consensus that people strongly disliked the smoke from wood stoves, and they would adopt modern cooking fuels if the cost was the same as their current expenditure on charcoal and wood. Survey participants also preferred stoves that allow cookingwith a larger pot.

Questions and discussion that arose:

1. How was the survey conducted and could it have influenced the way the respondents answered their questions

The choice modelling was chosen because it prevents people giving answers that they think the interviewer wants. The respondents are presented with pairs of cards and have to choose one of the two. The respondent is making complex choices across many variables in the same choice, and so they cannot game the survey. Statistical analysis is able to unpack the different variables and give insight into the choices people were making.

2. In what regions of Kenya was the survey done; can the analysis be done per the regions to see if there is a difference in the conclusion? This is due to the different cultural practises in Kenya.

Please see the full survey report.

Demonstrations day 1

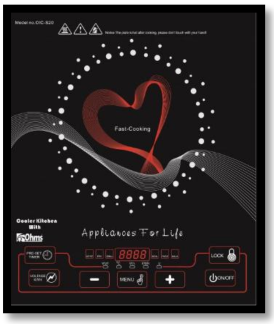
These demonstrations were to enable theparticipants to get to know the parts of the stoves and how it they are used. It was more specific to the features. The stoves that were on display included;

a. Induction cooker
b. Solar Battery e-cooker –Gamos
c. Forced draught two burner stove – UIU product
d. Solar clay cooker- UIU product

e. Wonder bag – South African product
f. Insulated cooking options – UIU product

Induction cooker specifications

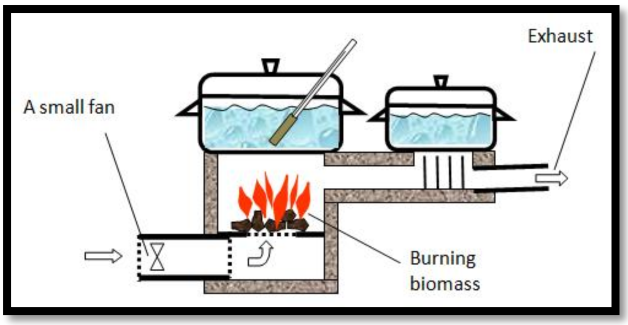
The induction cooker uses electricity and uses a specific kind of pot (iron or steel) to cook. It is has a timer, temperature controller, different methods of cooking: boil, simmer and grill. The surface of the cooker is heated only by the pot and does not reach a hazardous temperature. No power is drawn if a pot is not placed on it,. It has a flat working surface and very smooth hence easy to clean and the surface does not get hot enough to burn or stick spilled food.



Solar battery e-cooker- Gamos Prototype

A first generation user prototype 'solar' battery electric stove had been developed by the Gamos team. It presented a 1kW hotplate of 300mm diameter (designed for the larger pots of Africa), with surrounding support for even bigger pots. In this first generation prototype, for simplicity of design the hotplate is driven at 240V, with an internal inverter to convert the 12V of the Lithium Iron Phosphate battery to AC. A battery charger is included for recharge from the mains. This is all set within a rounded triangular housing of 25cm high (designed to be stable on mud floors and at a height appropriate for squatting or to be put on a table) with necessary thermostat control, power switches, battery monitor and external plugs for mains and solar charging. Since Lithium Iron Phosphate batteries cannot be transported easily, the unit was set up with an external lead acid battery for the purposes of the workshop demonstration.

Forced draught specifications



It has a draught fan (like the fans used for cooling inside computers or other electronic devices) is of very small size and consumes very small amount of power (less than 2W) and is low cost. It also has a chimney. The amount of air flow from the fan can be controlled electronically and the actual rate of combustion inside the combustion chamber can thus be controlled to control the actual amount of heating generated. A small Solar Home System can be used to energize the fan without having any significant impact on the energy budget of the system.

Solar e-cooker

This model has a hotplate inside an insulated frame that constitutes the stove and the pan is placed on top of it. The temperature of the pan has been set to less than 100C hence no risk of fire from the jacket. The temperature sensor was placed near the outer edge of the insulator close to the hotplate such that the bottom surface of the pan touches the sensor. This ensures a better sensing of the pan temperature and premature operation of the temperature sensor can be avoided.

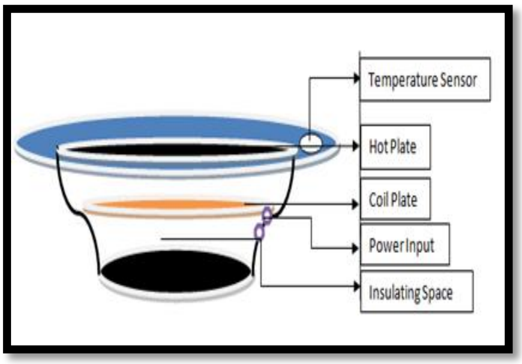


Figure 5: Pictures captured while demonstrations were going on.

After the demonstrations the participants returned inside to discuss the challenges and opportunities to cookstove development and marketing in Kenya.

This session was moderated by Ms. Mourine Chepkemoi, a research assistant/ Project administrator at ACTS. The participants were requested to form two groups and one group were to brainstorm on the Challenges to cookstove development and marketing in Kenya and the other group handled the opportunities to cookstove development and marketing in Kenya

GROUP 1: the challenges to cookstove development and marketing in Kenya presented by Dan Waithaka from Wisdom Stoves Co, Kenya.

- Finances/ funding
- Locally available materials
- Research and development
- Attitude/ behaviour change
- Cost of production with good quality materials

- Prioritizing cookstoves

GROUP 2: the opportunities to cookstove development and marketing in Kenya presented by Daniel Abonyo from Rachuonyo Environmental Conservation initiatives-RECI, Kisumu.

- Availability of fuels
- Confidence & mindset of the market
- Consumer finances availability; funded projects, individual companies, increased donors & initiatives.
- Rural market
- Awareness of negative impacts
- Global support
- Raw data on successes and failures

Day 2

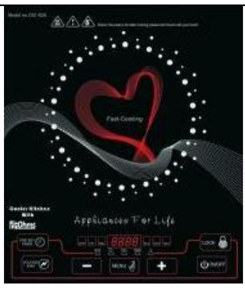
On day 2 a further demonstration session was held. This demonstration focused on cooking performance of the prototypes alongside existing stoves on the Kenyan market, two 'tests' were conducted (not under rigorous testing conditions) to see which technology boiled water the fastest and which cooked rice the quickest. Five models of stoves were included in the demonstration,.

a. Induction cooker- available in retail shops in Kenya
b. E- cooker- Gamos product
c. Gasifier cook stove – Wisdom product available on the market in Kenya
d. Forced draught – UIU product
e. Solar modified ceramic jiko (KCJ design available in Kenya) - Kenyan KCJ available on the market in Kenya with UIU solar powered element
f. retained hear / passive cooker – Wonderbag

The results of this informal test are shown below in table 1.

Table 1: performance details from the cookstove 'test'

PRODUCT	IMAGE	WATTAGE	TIME TO BOIL	TIME TO COOK RICE	COMMENTS
Solar Battery e-cooker		1000	5.09	16.28	Started on high then reduced once boiling.

Induction Cooker		1300	2 mins	Put in wonderbag	Reduced heat to 400 after started boiling.
wonderbag		Initial boiling from Induction stove		30 mins	Put into Wonderbag after 5 mins boiling.
Rocket		Sticks collected from the garden. Time required to light up	3-4 mins	11.35 mins	Very hot, boiled over, soot issue, still loads of fuel left over.
Solar modified KCJ		300	19.36 mins	28.50 mins	It takes the longest time to boil

It is worth noting that the induction stove utilized half the energy of the two solar electric cookstoves by use of the Wonderbag - bringing the rice to the boil and then letting the temperature cook the rice without further input of energy.
[Induction plus Wonderbag = 1300W*2 minutes, 400W*3 minutes, 0W*30 minutes = 228KJ]

The other interesting feature is that the two solar based cookers despite being quite different in their capability of maximum power delivery, both consumed a similar amount of energy (20% different).
[Gamos prototype 1000W*5 minute, 200W*16.5 minutes = 507KJ]
[UIU prototype 200W*20 minutes, 100W*28 minutes = 408KJ]

It should be noted that the UIU model as a prototype had some challenges with the thermostat, and that the UIU incorporates insulation.

The point of the demonstrations was not so much to gain rigorously scientific data on performance but to enable participants to be inspired and see the potential of modern energy use.

Following the morning's demonstrations the participants returned to plenary to discuss stove designs. Specifically, they considered the comparisons between the different stoves that had been used and discussed during the workshop.

COOKSTOVE COMPARISON ISSUES.

- Affordability
- Cost effectiveness (different fuels and amount of fuel etc.)
- Battery size and battery use generally
- Power both a). Wattage and cost per KWH and b). Control of power while cooking
- Ease of use both a). New technologies e.g. Insulators and b). Cooking habits and techniques
- Ability to commercialize (market) and ensure adoption
- Resources and partnerships required
- Engineering and design decisions e.g. Material choice (linked to material availability)
- Manufacturing capability
- Regulation of product e.g. Standards and waste/ recycling
- Durability of product
- Health issues

A discussion was then held to identify and rank challenges within the enabling environment that impede technicians from developing and introducing new products.

The participants were requested to form two groups and identify and rank challenges within the enabling environment that imped technicians from developing and introducing new products. The main findings from the group discussions are presented below.

GROUP 1:	**These findings were presented by Paul Mwaniki from Eco Spark, Kenya.**
	i) Lack of awareness- government/consumers ii) Government policy iii) Lack of financing- because stoves on market are very expensive for consumers iv) Appropriate financing model- some soft finance from international development institutions but channeled through banks but when they try to access they can't get at favorable rates. (Plus procedures are too long – CDM). Debt vs equity v) Political influence vi) Technology dissemination. vii) Affordability
GROUP 2:	**These findings were presented by Josephine from cookswell, Nairobi.**
	i) Corruption and poor leadership ii) Poverty- bright students not given an opportunity to study and having great ideas iii) Cost of doing business is high iv) Lack of established training/ skills v) Lack of good materials locally vi) Resistance to change –culture vii) Lack of incubation centres/labs viii) Poor infrastructure ix) Creating awareness- advertisements/demonstrations x) High cost of inputs xi) Lack of financial support xii) Inefficient regulatory environment (KEBS)

WAY FORWARD

The final session of the day was moderated by Dr. Ann Kingiri where she requested all participants to form 2 groups. She introduced the session by highlighting that over the two days, participants had shared and learnt a great deal. She continued that we still have opportunities for more sharing and learning in a range of areas not least investment and marketing. Dr Kingiri also acknowledged the challenges present in the industry and asked the participants to think of how we need to move forward keeping in mind the innovators, manufacturing, entrepreneurs, fabricators etc. She also asked them to think of what the partners (ACTS/UIU/Gamos) should do in order to help them in the process. As such, the participants considered these issues in groups before returning to plenary. An overview of the issues raised in each of the group discussions is outlined below.

Group 1:.	• Engage each other – social networks and other media • Watch solar cooking and see how it will develop e.g. concentrated solar power as an option? • Develop documentation and share with partners; create awareness of alternatives • More advancement in the market – gasifers and pressure cookers • Identify the best source of materials e.g. Better soils for clay • Look at how we can merge/ integrate technologies e.g. Mkopa and cooking • Introduce the technologies into the curriculum • Do more calculations – energy audit in the household situation
Group 2:.	• What will we do immediately o Testing o Thinking of battery life o Retrofit stove and try it in field o Raise awareness on stoves o Raise financing o Further develop the technologies and how can improve especially inductions With regards the next steps recommended by the participants to the project partners, they wished to be supported financially in product dissemination and marketing. They also wanted more opportunities like this workshop to be able to share knowledge.

In response, and taking into consideration the resources available to the partners, the following activities were proposed by the partners:

ACTS	- Support financing and technical aspects of the project find from different sources - Be a platform for education and dissemination e.g. Through facebook - Help with customization and field tests - Further research and info on the technology - Further development of the model used here - Financing of innovative entrepreneurs including outside academia - Linkage agencies
United International University	• Seen what challenges are with his technology and will try to improve • Develop a low cost induction heating mechanism.
Gamos Ltd UK	• 5 years isn't a long time for getting this into the market. Gamos thinks that there is no one path to take to success for a stove and that the path and thinking continually changes. • He mentioned that 2030 is the target with SDGs and that he still needs to work on mechanisms to include into mini-grids or focus on anchor clients or corporates or public institutions e.g. Schools, hospitals etc. • Need grid connectivity, improved cook stoves and funding come together

Conclusion

The workshop successfully introduced new stove designs to technicians working in the field in Kenya. At the same time, it started a dialogue with regards the future of improved cooking and clean cooking options. The LCT project team also received good feedback from the participants which will be utilized to enhance the design of the project activities moving forward. These include how best to design clean energy efficient cooking solutions that meet the needs of the Kenyan environment. .

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By the end of the workshop, there appeared to be considerable interest from participants to take some of the ideas presented forward. Not least one NGO participant took away the Wonderbag so that her constituency of women's groups might consider their viability in Kenya – this seems to be a simple and easy win for the project. The ACTS team in Nairobi will now work with interested participants as they work through business plans to take any of the technologies forward.

Details of the project can be found at: http://dpp.open.ac.uk/research/projects/next-generation-low-cost-efficient-appliances-and-devices-benefit-bottom-pyramid

For more information on the workshop please contact Mourine Cheruiyot at m.cheruiyot@acts-net.org.

FINAL PROGRAMME

DAY 1		
TIME	ACTIVITY	Moderator
9:00-9:30	Welcome & key note address	Aschalew Tigabu and others
9:30-10:30	Introduction to the project and landscaping of the opportunity that is available	Becky Hanlin and/or Simon Batchelor
10:30-11:00	Break	
11:00 – 12:00	First demonstration/ getting to know the equipment sessions	Rezwan Khan
12:00-13:00	Results of survey and implications for design and engineering of the stoves	Simon Batchelor
13:00-14:00	Lunch	
14:00-15:15	Second demonstration/ getting to know the equipment sessions	Rezwan Khan
15:15-15:30	Break	
15:30-16:30	Challenges and opportunities to cookstove development and marketing in Kenya	Mourine Cheruiyot
19:00	Dinner	ALl
DAY 2		
8:00-10:00	Third demonstration/ getting to know the equipment sessions	Simon Batchelor
10:00-10:30	Break	
10:30- 11:30	Keynote by significant engineer in another field	TBC
11:30 – 12:30	Challenges to being an engineer in Kenya: training, careers, moving products to innovation etc.	Aschalew Tigabu
12:30-13:30	Lunch	
13.30-15:00	How to move this project forward; concrete plans for moving forward discussions between innovators	Becky Hanlin
15:00	Tea and close	

List of Participants Present

NO	COMPANY	DETAILS
1.	Wisdom Stoves	Dan Waithaka
2.	Better family life trust	Josephine Elizabeth
3.	Envirofit	David Small
4.	Envirofit	Perminus Nyangena
5.	Practical Action	Jechoniah Kitala
6.	Practical Action	Jackson
7.	GRACELAND COLLECTIONS Adapt a Jiko	Kinyanjui Mathenge.
8.	RACHUONYO Environmental Conservation initiatives-RECI	Abonyo Daniel
9.	Eco Spark	Paul Mwaniki
10.	University of Nairobi	Jacob Kithinji
11.	Ramogi Institute of Technology	patrick nabatwa
12.	Ramogi Institute of Technology	Mr. Thomas Owiny
13.	Oriang stoves centre	Phoebe Roy
14.	Kabondo stoves pottery	Justus Odhiambo
15.	Greenenergy protech ltd	George theuri
16.	Ecogro Technologies	Paul Wambua
17.	TradeCare Africa	Joyce Gema
18.	Gamos Ltd UK	Simon Batchelor
19.	Gamos Ltd UK	Nigel Scott
20.	United International University	Rezwan Khan
21.	United International University	Arifur Rahman Talukder
22.	ACTS	Ann Kingiri
23.	ACTS	Rebecca Hanlin
24.	ACTS	Aschalew Tigabu
25.	ACTS	Moses Owidhi
26.	ACTS	Mourine Chepkemoi