eCook Zambia Focus Group Discussions Summary Report

March 2019 Final Report

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Executive Summary

This report summarises the findings **from four Focus Group Discussions (FGDs) held in Zambia**, with the aim of informing the development of a battery-supported electric cooking concept, eCook. It is part of a broader programme of work, designed to identify and investigate the opportunities and challenges that await in high impact markets such as Zambia. Women and men from rural, urban and peri-urban contexts were asked about their current cooking practices and how they aspire to cook in the future. The evidence from these FGDs suggests that **electricity is the aspirational fuel** for most households in Zambia and confirms that **access, affordability (or perception of affordability) and reliability** are the **main barriers** holding back wider adoption of electric cooking.

There is a general **perception that cooking with electricity is expensive**, however the evidence from the cooking diaries shows that **even cooking with inefficient electric hotplates is cheaper than charcoal**. This false perception has led many landlords/ladies, whose tenants share their electricity meter, to ban cooking with electricity. Even if electric cooking is allowed, long boiling dishes such as beans are often specifically prohibited, forcing their tenants to pay more to cook with charcoal. The national utility, ZESCO, offers a very generous lifeline tariff of 0.15 ZMW/kWh (just 0.015 USD/kWh) for the first 200 kWh/month. Whilst this is more than enough to cook with, even on inefficient hotplates, it is not accessible to many poorer households, who live in rented accommodation with a shared meter. Nonetheless, even at the standard tariff of 0.89 ZMW/kWh (0.089 USD/kWh), the evidence from the cooking diaries shows that electricity is still cheaper than charcoal, as almost all meals can be cooked for under 2kWh (1.78 ZMW or 0.178 USD), regardless of household size.

Overcoming the intangibility of electricity by clearly showing cooks how much has been used (or better, how much money has been spent) on each dish will be key to overcoming this false perception. Most people have no idea how much electricity goes into cooking a typical dish and therefore how much it costs. In contrast, with charcoal and firewood it is physically very obvious. If future electric stoves included an energy meter, which clearly displayed how much money had been spent on the last dish, the comparison would be much clearer. PV-eCook (solar electric cooking) devices have a significant advantage here, as they do not rely on an external power supply, as a result, the size of the repayments should clearly communicate to the user just how much (or how little) it costs to cook with electricity.

Cooking beans is a major drain on the finances of poorer households. The evidence from the cooking diaries shows that **electric pressure cookers can cook beans in half the time and for a fraction of the cost of charcoal** (under 1 ZMW). Electricity & firewood are both already favoured for quick foods. Charcoal is harder to light, but burns steadily for several hours, making it the preferred fuel for longer boiling dishes, such as beans, trotters, game meat or village chicken. The electric pressure cooker

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yields the greatest time and cost savings of any appliance on long boiling dishes, positioning it well to take over from charcoal. Most households in the FGDs only had experience with hotplates, but were impressed with how quickly the electric pressure cooker could cook beans and how tasty they were.

Many people say that food cooked on charcoal is tastier than electricity, as it cooks too fast. **Just because electricity can cook quickly, it doesn't mean it has to**. In fact, slow cookers cook even more slowly than charcoal, allowing meat to tenderise and flavours to combine over many hours. Cooking slowly is one way of allowing heat to penetrate all the way through food. Raising the temperature of the water that is boiling the food with a pressure cooker is another. Electric pressure cookers cook even faster than hotplates, but produce tender, flavoursome food like the slow cooker by raising the boiling point of water to 120°C. Many people assume that an electric pressure cooker can only cook long boiling foods with the lid on. In fact, it can also fry, steam or boil with the lid on or off (some baking is even possible), leading many to market them as 'multicookers'.

The FGD participants prioritised a separate food warmer, automatic control mechanisms & pressure cookers, **all of which are all energy-efficient features that can make future eCook products more affordable by reducing battery size**. They also highlighted **affordable monthly payments**, **powering other appliances** and **safe design to avoid shocks** - all of which are integral features of any eCook product/service. In addition, many mentioned the critical role of **user training**, especially if incorporating appliances that require significant changes in cooking habits, such as electric pressure cookers. Surprisingly, **baking was found to be relatively important**, however in a conventional oven, this is the most energy intensive cooking process. Fortunately, many electric pressure cookers come with a 'cake' button that could provide an aspirational purchasing trigger. Interestingly, **portability was generally seen as negative**, due to durability & safety concerns. This bodes well for bulky energy storage technologies such as sodium ion batteries.

In peri-urban contexts, **many households that used to collect firewood are now forced to purchase it**, as access to the bush becomes harder as population density increases. Charcoal is the next step, as it is more energy dense, so it can be transported from further afield. **This creates an opportunity for eCook**, because this commercialisation of polluting fuels is an existing expenditure that can be redirected into repayments on an eCook system. Existing expenditures on a blend of firewood and charcoal among FGD participants seem to be in the order of 80-200 ZMW/month. At **100 ZMW/month (10 USD),** the economic proposition of eCook becomes viable with a **4-5 year payback** period. At **200 ZMW/month (20 USD), 2-3 year payback** periods become possible.

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1 Introduction

This report presents one part of the detailed in country research carried out to explore the market for eCook in Zambia. In particular, this in country work aims to gain much greater insight into culturally distinct cooking practices and explore how compatible they are with battery-supported electric cooking. The report is rich with detail and is intended to provide decision makers, practitioners and researchers with new knowledge and evidence.

This report presents findings from four focus groups designed to inform the future development of eCook within Zambia. It is one component of a broader study designed to assess the opportunities and challenges that lay ahead for eCook in high impact potential markets, such as Zambia, funded through Innovate UK's Energy Catalyst Round 4 by DfID UK Aid and Gamos Ltd. (https://elstove.com/innovate-reports/). A much deeper analysis of the data collected during this project was supported by the Modern Energy Cooking Services (MECS) programme, which included the writing of this report.

The overall aims of the Innovate project, plus the series of interrelated projects that precede and follow on from it are summarised in in *Appendix A: Problem statement and background to Innovate eCook project*.

1.1 Background

1.1.1 Context of the potential landscape change by eCook

The use of biomass and solid fuels for cooking is the everyday experience of nearly 3 billion people. This pervasive use of solid fuels and traditional cookstoves results in high levels of household air pollution with serious health impacts; extensive daily drudgery required to collect fuels, light and tend fires; and environmental degradation. Where households seek to use 'clean' fuels, they are often hindered by lack of access to affordable and reliable electricity and/or LPG. The enduring problem of biomass cooking is discussed further in *Appendix A: Problem statement and background to Innovate eCook project*, which not only describes the scale of the problem, but also how changes in renewable energy technology and energy storage open up new possibilities for addressing it.

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1.1.2 Introducing 'eCook'

eCook is a potentially transformative battery-supported electric cooking concept designed to offer access to clean cooking and electricity to poorer households (HHs) currently cooking on charcoal or other polluting fuels (Batchelor 2013; Batchelor 2015a; Batchelor 2015b). Enabling affordable electric cooking sourced from renewable energy technologies, could also provide households with sustainable, reliable, modern energy for a variety of other purposes.

A series of initial feasibility studies were funded by DfID UK AID under the PEAKS mechanism (available from https://elstove.com/dfid-uk-aid-reports/). Slade (2015) investigated the technical viability of the proposition, highlighting the need for further work defining the performance of various battery chemistries under high discharge and elevated temperature. Leach & Oduro (2015) constructed an economic model, breaking down PV-eCook into its component parts and tracking key price trends, concluding that by 2020, monthly repayments on PV-eCook were likely to be comparable with the cost of cooking on charcoal. Brown & Sumanik-Leary's (2015), review of behavioural change challenges highlighted two distinct opportunities, which open up very different markets for eCook:

- PV-eCook uses a PV array, charge controller and battery in a comparable configuration to the popular Solar Home System (SHS) and is best matched with rural, off-grid contexts.
- Grid-eCook uses a mains-fed AC charger and battery to create distributed HH storage for unreliable or unbalanced grids and is expected to best meet the needs of people living in urban slums or peri-urban areas at the fringes of the grid (or on a mini-grid) where blackouts are common.

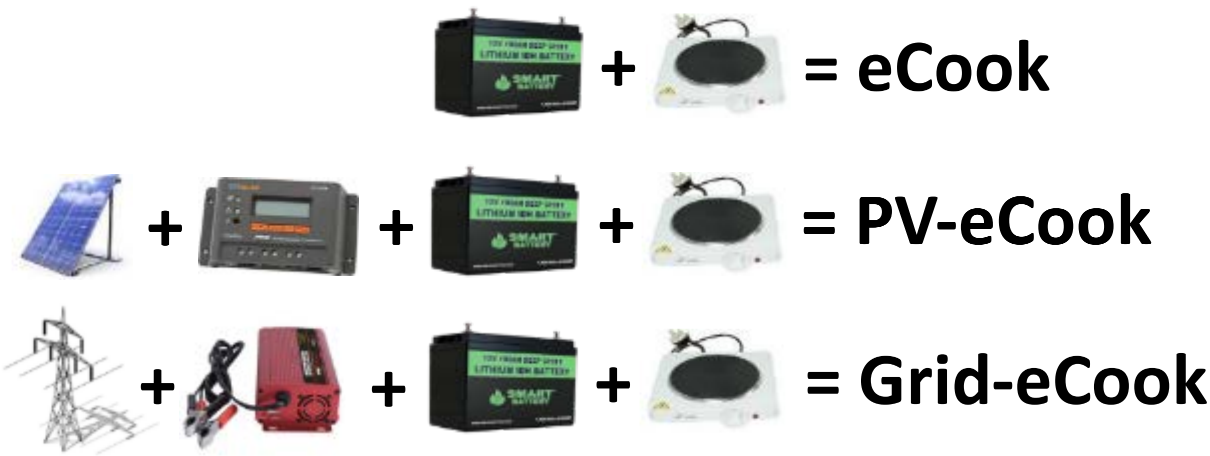

Figure 1: Pictorial definitions of 'eCook' terminology used in this report.

1.1.3 eCook in Zambia

Given the technical and socio-economic feasibility of the systems in the near future, Gamos, Loughborough University and the University of Surrey have sought to identify where to focus initial

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marketing for eCook. Each country has unique market dynamics that must be understood in order to determine which market segments to target are and how best to reach them. Leary et al. (2018) carried out a global market assessment, which revealed Zambia as the third most viable context for PV-eCook, as 10% of the population already cook on electricity and recent load shedding caused a significant number of these users to revert back to charcoal, rapidly accelerating deforestation.

The accompanying reports from the other activities carried out in Zambia can be found at: https://elstove.com/innovate-reports/.

1.2 Aim

The aim of this study is to gain a deeper understanding of how Zambians currently cook and how they aspire to cook.

In particular, the objectives of the study are:

- To assess the compatibility of current and aspirational cooking practices with battery-supported electric cooking (eCook).
- To identify design modifications and marketing strategies that can enable the generic eCook concept to evolve around the needs and aspirations of Zambian cooks.

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2 Methodology

Four focus groups were carried out to gain further insight into how Zambians currently cook and how they aspire to cook. A series of questions were designed to guide the discussion (see Appendix B: Focus group design brief), however open dialogue was encouraged when unforeseen issues were brought up by the participants. An electric pressure cooker was demonstrated during each session, inviting comments from the audience on how compatible the device was with the current and aspirational cooking practices.

Table 1 shows the four locations selected for the focus group discussions. These contexts were chosen to be able to compare and contrast the issues faced by people in rural and urban areas, of different genders and who are using different cooking fuels.

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Table 1: Description of the 4 locations chosen for focus group discussions.

Location	Context	Participants	Context	fuels
Mtendere 	Urban slum	Lower income. Female plus one male assistant facilitator.	Several cooking diary study participants & friends.	Charcoal and/or electricity.
Mungule 	Peri-urban village	Female plus two male assistant facilitators.	Pre-existing link through Childfund NGO	Mostly 3-stone fires, some mud stoves and charcoal mbaulas.
Ng'ombe 	Peri-urban	All female	Women who had expressed an interest in the research.	Mostly charcoal, some electricity.
Shimabala 	Rural village	All female	Pre-existing link through AREED I & II (UNEP supported project)	3-stone fires, Supa Moto pellet stoves, charcoal mbaula and electricity.

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3 Results

3.1 Current cooking practices - what do you currently cook and how?

3.1.1 Preferred foods and preparation methods

Although any food can be prepared on any stove, participants expressed preferences for specific types of foods. In Shimabala, the women all said they cook vegetables and the preferred method of preparation is frying. They also mentioned cooking chicken by boiling first to soften and then frying. Beans are also cooked and required boiling for several hours. In Mungule it was noted that smokey food is only accepted if it is a braii on charcoal, but not on firewood. Table 2 and Table 3 list the most popular foods in Ng'ombe and Mtendere, the processes required to prepare them and the preferred fuel for each.

ELECTRICITY & FIREWOOD ARE BOTH FAVOURED FOR QUICK FOODS. CHARCOAL IS HARDER TO LIGHT, BUT BURNS STEADILY FOR SEVERAL HOURS, MAKING IT THE PREFERRED FUEL FOR LONGER BOILING DISHES, SUCH AS BEANS, TROTTERS, GAME MEAT OR VILLAGE CHICKEN.

Table 2: Popular foods in Ng'ombe, their typical preparation methods and preferred fuels/devices.

Dish	Process	Fuel/Device
Beans	Boiling	Charcoal/mbaula (*Figure 2*)
Fresh fish	Boiling	Charcoal/mbaula
Fresh fish	Frying	Electric stove and charcoal/mbaula
Eggs	Frying	Electric stove and charcoal/mbaula
Nsima	Boiling	Electric stove and charcoal/mbaula
Kapenta	Frying	Electric stove and charcoal/mbaula
Veggies	Frying/boiling	Electric stove and charcoal/mbaula
Chicken	Boiling	Electric stove and charcoal/mbaula
Water	Boiling	Electric stove (landlords) Charcoal/mbaula (tenants)

THE ELECTRIC PRESSURE COOKER YIELDS THE GREATEST TIME AND COST SAVINGS ON LONG BOILING DISHES, POSITIONING IT WELL TO TAKE OVER FROM CHARCOAL. MOST HOUSEHOLDS IN THE FGDS ONLY HAD EXPERIENCE WITH HOTPLATES, BUT WERE IMPRESSED WITH HOW QUICKLY IT COULD COOK BEANS AND HOW TASTY THEY WERE.

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Figure 2: The mbaula, the most popular charcoal stove in Zambia. it can be used indoors or outdoors. The mbaula is used indoors during the rainy season, and very early in the morning or late at night regardless of the season. Lighting is done outside because of the process involved (pine wood pieces or use of plastic/paper/dry grass) which results in smoke production. Poor quality charcoal also produces smoke when lighting.

Table 3: Popular foods in Mtendere, their typical preparation methods and preferred fuels/devices.

Dish	Process	Pot	Device for cooking
Vegetable	Boil & fry	Ordinary pot	Electric stove
Fresh and dry fish	Boil	Ordinary pot	Charcoal mbaula
Beans	Boil	Ordinary pot	Charcoal mbaula
Trotters	Boil	Ordinary pot	Charcoal mbaula
Fresh fish	Fry	Ordinary pot	Charcoal mbaula
Village chicken	Boil	Ordinary pot	Charcoal mbaula
Munkoyo (maize meal drink)	Boil	Ordinary pot or bucket	Charcoal mbaula
Eggs	Fry	Ordinary pot	Electric stove
Game meat	Boil	Ordinary pot	Charcoal mbaula
Kapenta	Fry	Ordinary pot	Electric stove
Nsima	Boil	Ordinary pot	Charcoal mbaula

MANY PEOPLE SAY THAT FOOD COOKED ON CHARCOAL IS TASTIER THAN ELECTRICITY, AS IT COOKS TOO FAST.

JUST BECAUSE ELECTRICITY CAN COOK QUICKLY, IT DOESN'T MEAN IT HAS TO. IN FACT, SLOW COOKERS COOK EVEN MORE SLOWLY THAN CHARCOAL, ALLOWING MEAT TO TENDERISE AND FLAVOURS TO COMBINE OVER MANY HOURS.

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3.1.2 What fuels, appliances and utensils do you use?

In Shimabala, participants stated that they have different pots for different tasks. Unsurprisingly, big pots are for preparing a large amount of food and small pots for smaller amounts of food. Any pot can be used for cooking nsima and vegetables. In Mtendere, it was reported that the traditional maize meal drink, munkoyo, is normally cooked in a 25 litre bucket and is too big to be placed on the [electric] stove. The beverage requires a lot of heat, time and patience to allow the heat to penetrate and cook thoroughly.

When asked what fuel they use to cook each of the dishes mentioned, the group in Shimabala indicated that the choice of fuel depends on the time of day. They said firewood cooks fast hence the reason it is the first choice for cooking in the morning when there is less time available. All dishes are cooked on firewood, especially kapenta and nsima. People in Mungule normally cook vegetables on firewood. The women responded that they do all their cooking on firewood with a three stone fire. However, they prefer to cook long-cooking dishes on charcoal.

In Ng'ombe and Mtendere, all cooking is done in ordinary pots of different sizes either on electric stoves or on charcoal/mbaula. They cook vegetables, fresh fish, chicken and especially longer cooking dishes such as beans, trotters, beef, even bones (for soup), etc., on charcoal. In Mtendere, nobody was aware of improved cookstoves. The mbaula was the charcoal stove of choice because it allows air to pass through which makes fire light easily and burn intensely, but also because it is the only type available.

ELECTRIC PRESSURE COOKERS COOK EVEN FASTER THAN HOTPLATES, BUT PRODUCE A SIMILAR RESULT TO THE SLOW COOKER BY RAISING THE BOILING POINT OF WATER TO 120C. THE RESULT IS MUCH SOFTER FOOD IN A MUCH SHORTER TIME.

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Table 4: Likes and dislikes of popular fuels expressed by FGD participants (collated from all four FGDs). SH = Shimbala, MG = Mungule, NG = Ng'ombe, MT = Mtendere.

	Likes	Dislikes
Firewood	**Fast** • If you receive unexpected visitors, it is easy to prepare food for them in the shortest time (SH) **Free** • Collected from nearby farmland where they simply have to get permission to harvest the fuel. (SH)	**Smokey** • It produces a heavy smoke when lighting (SH) **Doesn't last long** • Firewood runs out fast while charcoal does not (MG) • More firewood than charcoal needed to cook the same amount of food (MG)
Electricity	**Aspirational** • If we have enough electricity units, we use electricity (MT) • Also good for lighting and refrigeration (SH) **Convenient** • Fast to switch on and cook, just like firewood (SH, MG, MT) • Less labour compared to cooking on firewood and charcoal. (MG) • Time saving (MT, NG) • Can be used any time, e.g. you can wake up at 02:00 to cook in the house at the turn of a button instead of going outside to light a mbaula (MT) **Controllable** • Can be controlled with a knob (MT) • No excess heat lost - all heat is directed towards the pot (MT) **Affordable** • Able to track electricity use &budget for a whole month[1] (NG) **Clean** • No smoke (MG) • It is clean (MT) • Pots do not get dirty when cooking (MG) **Taste** Baking (NG, SH)	**Perceived to be expensive** • Electricity is expensive. (MG) **Payment challenging** • Landlords in this location do not allow their tenants to use electricity to prepare long-cooking dishes[2]. (NG) • If we don't have enough units, we use charcoal (MT) • It is expensive (K100 only lasts for 3 days because their meters use commercial tariffs[3]) (SH) • High transport cost to the nearest sales point for electricity tokens (MG) **Dangerous** • Risk of electric shocks (SH) • Electricity shocks the user (SH, MT) **Taste** • Taste of food different to charcoal (MT) • Cooking long-cooking dishes on the stove at high heat setting removes the taste/flavour. (NG) **Reliability** • Electricity doesn't warm when hotplate has blown up (MT) • Blackouts/power outage (NG, MG) & load shedding (MT)

[1] The household that brought up this point indicated that they were spending about ZMW210 on charcoal per month before grid connection. After, they paid ZMW210 on electricity units, which last more than a month.

[2] Some short-cooking dishes are allowed, as long as there are many units on the meter (>100).

[3] The area has commercial farmers who have agricultural equipment like water pumps.

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	Likes	Dislikes
Charcoal	**Aspirational** • The women could not mention anything they did not like about charcoal. They said they loved it and would pay any amount to acquire it. (NG) **Portability** • Portability of cooking device (mbaula) (SH) **Clean** • Pot is clean when cooking [compared to firewood] (SH) • Space heating (SH) **Taste** • Cooks food well (NG) • Maintains flavour in food (NG) • Produces a nice 'chikoko' of 'chikwangwa' (crust) in nsima and beans (NG) • The traditional maize meal drink, munkoyo, cooks better on charcoal (NG) • Food takes time to cook on charcoal, thereby cooking well. Electricity cooks fast and does not allow food to get cooked inside properly (MT) **Fast** • As long as the fire is well lit, the charcoal cooks fast (NG) **Easy to budget** • Even for as little as ZMW1, a proper meal can be prepared (NG) • Easy for a household to budget, unlike with electricity, which is usually shared (MT) **Convenient** • Charcoal is more convenient and it allows them to do other things as they cook [compared to firewood] (MG) • Charcoal lasts longer and this makes it suitable for cooking long-cooking foods. (MT)	**Difficult to light** • Slow to light (SH) • When not lit properly, it releases bad air which chokes and/or can cause death. (SH) **Expensive** • Charcoal is expensive [compared to firewood] (SH) • Prices shoot up in the rainy season (NG, MT, MU) **Dirty** • Charcoal gets the hands dirty (MT) **Unsafe** • Charcoal is not safe for mothers with young children that are crawling (MT)

COOKING A MEAL FOR 1 ZMW IS ACTUALLY VERY EASY ON ELECTRICITY. THE EVIDENCE FROM THE COOKING DIARIES SUGGESTS THAT ALMOST ALL MEALS CAN BE COOKED FOR UNDER 2KWH, REGARDLESS OF HOUSEHOLD SIZE. AT CURRENT ZESCO PRICES, THIS IS EITHER 0.3 ZMW (IF CONSUMING UNDER 200KWH/MONTH, IF NOT, STILL A MAXIMUM OF JUST 1.78 ZMW).

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3.1.2.1 Where/how do you store each fuel?

In Shimabala, firewood is stacked outside their homes on big stones so that it does not get submerged when the rains come. In other cases, the firewood is made to stand around a tree in the yard. The firewood does get wet in the rainy season but when they want to use it, they separate a bundle from the big stack and put it around the house in an upright position for it to dry: “it is not difficult to use wet wood as it dries once the fire is lit”.

In Shimabala, charcoal is usually kept in the house because it is already packaged in a sack. In Ng’ombe, both firewood and charcoal are stored in the house, because it would be stolen if left outside. In Mtendere, charcoal is stored in the house or outside depending on the season. During the rainy season, it is stored in the house and is kept outside when the rainy season finishes.

SHARED ELECTRICITY METERS ARE A BIG OBSTACLE, AS LANDLORDS CAN NEVER BE SURE QUITE HOW MUCH THEIR TENTANTS ARE ACTUALLY USING. INCLUDING A SUB-METER IN FUTURE GRID E-COOK APPLIANCES COULD HELP OVERCOME THE PERCEPTION THAT COOKING WITH ELECTRICITY IS EXPENSIVE.

3.1.2.2 Availability and seasonal patterns?

In Shimabala, participants noted that “we are approaching the rainy season now. So we cut the firewood for 10 days and we use this from December to April” (6 months).

In Ng’ombe, charcoal is always available, but in the rainy season, traders and transporters of charcoal face a lot of challenges thereby affecting the availability and cost but it is always available. Firewood is readily available during the dry season, but difficult to find especially in rainy season. The users often switch to use planks which they obtain from construction sites. If they desperately want firewood, they have to walk a long distance (up to 2hrs) to Meanwood, Chamba valley.

PV-ECOOK HAS A SIGNIFICANT ADVANTAGE HERE, AS IT IS DISCRETELY PACKAGED, ALLOWING THE SIZE OF THE REPAYMENTS TO CLEARLY COMMUNICATE THEIR AFFORDABILITY TO THE USER.

In Mungule, they still use firewood in the rainy season, but it is more expensive. They use less firewood during the hot season and more during the rainy and cold seasons because of space heating and heating of water for bathing.

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In Mtendere, the cost of charcoal is different over the seasons. In the rainy season, charcoal is expensive because of (i) high demand, and (ii) the difficulty the charcoal producers face during preparation of the fuel. During the rainy season it is difficult to find dry charcoal. Wet charcoal is not easy to light. During the dry season, there is plenty of charcoal available and the cost of charcoal therefore reduces. There is a high fire risk while space heating and choking because of smoke and carbon monoxide emissions.

THE AVAILABILITY OF FIREWOOD AND CHARCOAL VARIES SEASONALLY, WHICH WILL BE SIMILAR FOR PV-ECOOK, AS SIGNIFICANTLY MORE ENERGY WILL BE AVAILABLE IN THE DRY SEASON THAN IN THE RAINY SEASON. UNFORTUNATELY, THIS IS WHEN DEMAND FOR SPACE HEATING & HOT WATER FOR BATHING PEAKS.

3.1.2.3 Cost?

In Shimabala, nobody was producing charcoal, but it was available from the producers at 35 ZMW for a 25kg bag. If bought from the transporters it costs 40 ZMW. The charcoal that ends up at the market costs 60 ZMW. A 25kg bag of charcoal reportedly lasts 7 days for a family of 9, without cooking any beans.

In Ng'ombe, in the rainy season, a 25kg sack costs about 70 ZMW while a 90kg bag costs 200 ZMW. One woman indicated that a 25kg sack can last for a month in her household of 5 people when they extinguish the charcoal after cooking and reserve it for preparing other meals. They use firewood for heating bath water. Firewood is mostly free, but if it is bought, it is at a cost of 15 ZMW for a bundle carried on the head by the trader. The bundle sizes vary and so do the prices.

COOKING BEANS IS A MAJOR DRAIN ON THE FINANCES OF POORER HOUSEHOLDS. THE EVIDENCE FROM THE COOKING DIARIES SHOWS THAT ELECTRIC PRESSURE COOKERS CAN COOK BEANS IN HALF THE TIME AND FOR A FRACTION OF THE COST (UNDER 1 ZMW) OF CHARCOAL.

Table 5: Cost of charcoal in Ng'ombe.

Bags size	Cost (ZMW)	Description	Days used
Medium plastic bag	5	If beans are also cooked	1
		No beans cooked, family of 2	1 and 1/2
25kg	45/50	Household of 2	28 - 30
		Household of 5-8 cooking beans	7

In Mungule, firewood costs 50 ZMW per stack, equivalent to an ox-cart full. This lasts up to a month if supplemented with a 25kg bag of charcoal. Four of the ladies in attendance raised their hands and said their families make and sell charcoal. They also indicated that they sell to neighbours but prefer

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to sell outside the rural area to locations in town for more money. A 50kg bag of charcoal costs 60–80 ZMW in the dry season. During the rainy season the same bag costs 120 ZMW.

ZESCO OFFERS A LIFELINE TARIFF OF 0.15 ZMW/KWH FOR CUSTOMERS USING UNDER 200 KWH/MONTH. ABOVE THIS LEVEL, IT RISES TO 0.89 ZMW/KWH. HOWEVER MOST POORER FAMILIES CANNOT PROPERLY ACCESS THIS, AS THEY LIVE IN RENTED ACCOMODATION WITH A SHARED METER.

In Mtendere, charcoal is also readily available and in the hot season the cost of charcoal is 50 ZMW for 25kg bag and 100 ZMW for a 50kg bag. In the rainy season, the prices range from 65 ZMW for a 25kg bag to 180 ZMW for 90kg bag. A 90kg bag can last for one month if beans are not cooked regularly. For electricity, 200 ZMW can last for 3 weeks if the household is also using an iron. 100 ZMW lasts three to four days for shared meter (here no long-cooking dishes are allowed on the stove. Ironing is allowed).

3.1.2.4 Has anybody tried cooking on electricity?

3.1.2.4.1 If you have electricity at home, when do you use it?

In Shimabala, electricity is normally used for cooking foods fast in the mornings and evenings because you just turn a switch. In Ng'ombe, in households that cook on electricity, it is used in the mornings for water heating and preparing quick meals. It is also used throughout the day to prepare lunch and dinner, including in between meals. For households where the landlords are strict about use of electricity, only quick meals are prepared in the mornings. In Mtendere, electricity is normally used for cooking foods fast in the morning because you just turn a switch unlike charcoal which requires time and getting out of the house to light.

3.1.2.5 Does anybody use task specific appliances (e.g. kettle, rice cooker) or pots (e.g. pressure cooker/kettle without heating element)

In Ng'ombe, those that have specialized pots like electric kettles have been forced to pack them/put away because their landlords do not allow use of such electrical appliances. In Mtendere, kettles (with or without an element) are used for boiling water for tea. In Mungule, cooking is only done in ordinary pots, whether boiling water or cooking relish.

EXISTING EXPENDITURES ON A BLEND OF FIREWOOD AND CHARCOAL SEEM TO BE IN THE ORDER OF 80-200 ZMW PER MONTH. AT 100 ZMW PER MONTH ($10), THE ECONOMIC PROPOSITION OF ECOOK BECOMES VIABLE WITH A 4-5 YEAR PAYBACK PERIOD. AT 200 ZMW PER MONTH ($20), 2-3 YEAR PAYBACK PERIODS BECOME POSSIBLE.

This research is funded by DfID/UK Aid and Gamos through the Innovate UK Energy Catalyst and the MECS programme.

3.1.3 Is there any experience of people changing the way they cook?

In all groups, it was reported that people cook differently according to preferred tasted. Some like to boil foods without frying and others like to fry after boiling.

In Shimabala, some people have changed from cooking on firewood to cooking on electricity. In Ng'ombe, some people that were previously cooking on charcoal are now cooking on electricity. Some participants said that there has not been any change for them because of the houses that they are renting and the landlords do not allow them to do all cooking on electricity. It was also mentioned that most of them will always have a mbaula for back-up.

In Mungule, they are not using the mud stove that was introduced to the area, but they are aware of them. Some years back, firewood was collected but now because most of the land has been sold, they have to buy firewood. Transportation of firewood is difficult because there are no animals to transport thereby affecting supply of the fuel. Charcoal is easier to supply because it can easily be carried on motorbikes.

3.1.3.1 How much resistance to change is there?

In Shimabala, it was stated that there is no resistance but those that are still cooking on firewood either do not have electricity or do not have electric stoves. In Ng'ombe, people are willing to change, but the problem is the issue of buying electricity units. Power outages occur at different times in a day and last from less than 5 minutes to about 8 hours - usually because of a fault, not load shedding. In Mtendere, there was seemingly

THE CONVENIENCE OF BEING ABLE TO TURN ON THE STOVE AND CONTROL THE HEAT OUTPUT AT THE PRESS OF A BUTTON IS HIGHLY VALUED BY THE MAJORITY OF F.G.D. PARTICIPANTS.

EVEN USING INEFFICIENT ELECTRIC HOTPLATES, ELECTRICITY IS ALREADY CHEAPER TO COOK WITH THAN CHARCOAL. HOWEVER, THE PERCEPTION IS THE OTHER WAY AROUND, AS MOST PEOPLE DO NOT TRACK THEIR USAGE THIS CAREFULLY, ESPECIALLY THOSE IN RENTED ACCOMMODATION WITH A SHARED METER.

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no resistance to change of cooking habits. Learning of other ways of preparing dishes is good and if the idea of cooking takes away stressful methods, then it is very welcome and quickly adopted.

IN PERI-URBAN CONTEXTS, MANY HOUSEHOLDS THAT USED TO COLLECT FIREWOOD ARE NOW FORCED TO PURCHASE IT, AS ACCESS TO THE BUSH BECOMES HARDER AS POPULATION DENSITY INCREASES. CHARCOAL IS THE NEXT STEP, AS IT IS MORE ENERGY DENSE, SO IT CAN BE TRANSPORTED FROM FURTHER AFIELD. THIS CREATES AN OPPORTUNITY FOR ECOOK, BECAUSE THIS COMMERCIALISATION OF POLLUTING FUELS IS AN EXISTING EXPENDITURE THAT CAN BE REDIRECTED INTO REPAYMENTS ON AN ECOOK SYSTEM.

3.1.3.2 What would make people change?

In Shimabala, the connection fee is too high. There was a strong suggestion that if government could take the 150 ZMW connection fee promotion to their area, they would get connected and switch to cooking on electricity. In Ng'ombe, education for landlords on how much electricity appliances use was requested. In Mtendere, the speed of cooking- e.g. charcoal is slow, cleanliness of the fuel (electricity is clean while charcoal gets the hands dirty) and safety ("charcoal is not safe for mothers with young children that are crawling") were all seen as key drivers for change.

3.2 Demonstration

Each FGD concluded with a demonstration of an electric pressure cooker to provoke discussion on the compatibility of the device with participants' cooking practices. In Shimabala, we checked on the beans after the 30 minute timer went off. Demonstration of how to open the pressure cooker was done, with the "Dos and Don'ts" explained. The beans just needed a little more time to cook, so it was left to cook for an additional 25 minutes. It was observed by the participants that there was too much water at the end of the cooking process. It was explained to them that since the pot is tightly closed when cooking, almost no water is lost when boiling. The women were delighted to see that the beans had cooked to the observed stage in just 30 minutes. The women also appreciated the "lovely bean smell" when the pressure cooker was opened.

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In Ng'ombe, beans were prepared (about 3 cups) and set it to cook in the pressure cooker at 10:55am. We used the household meter to measure energy consumed. The meter read 46.7 units at start. Safety tips on handling were mentioned with demonstrations. The beans were not completely done the first time the pressure cooker was opened, so we closed it and started another 35 minutes cooking cycle. The pressure cooker was switched off at 12:44pm. The meter reading at the end of cooking was 46.4 units. 0.3units of electricity were consumed to cook the beans. The beans were well cooked and the women were given some to taste.

AS EXPECTED, THE MAIN BARRIERS TO USING ELECTRICITY FOR COOKING HAVE BEEN EXPRESSED BY F.G.D. PARTICIPANTS AS COST (OR AT LEAST PERCEIVED COST), ACCESS AND RELIABILITY. BY DESIGN, ECOOK ADDRESSES THE LATTER TWO OF THESE CONCERNS AND WITH THE SUPPORT OF PAY-AS-YOU-GO FINANCING MECHANISMS, ALSO ADDRESSES THE FIRST.

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Figure 3: Ng'ombe: "The women noted that the beans were well cooked; it had wonderful smell and flavour."

In Mtendere, rice was the dish of choice to show how the pressure cooker worked. Six cups of rice were cooked in 41 minutes with 0.3kWh. The final dish was a pudding that was served to the participants. The women expressed happiness at how well the rice was cooked and the texture. They liked the taste also. They said it tasted different, but in a very good way. They indicated that "someone who was not here to see how it was cooked would never guess what kind of pot cooked the rice". The focus group meeting ended with Jasiel, cook of the day, talking the group through different methods of cooking in the pressure cooker. He talked about how to fry potatoes and cook nshima. "The pot can be used for cooking any dishes, but it becomes a pressure cooker when the lid is placed on it". The women requested for updates on the development of eCook after this research is completed.

MOST PEOPLE HAVE NO IDEA HOW MUCH ELECTRICITY GOES INTO COOKING A TYPICAL DISH AND THEREFORE HOW MUCH IT COSTS. IN CONTRAST, WITH CHARCOAL AND FIREWOOD IT IS PHYSICALLY VERY OBVIOUS. AS A RESULT, THIS FUELS THE PERCEPTION THAT ELECTRICITY IS EXPENSIVE, EVEN THOUGH THE EVIDENCE FROM THE COOKING DIARIES SHOWS THAT IT IS NOT.

IF FUTURE ELECTRIC STOVES WERE TO CONTAIN AN ENERGY METER, WHICH CLEARLY DISPLAYED HOW MUCH MONEY HAD BEEN SPENT ON THE LAST DISH, THE COMPARISON WOULD BE MUCH CLEARER.

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Figure 4: Chef Jasiel serving the rice to the women in the focus group after it had been cooked in the pressure cooker

Figure 5: The bean boiling demonstration in Mungule, which was ironically cut short by a blackout.

MANY PEOPLE ASSUME THAT AN ELECTRIC PRESSURE COOKER CAN ONLY COOK LONG BOILING FOODS. IN FACT, IT CAN FRY, BOIL AND PRESSURE COOK, LEADING MANY TO MARKET THEM AS 'MULTICOOKERS'.

THEY COULD COOK AN EVEN WIDER SET OF DISHES IF IT WERE POSSIBLE TO MANUALLY CONTROL THE HEAT LEVEL IN THE POT DURING FRYING AND BOILING. THIS WOULD ALLOW DEEP FRYING OF DISHES LIKE CHIPS.

This research is funded by DfID/UK Aid and Gamos through the Innovate UK Energy Catalyst and the MECS programme.

3.3 Future cooking practices - what and how would you prefer to cook in the future?

COOKING SLOWLY IS ONE WAY OF ALLOWING HEAT TO PENETRATE ALL THE WAY THROUGH FOOD. RAISING THE TEMPERATURE OF THE WATER THAT IS BOILING THE FOOD WITH A PRESSURE COOKER IS ANOTHER.

3.3.1 Desirable foods and preparation methods

In Shimabala, the women grouped the foods they like to cook and how they prefer to cook them as indicated in the table below. For the food marked under firewood and charcoal, the women said that they prefer to start cooking the dishes on firewood but finish off the preparations on charcoal. They do this so that the food cooks slow with penetrating heat thereby cooking the food “better”. If the dishes are left to cook on firewood up to the end, they burn. This is mostly favoured for long- cooking dishes.

Table 6: Food and choice of fuel in Shimbala.

Foods	Electricity	Firewood	Charcoal
Beans[4]	X		
Cassava leaves (katapa)	X		X
Fresh meats	X	X	X
Rice	X	X	X
Dry fish[4]	X		
Sampo		X	X
Kapenta		X	X
Game meat			X

[4] The respondents stating that they preferred to cook beans & dried fish on electricity were from 2 or 3 small families and seemed able afford to cook the beans and dry fish on electricity. There is no data under firewood and charcoal which could be because the households using these fuels were not cooking those dishes.

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Table 7: Dish and preferred method of preparation in Ng'ombe.

Dish	Preferred method of preparation
Beef	Boil, fry, roast
Beans	Boil
Dry fish	Boil
Bath water	Boil
Chicken	Boil and grill
Cakes/scones, etc.	Baking

3.3.2 Desired fuel/appliance use

3.3.2.1 What are the desirable features of the ideal cooking appliance?

Participants were asked to list the most important features of their ideal cooking appliance and then to rank them. The results of this exercise can be seen in Table 8.

The most preferred mode of acquisition for the women in attendance was monthly instalments. The women also indicated that they have village banks which involve making contributions over a month and then giving out loans to members based on the total amount contributed. They said they would be happy to use a stove provided by ZESCO because previously organizations have come to promote different items, but they are not sustained, and the projects have failed. But ZESCO has been around and have gained a good reputation for sustainability.

ZESCO'S REPUTATION AS AN ESTABLISHED INSTITUTION THAT CAN BE TRUSTED TO PROVIDE LONG TERM SUPPORT COULD BE VERY INFLUENTIAL FOR UPTAKE OF FUTURE ECOOK PRODUCTS.

In Ng'ombe, the women responded that they would all like to do their cooking on electricity so that money that is been used to buy charcoal can instead be used for purchasing electricity units.

In Mungule, other points raised but not rated included:

- Can be used with other appliances
- Can power a fridge
- Community demonstrations (as done with the pressure cooker)
- 10 community technicians trained to support the households.

Solar products were previously promoted in the area in packages of:

- 1000 ZMW - consisting 3 bulbs, stand, wiring, power pack, charging system for phone and a USB. To be paid for over 6 month period.

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- 370 ZMW - consisting 1 bulb, USB, stand but no wiring.
- 150 ZMW - 1 bulb and stand, no charging system.

Table 8: Collated table of prioritised design features for the ideal cooking appliance of FGD participants. Highlighted in green are the features that are relatively easy to incorporate in a future eCook product. In red are those that are more challenging, primarily due to their higher energy demand.

Priority	Desired features			
	Shimbala	**Ng'ombe**	**Mungule**	**Mtendere**
1	Affordability (price)	Access to pot	4 plate/2 plate	Provision for lamp and lamp stand
2	If they will be loaned out, interest should be reasonable	Grey colour	Oven for baking	Oven
3	Should not be portable	1-, 2- and 4-plate with oven	Warmer, which is separate from the cooking point	Separate space for warmer
4	4 and 2- plates with oven -grill[5]	Monthly payment scheme	Not portable, as this will affect the longevity of the appliance	Knobs for adjusting heat
5	Pressure cooker	Big stove with wheels and safety lever	It should be safe - no electric shocks to the user	Plug-in meters (so that they know how much electricity is been consumed)
6	Ownership very important	Demonstrations for safety and easy operations	Can be acquired by making monthly instalments with intentions of owning after final payment	Allows for monthly or pay slow options of acquisition ("village banking practiced here")
7	Monthly payments most suitable	Pressure cooker	Allows for cooking when desired	No electric shocks
8	No electric shocks	Basic operation and	Basic repair training for users	Demonstration of how to use

AFFORDABLE MONTHLY PAYMENTS, ABILITY TO POWER OTHER APPLIANCES AND SAFE DESIGN TO AVOID SHOCKS ARE ALL INTEGRAL FEATURES ANY ECOOK PRODUCT/SERVICE.

USER TRAINING WILL BE CRITICAL, ESPECIALLY IF INCORPORATING APPLIANCES THAT REQIRE SIGNIFICANT CHANGES IN COOKING HABITS, SUCH AS ELECTRIC PRESSURE COOKERS.

BAKING SEEMS TO BE RELATIVELY IMPORTANT, BUT IS THE MOST ENERGY INTENSIVE COOKING PROCESS. FORTUNATELY, MANY ELECTRIC PRESSURE COOKERS COME WITH A 'CAKE' BUTTON THAT COULD PROVIDE AN

A SEPARATE WARMER FOR COOKED FOODS, AUTOMATIC CONTROL MECHANISMS & PRESSURE COOKERS ARE ALL ENERGY-EFFICIENT FEATURES THAT CAN MAKE FUTURE ECOOK PRODUCTS MORE AFFORDABLE.

[5] For "shokaz" (smoked beef pieces).

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		maintenance training for user		
9	Should be in either white or black or grey colour		Can be controlled and its automated	Timer with sensor[6]
10	Height should be similar to the big stoves on the market		Pressure cooker	Basic operation and maintenance training for use[7]
11	Control switch with symbols for those that cannot read		Can be upgraded when financial resources are available	4- plate with solid or coil options
12	Acquire through village banking groups			Height similar to the current big stoves
13	Demonstrations to be held to avoid accidents			Not portable[8]
14	Basic O&M training for user			Pressure cooker
15	Timer			Access to pot[9]

3.3.2.2 What prevents people from using this ideal fuel/device?

In Ng'ombe, everybody would use electricity for all cooking activities if the current issue with their landlords banning electric cooking appliances is sorted out. It was asked how much the electric pressure cooker costs? On being told that the one been used for demonstration cost 750 ZMW, the participants remarked that it is very affordable, and had thought it was 3,000 ZMW or more. They also remarked that:

[6] "So that food does not burn while the cook is attending to other chores."

[7] "Because the user might not be able to afford someone to repair for them"

[8] "Portability not safe with small children around the house"

[9] Dependent on dish being prepared

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"we love it because it can be used to cook even in the bedroom without anyone's knowledge - including our landlords."

THE EVIDENCE SUGGESTS THAT ELECTRICITY IS THE ASPIRATIONAL FUEL FOR MOST HOUSEHOLDS IN ZAMBIA AND THAT ACCESS, AFFORDABILITY (OR PERCEPTION OF AFFORDABILITY) AND RELIABILITY ARE THE MAIN BARRIERS HOLDING BACK ELECTRIC COOKING.

Figure 6: Participants in the Ng'ombe FGD with the electric pressure cooker used during the demonstration.

In Mungule, it was stated that the process to get electricity connection is too long and very costly. In Shimabala, everyone would use electricity for everything, "but at this particular location, good developmental projects seem to skip them"

In Mtendere, it was noted that "from previous experience, we lived in a place where electricity was available to each household and at no cost. Everyone used it for whatever they wanted to. It was noticed that during peak use, there would be low voltage leading to slow cooking of food on the stoves because of high demand". Technical reliability was also mentioned: "breakdown of household equipment due to short circuit".

BLACKOUTS ARE NOT THE ONLY RELIABILITY ISSUE – VOLTAGE DIPS ON OVERLOADED GRIDS SLOW DOWN COOKING SIGNIFICANLTY, ESPECIALLY AT PEAK TIMES, SUCH AS DINNER TIME!

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4 Conclusion

The FGDs have confirmed that there is a strong market for eCook products and services in Zambia. The convenience of being able to turn on an electric stove and control the heat output at the press of a button is highly valued by the majority of FGD participants. Today, electricity is the aspirational cooking fuel in Zambia and as expected, the main barriers preventing its wider adoption have been expressed by FGD participants as cost (or at least perceived cost), access and reliability. By design, eCook addresses the latter two of these concerns and with the support of pay-as-you-go financing mechanisms, also addresses the first.

The findings from these FGDs will be combined with those from the other activities that have been carried under the eCook Zambia Market Assessment. Together they will build a more complete picture of the opportunities and challenges that await this emerging concept. Further outputs will be available from https://elstove.com/innovate-reports/.

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5 Appendix

5.1 Appendix A: Problem statement and background to Innovate eCook project

5.1.1 Beyond business as usual

The use of biomass and solid fuels for cooking is the everyday experience of nearly 3 Billion people. This pervasive use of solid fuels—including wood, coal, straw, and dung—and traditional cookstoves results in high levels of household air pollution, extensive daily drudgery required to collect fuels, and serious health impacts. It is well known that open fires and primitive stoves are inefficient ways of converting energy into heat for cooking. The average amount of biomass cooking fuel used by a typical family can be as high as two tons per year. Indoor biomass cooking smoke also is associated with a number of diseases, including acute respiratory illnesses, cataracts, heart disease and even cancer. Women and children in particular are exposed to indoor cooking smoke in the form of small particulates up to 20 times higher than the maximum recommended levels of the World Health Organization. It is estimated that smoke from cooking fuels accounts for nearly 4 million premature deaths annually worldwide –more than the deaths from malaria and tuberculosis combined.

While there has been considerable investment in improving the use of energy for cooking, the emphasis so far has been on improving the energy conversion efficiency of biomass. Indeed in a recent overview of the state of the art in Improved Cookstoves (ICS), ESMAP & GACC (2015), World Bank (2014), note that the use of biomass for cooking is likely to continue to dominate through to 2030.

"Consider, for a moment, the simple act of cooking. Imagine if we could change the way nearly five hundred million families cook their food each day. It could slow climate change, drive gender equality, and reduce poverty. The health benefits would be enormous." ESMAP & GACC (2015)

The main report goes on to say that "The "business-as-usual" scenario for the sector is encouraging but will fall far short of potential." (ibid,) It notes that without major new interventions, over 180 million households globally will gain access to, at least, minimally improved[10] cooking solutions by the end of the decade. However, they state that this business-as-usual scenario will still leave over one-half (57%) of the developing world's population without access to clean cooking in 2020, and 38% without even minimally improved cooking solutions. The report also states that 'cleaner' stoves are barely affecting the health issues, and that only those with forced gasification make a significant

[10] A minimally improved stove does not significantly change the health impacts of kitchen emissions. "For biomass cooking, pending further evidence from the field, significant health benefits are possible only with the highest quality fan gasifier stoves; more moderate health impacts may be realized with natural draft gasifiers and vented intermediate ICS" (ibid)

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improvement to health. Against this backdrop, there is a need for a different approach aimed at accelerating the uptake of truly 'clean' cooking.

Even though improved cooking solutions are expected to reach an increasing proportion of the poor, the absolute numbers of people without access to even 'cleaner' energy, let alone 'clean' energy, will increase due to population growth. The new Sustainable Development Goal 7 calls for the world to "ensure access to affordable, reliable, sustainable and modern energy for all". Modern energy (electricity or LPG) would indeed be 'clean' energy for cooking, with virtually no kitchen emissions (other than those from the pot). However, in the past, modern energy has tended to mean access to electricity (mainly light) and cooking was often left off the agenda for sustainable energy for all.

Even in relation to electricity access, key papers emphasise the need for a step change in investment finance, a change from 'business as usual'. IEG World Bank Group (2015) note that 22 countries in the Africa Region have less than 25 percent access, and of those, 7 have less than 10 percent access. Their tone is pessimistic in line with much of the recent literature on access to modern energy, albeit in contrast to the stated SDG7. They discuss how population growth is likely to outstrip new supplies and they argue that "unless there is a big break from recent trends the population without electricity access in Sub-Saharan Africa is projected to increase by 58 percent, from 591 million in 2010 to 935 million in 2030." They lament that about 40% of Sub-Saharan Africa's population is under 14 years old and conclude that if the current level of investment in access continues, yet another generation of children will be denied the benefits of modern service delivery facilitated by the provision of electricity (IEG World Bank Group 2015).

> "Achieving universal access within 15 years for the low-access countries (those with under 50 percent coverage) requires a quantum leap from their present pace of 1.6 million connections per year to 14.6 million per year until 2030." (ibid)

Once again, the language is a call for a something other than business as usual. The World Bank conceives of this as a step change in investment. It estimates that the investment needed to really address global electricity access targets would be about $37 billion per year, including erasing generation deficits and additional electrical infrastructure to meet demand from economic growth. "By comparison, in recent years, low-access countries received an average of $3.6 billion per year for their electricity sectors from public and private sources" (ibid). The document calls for the Bank Group's energy practice to adopt a new and transformative strategy to help country clients orchestrate a national, sustained, sector-level engagement for universal access.

In the following paragraphs, we explore how increasing access to electricity could include the use of solar electric cooking systems, meeting the needs of both supplying electricity and clean cooking to a number of households in developing countries with sufficient income.

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5.1.2 Building on previous research

Gamos first noted the trends in PV and battery prices in May 2013. We asked ourselves the question, is it now cost effective to cook with solar photovoltaics? The answer in 2013 was 'no', but the trends suggested that by 2020 the answer would be yes. We published a concept note and started to present the idea to industry and government. Considerable interest was shown but uncertainty about the cost model held back significant support. Gamos has since used its own funds to undertake many of the activities, as well as IP protection (a defensive patent application has been made for the battery/cooker combination) with the intention is to make all learning and technology developed in this project open access, and awareness raising amongst the electrification and clean cooking communities (e.g. creation of the infographic shown in Figure 7 to communicate the concept quickly to busy research and policy actors).

Gamos has made a number of strategic alliances, in particular with the University of Surrey (the Centre for Environmental Strategy) and Loughborough University Department of Geography and seat of the Low Carbon Energy for Development Network). In October 2015, DFID commissioned these actors to explore assumptions surrounding solar electric cooking[11] (Batchelor 2015b; Brown & Sumanik-Leary 2015; Leach & Oduro 2015; Slade 2015). The commission arose from discussions between consortium members, DFID, and a number of other entities with an interest in technological options for cleaner cooking e.g. Shell Foundation and the Global Alliance for Clean Cookstoves.

Drawing on evidence from the literature, the papers show that the concept is technically feasible and could increase household access to a clean and reliable modern source of energy. Using a bespoke economic model, the Leach and Oduro paper also confirm that by 2020 a solar based cooking system could be comparable in terms of monthly repayments to the most common alternative fuels, charcoal and LPG. Drawing on published and grey literatures, many variables were considered (e.g. cooking energy needs, technology performance, component costs). There is uncertainty in many of the parameter values, including in the assumptions about future cost reductions for PV and batteries, but the cost ranges for the solar system and for the alternatives overlap considerably. The model includes both a conservative 5% discount rate representing government and donor involvement, and a 25% discount rate representing a private sector led initiative with a viable return. In both cases, the solar system shows cost effectiveness in 2020.

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[11] The project has been commissioned through the PEAKS framework agreement held by DAI Europe Ltd.

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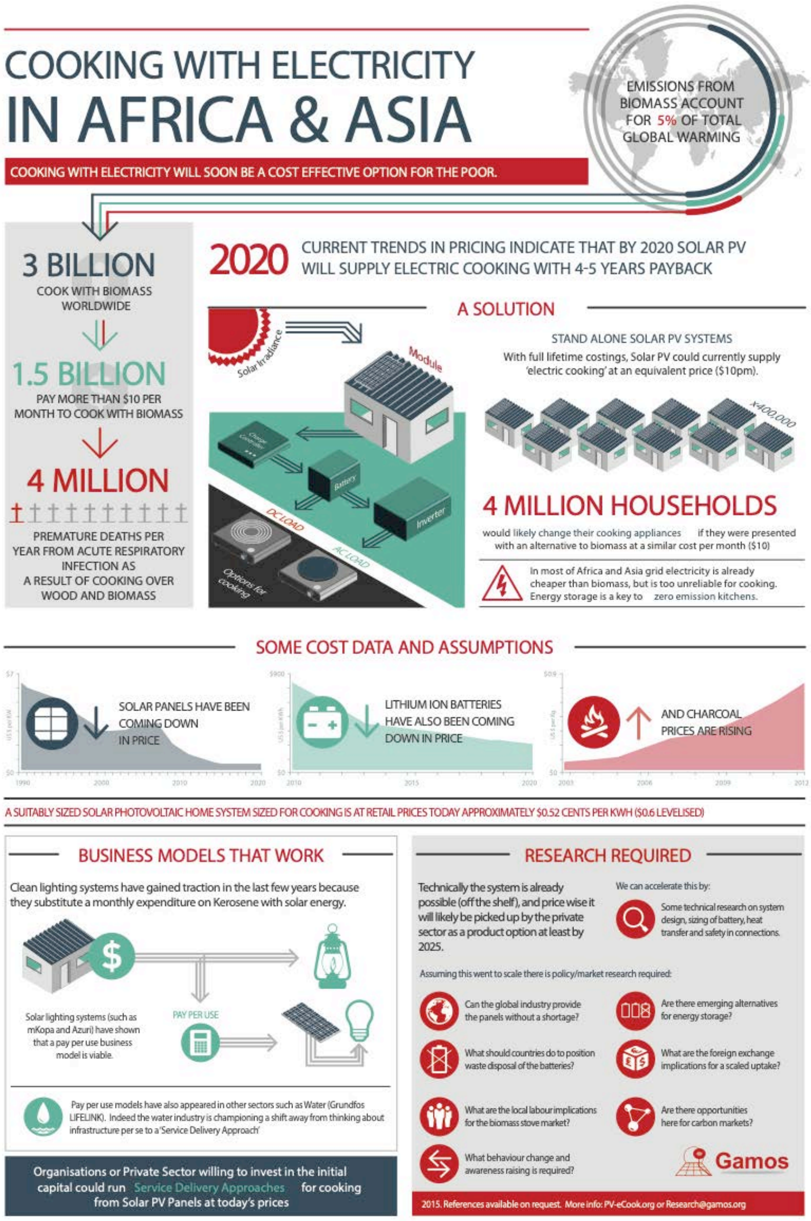

Figure 7 Infographic summarising the concept in order to lobby research and policy actors.

The Brown and Sumanik-Leary paper in the series examines the lessons learned from four transitions – the uptake of electric cooking in South Africa, the roll out of Improved Cookstoves (ICS), the use of LPG and the uptake of Solar Home Systems (SHS). They present many behavioural concerns, none of which preclude the proposition as such, but all of which suggest that any action to create a scaled use of solar electric cooking would need in depth market analysis; products that are modular and paired with locally appropriate appliances; the creation of new, or upgrading of existing, service networks; consumer awareness raising; and room for participatory development of the products and associated equipment.

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A synthesis paper summarising the above concludes by emphasising that the proposition is not a single product – it is a new genre of action and is potentially transformative. Whether solar energy is utilised within household systems or as part of a mini, micro or nano grid, linking descending solar PV and battery costs with the role of cooking in African households (and the Global South more broadly) creates a significant potential contribution to SDG7. Cooking is a major expenditure of 500 million households. It is a major consumer of time and health. Where households pay for their fuelwood and charcoal (approximately 300 Million) this is a significant cash expense. Solar electric cooking holds the potential to turn this (fuelwood and charcoal) cash into investment in modern energy. This "consumer expenditure" is of an order of magnitude more than current investment in modern energy in Africa and to harness it might fulfil the calls for a step change in investment in electrical infrastructure.

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5.1.3 Summary of related projects

A series of inter-related projects have led to and will follow on from the research presented in this report:

- Gamos Ltd.'s early conceptual work on eCook (Batchelor 2013).
  - The key **CONCEPT NOTE** can be found here.
  - An early infographic and a 2018 infographic can be found here.
- Initial technical, economic and behavioural feasibility studies on eCook commissioned by DfID (UK Aid) through the CEIL-PEAKS Evidence on Demand service and implemented by Gamos Ltd., Loughborough University and University of Surrey.
  - The key **FINAL REPORTS** can be found here.
- Conceptual development, stakeholder engagement & prototyping in Kenya & Bangladesh during the "*Low cost energy-efficient products for the bottom of the pyramid*" project from the USES programme funded by DfID (UK Aid), EPSRC & DECC (now part of BEIS) & implemented by University of Sussex, Gamos Ltd., ACTS (Kenya), ITT & UIU (Bangladesh).
  - The key **PRELIMINARY RESULTS** (Q1 2019) can be found here.
- A series of global & local market assessments in Myanmar, Zambia and Tanzania under the "*eCook - a transformational household solar battery-electric cooker for poverty alleviation*" project funded by DfID (UK Aid) & Gamos Ltd. through Innovate UK's Energy Catalyst Round 4, implemented by Loughborough University, University of Surrey, Gamos Ltd., REAM (Myanmar), CEEEZ (Zambia) & TaTEDO (Tanzania).
  - The key **PRELIMINARY RESULTS** (Q1 2019) can be found here.
- At time of publication (Q1 2019), a new DfID (UK Aid) funded research programme '*Modern Energy Cooking Services*' (MECS) lead by Prof. Ed Brown at Loughborough University is just beginning and will take forward these ideas & collaborations.

This data and material have been funded by UK AID from the UK government; however, the views expressed do not necessarily reflect the UK government's official policies.

5.1.4 About the Modern Energy Cooking Services (MECS) Programme.

Sparking a cooking revolution: catalysing Africa's transition to clean electric/gas cooking.

www.mecs.org.uk | mecs@lboro.ac.uk

Modern Energy Cooking Services (MECS) is a five-year research and innovation programme funded by UK Aid (DFID). MECS hopes to leverage investment in renewable energies (both grid and off-grid) to address the clean cooking challenge by integrating modern energy cooking services into the planning for access to affordable, reliable and sustainable electricity.

Existing strategies are struggling to solve the problem of unsustainable, unhealthy but enduring cooking practices which place a particular burden on women. After decades of investments in improving biomass cooking, focused largely on increasing the efficiency of biomass use in domestic stoves, the technologies developed are said to have had limited impact on development outcomes. The Modern Energy Cooking Services (MECS) programme aims to break out of this "business-as-usual" cycle by investigating how to rapidly accelerate a transition from biomass to genuinely 'clean' cooking (i.e. with electricity or gas).

Worldwide, nearly three billion people rely on traditional solid fuels (such as wood or coal) and technologies for cooking and heating[12]. This has severe implications for health, gender relations, economic livelihoods, environmental quality and global and local climates. According to the World Health Organization (WHO), household air pollution from cooking with traditional solid fuels causes to 3.8 million premature deaths every year – more than HIV, malaria and tuberculosis combined[13]. Women and children are disproportionally affected by health impacts, and bear much of the burden of collecting firewood or other traditional fuels.

Greenhouse gas emissions from non-renewable wood fuels alone total a gigaton of CO_2e per year (1.9-2.3% of global emissions)[14]. The short-lived climate pollutant black carbon, which results from incomplete combustion, is estimated to contribute the equivalent of 25 to 50 percent of carbon dioxide warming globally – residential solid fuel burning accounts for up to 25 percent of global black

[12] http://www.who.int/indoorair/health_impacts/he_database/en/

[13] https://www.who.int/en/news-room/fact-sheets/detail/household-air-pollution-and-health https://www.who.int/gho/hiv/epidemic_status/deaths_text/en/, https://www.who.int/en/news-room/fact-sheets/detail/malaria, https://www.who.int/en/news-room/fact-sheets/detail/tuberculosis

[14] Nature Climate Change 5, 266–272 (2015) doi:10.1038/nclimate2491

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carbon emissions[15]. Up to 34% of woodfuel harvested is unsustainable, contributing to climate change and local forest degradation. In addition, approximately 275 million people live in woodfuel depletion 'hotspots' – concentrated in South Asia and East Africa – where most demand is unsustainable[16].

Africa's cities are growing – another Nigeria will be added to the continent's total urban population by 2025[17] which is set to double in size over the next 25 years, reaching 1 billion people by 2040. Within urban and peri-urban locations, much of Sub Saharan Africa continues to use purchased traditional biomass and kerosene for their cooking. Liquid Petroleum Gas (LPG) has achieved some penetration within urban conurbations, however, the supply chain is often weak resulting in strategies of fuel stacking with traditional fuels. Even where electricity is used for lighting and other amenities, it is rarely used for cooking (with the exception of South Africa). The same is true for parts of Asia and Latin America. Global commitments to rapidly increasing access to reliable and quality modern energy need to much more explicitly include cooking services or else household and localized pollution will continue to significantly erode the well-being of communities.

Where traditional biomass fuels are used, either collected in rural areas or purchased in peri urban and urban conurbations, they are a significant economic burden on households either in the form of time or expenditure. The McKinsey Global Institute outlines that much of women's unpaid work hours are spent on fuel collection and cooking[18]. The report shows that if the global gender gap embodied in such activities were to be closed, as much as $28 trillion, or 26 percent, could be added to the global annual GDP in 2025. Access to modern energy services for cooking could redress some of this imbalance by releasing women's time into the labour market.

To address this global issue and increase access to clean cooking services on a large scale, investment needs are estimated to be at least US$4.4 billion annually[19]. Despite some improvements in recent

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[15] http://cleancookstoves.org/impact-areas/environment/

[16] Nature Climate Change 5, 266–272 (2015) doi:10.1038/nclimate2491

[17] https://openknowledge.worldbank.org/handle/10986/25896

[18] McKinsey Global Institute. *The Power of Parity: How Advancing Women's Equality can add $12 Trillion to Global Growth*; McKinsey Global Institute: New York, NY, USA, 2015.

[19] The SE4ALL Global Tracking Report shows that the investment needed for universal access to modern cooking (not including heating) by 2030 is about $4.4 billion annually. In 2012 investment was in cooking was just $0.1 billion. Progress toward Sustainable Energy: Global Tracking Report 2015, World Bank.

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years, this cross-cutting sector continues to struggle to reach scale and remains the least likely SE4All target to be achieved by 2030[20], hindering the achievement of the UN's Sustainable Development Goal (SDG) 7 on access to affordable, reliable, sustainable and modern energy for all.

Against this backdrop, MECS draws on the UK's world-leading universities and innovators with the aim of sparking a revolution in this sector. A key driver is the cost trajectories that show that cooking with (clean, renewable) electricity has the potential to reach a price point of affordability with associated reliability and sustainability within a few years, which will open completely new possibilities and markets. Beyond the technologies, by engaging with the World Bank (ESMAP), MECS will also identify and generate evidence on other drivers for transition including understanding and optimisation of multi-fuel use (fuel stacking); cooking demand and behaviour change; and establishing the evidence base to support policy enabling environments that can underpin a pathway to scale and support well understood markets and enterprises.

The five year programme combines creating a stronger evidence base for transitions to modern energy cooking services in DFID priority countries with socio-economic technological innovations that will drive the transition forward. It is managed as an integrated whole, however the programme is contracted via two complementary workstream arrangements as follows:

- An Accountable Grant with Loughborough University (LU) as leader of the UK University Partnership.
- An amendment to the existing Administrative Arrangement underlying DFID's contribution to the ESMAP Trust Fund managed by the World Bank.

The intended outcome of MECS is a market-ready range of innovations (technology and business models) which lead to improved choice of affordable and reliable modern energy cooking services for consumers. Figure 8 shows how the key components of the programme fit together. We will seek to have the MECS principles adopted in the SDG 7.1 global tracking framework and hope that participating countries will incorporate modern energy cooking services in energy policies and planning.

[20] The 2017 SE4All Global Tracking Framework Report laments that, "Relative to electricity, only a small handful of countries are showing encouraging progress on access to clean cooking, most notably Indonesia, as well as Peru and Vietnam."

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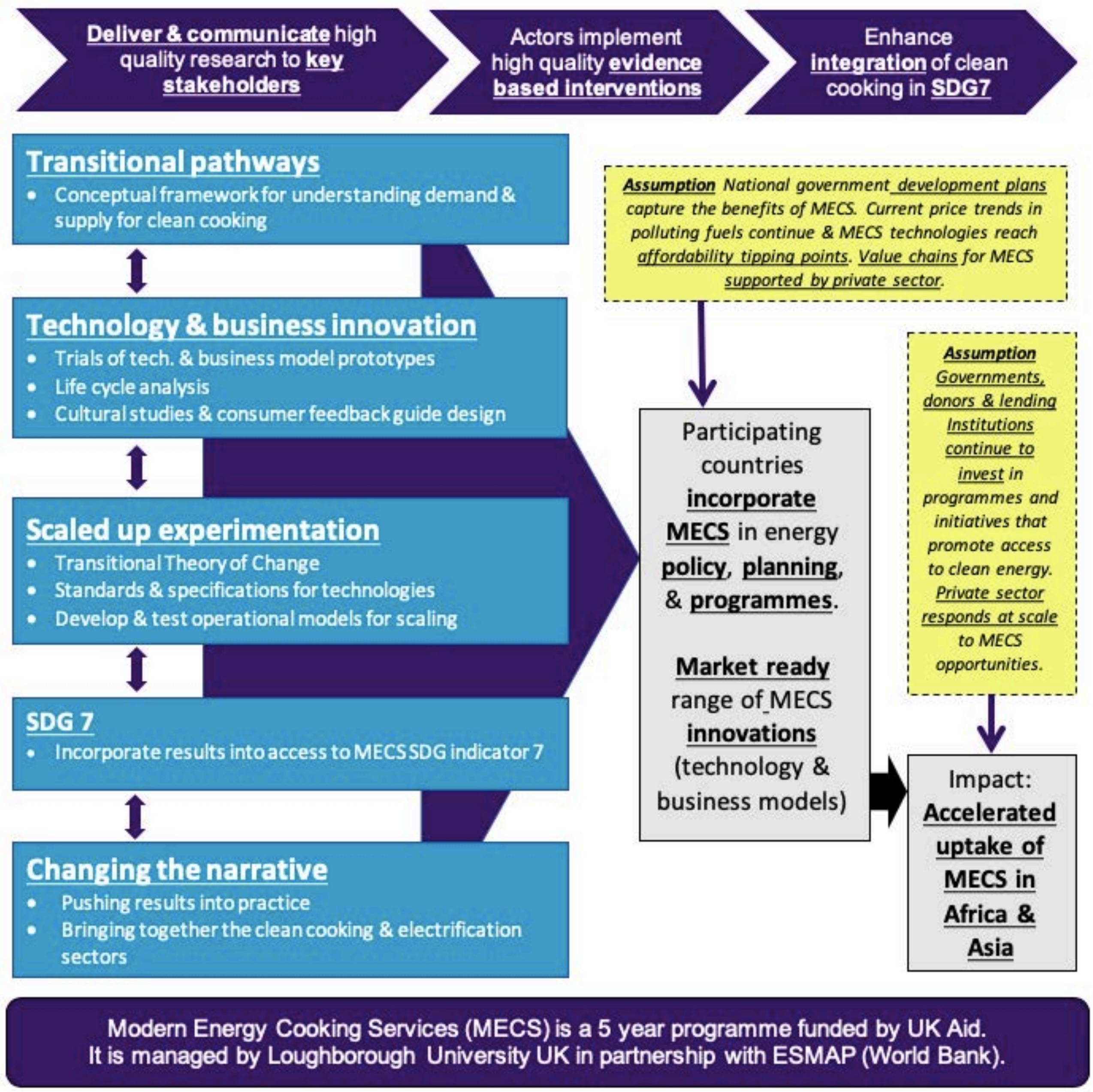

Figure 8: Overview of the MECS programme.

5.2 Appendix B: Focus group design brief

Topics to explore:

1. Current cooking practices - **what do you currently cook and how?**
   - **1.1. What foods do you cook?**
     - **1.1.1. What processes are required for each (e.g. boiling, frying)?**
     - **1.1.2. What appliances do you use for each (both stoves and pots)?**
   - **1.2. Why do you prefer specific fuels/appliances?**
     - 1.2.1. Where/how do you store each fuel?
     - 1.2.2. Availability?
     - 1.2.3. Seasonal patterns?
     - 1.2.4. Cost?
     - **1.2.5. Has anybody tried cooking on electricity?**
       - 1.2.5.1. If so, what did they like and what did they not like?
       - 1.2.5.2. If you have electricity at home, when do you use it?
     - **1.2.6. Do you cook differently on different fuels/appliances? If so, why?**
     - 1.2.7. Does anybody use task specific appliances (e.g. kettle, rice cooker) or pots (e.g. pressure cooker/kettle without heating element)
   - **1.3. Does everybody tend to cook in more or less the same way? If not, why do people cook differently?**
   - **1.4. Is there any experience of people changing the way they cook?**
     - 1.4.1. How much resistance to change is there?
     - 1.4.2. What would make people change (e.g. fuel shortages, fuel prices, access to electricity….)?
2. Future cooking practices **- what and how would you prefer to cook in the future?**
   - 2.1. **Desirable foods and preparation methods** (e.g. what foods would you like to cook more often if they were easier to prepare)
   - 2.2. Desired fuel/appliance use
     - **2.2.1. What are the desirable features of the ideal cooking appliance?**
       - Portability?
       - Multitasking – can people leave food to cook and get on with something else?
       - Access to pot (do you need to stir it the whole time)?
       - Importance of safety
       - Suitable mode of acquisition - self-build/cash/pay-as-you-go/utility
       - Skills for operation/maintenance
       - Access to fuel/device retailers
     - **2.2.2. What prevents people from using this ideal fuel/device?**
       - 2.2.2.1. If electricity were available in everybody's homes and had no cost, would everybody use it for everything or are there other barriers too?

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