eCook Myanmar Cooking Diaries

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Executive Summary

This report presents the key learning points from the cooking diaries study to inform the future development of eCook (battery-supported electric cooking) within Myanmar. The aim of this study is to gain a deeper understanding of how households in Myanmar cook and how compatible this is with electricity. This mixed methods approach gathers data from various sources: cooking diary forms, energy measurements, a registration survey an exit survey.

Despite decades of work on improving the efficiencies of biomass stoves, there seems to be little available data on 'how' people cook. Modern fuels such as gas & electricity are more controllable & can be turned on/off in an instant. There are also a huge range of electric cooking appliances, each designed for specific processes (e.g. microwave for reheating). Therefore, it is important to know how often people are frying, boiling, reheating or doing something else entirely.

22 households (HHs) were asked to keep detailed cooking diaries, recording exactly what they cooked, when and how for six weeks. For the first two weeks they were asked to cook as they would normally, using their usual fuels and stoves. For the remaining four weeks, they were asked to transition to cooking with electricity, using a range of electric cooking appliances, including rice cookers, Electric Pressure Cookers (EPCs), induction stoves and thermo-pots, plus any electrical appliances they already owned. Fuel quantities were measured by weighing firewood, charcoal or LPG cylinders before and after each "*cooking event*"; plug-in electricity meters were used for the electric cooking appliances.

The study samples were drawn from a mixture of rural and per-urban households in the Dry Zone and Ayeyarwady Delta regions and urban households in Yangon and therefore represent an evolved mix of traditional and modern cuisine. A database of foods cooked; cooking time and duration; and energy used was assembled. The probability distributions for the energy required to cook each meal type were produced, and disaggregated as far as possible to explore the influence of a variety of parameters, including fuel, appliance and meal type.

The cooking diaries study in Myanmar has shown that cooking with electricity is compatible with Myanmar cuisine and that modern energy-efficient appliances are highly desirable to everyday cooks. In particular, the rice cooker, electric frying pan, thermo-pot and Electric Pressure Cooker (EPC) are prime candidates for future eCook products. Insulation not only significantly reduces the energy demand for cooking, but also mitigates the impact of short blackouts and low voltage, simply by stopping heat from escaping from the cooking pot.

In Myanmar, electricity is already the aspirational fuel, however the grid is heavily overloaded, placing severe restrictions on how people cook with electricity. Many of the participants from the cooking

diaries study could only cook at certain times of the day, as at peak times, the voltage regularly sags to levels where it is unusable without a voltage stabiliser (<150V). As a result, integrating battery-storage into cooking appliances is likely to be beneficially from both a user and grid-stability perspective. For the user, it would enable cooking throughout the day and predictable performance, as the voltage would be much more stable. Plus it would also allow them to use other low power appliances by also connecting them to the battery. For the grid operator, it would smooth out the load profile, as the battery could be trickle charged at off-peak times and discharged at meal times, effectively time shifting cooking loads into times when spare generating capacity is available.

LPG is not yet popular in Myanmar, as the market was extremely restricted under military rule. However if the market develops, it may well become an attractive option to consumers. Nonetheless, as grid electricity is so cheap in Myanmar and electric appliances such as the rice cooker and electric frying pan are already so embedded within kitchen routines, it is unlikely that many households would completely switch over from electricity to LPG. Instead, a fuel stacking scenario with LPG and electric appliances seems much more attractive for modern cooks in Myanmar wanting to mitigate the highly unstable nature of electricity from the national grid. This scenario would have the additional advantage of combining the manual control of LPG and automatic control of electricity to enable both fine control for specific dishes and multi-tasking.

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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 Myanmar. 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 the design, assembly and testing of a concept prototype to inform the future development of eCook within Myanmar. 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 Myanmar, 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.

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 UK Aid (DfID) 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.

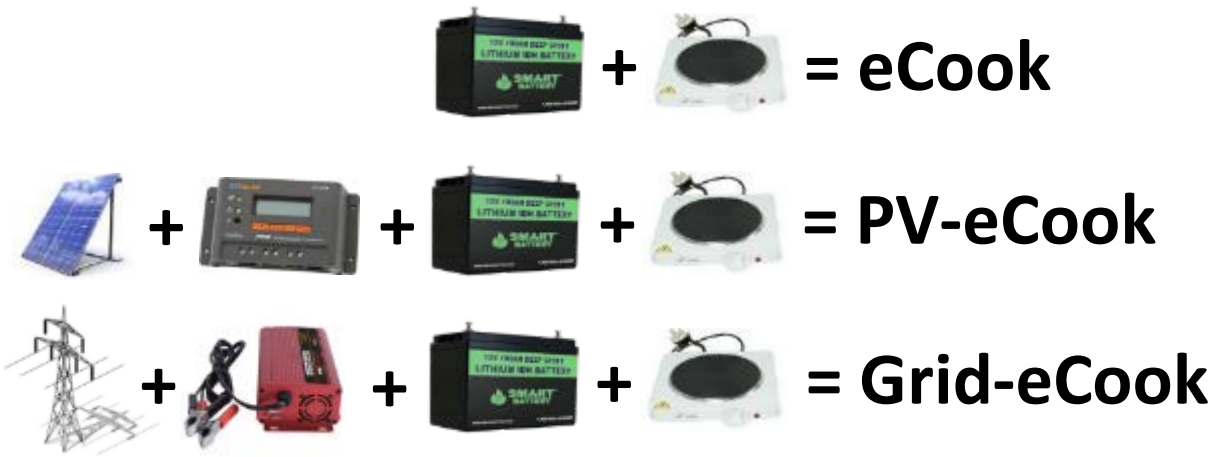

Figure 1: Pictorial definitions of 'eCook' terminology used in this report.

1.1.3 eCook in Myanmar

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 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, highlighting that the liberalisation of Myanmar opens the door to a significant charcoal market, with a small percentage of users already cooking on electricity, paving the way for eCook.

The accompanying reports from the other activities carried out in Myanmar can be found at: https://elstove.com/innovate-reports/ and www.MECS.org.uk.

1.2 Aim

The aim of this study is to gain a deeper understanding of how households in Myanmar cook and how compatible this is with electricity.

In particular, the objectives of the study are:

- To find out what households in Myanmar cook and how
- To assess the user acceptability of electricity for cooking popular Myanmar dishes
    - Can people cook the foods they want?
    - If so, which appliances are best matched with each food?
- To quantify the amount of energy households in Myanmar need to cook
    - To make comparisons between electricity and popular fuels
    - To generate cooking load profiles for typical households

2 Methodology

2.1 The cooking diary methodology

The cooking diary study is an innovative methodology that addresses limitations of the standard tests associated with improved cookstoves. To date, the standard international improved cookstove tests are the Water Boiling Test (WBT), Controlled Cooking Test (CCT) and the Kitchen Performance Test (KPT). None of these tests were designed to give key insights into 'how' a cook cooks, and whether, when they transition to a different fuel or appliance, their cooking practices change. Cooking is a deeply cultural experience, as the foods people cook and the practices they use to prepare them vary widely. To date studies of the 'how' people cook have been based on observational qualitative data.

The cooking diary study was applied in Myanmar to offer a deeper exploration into the unique cooking practices of individual households, paired with quantitative measurements of energy consumption. 22 households were selected to participate in the study, based upon the fuels they cooked with and their willingness and ability to record high quality data for the duration of the study. This mixed methods approach gathers data from various sources:

- *Cooking diary forms*
  - Data on foods cooked, cooking processes and times, appliances used.
  - *Appendix C: Cooking diary form.*
  - *Appendix D: Daily summary form.*
- *Energy measurements*
  - Manual measurements of fuel use and electricity consumption taken by participants.
- *Registration surveys*
  - Simple demographic data on participants.
  -
  - *Appendix B: Cooking* diaries registration form.
- *Exit surveys*
  - Qualitative feedback from participants.

DESPITE DECADES OF WORK ON IMPROVING THE EFFICIENCIES OF BIOMASS STOVES, THERE SEEMS TO BE LITTLE AVAILABLE DATA ON 'HOW' PEOPLE COOK.

MODERN FUELS SUCH AS GAS & ELECTRICITY ARE MORE CONTROLLABLE & CAN BE TURNED ON/OFF IN AN INSTANT. THERE ARE ALSO A HUGE RANGE OF ELECTRIC COOKING APPLIANCES, EACH DESIGNED FOR SPECIFIC PROCESSES (E.G. MICROWAVE FOR REHEATING).

THEREFORE, IT IS IMPORTANT TO KNOW HOW OFTEN PEOPLE ARE FRYING, BOILING, REHEATING OR DOING SOMETHING ELSE ENTIRELY.

- *Appendix E: Cooking diaries exit survey.*

Data was recorded in two stages:

- *Baseline*: cooking as normal.
- *Transition*: cooking with electric appliances only.

2.2 Cooking diaries in Myanmar

Enumerators visited participating households throughout the research. The study began with a registration survey designed to capture basic information on who cooks are cooking for, the appliances they use and why (

Appendix B: Cooking diaries registration form). Enumerators explained the purpose of the research, obtained informed consent from participants and showed participants how to take energy measurements complete the diary forms (*Appendix C: Cooking diary form and Appendix D: Daily summary form).*

Energy measurements were taken before and after each heating event to give '*meal-level resolution'* data (Table 1). Solid, liquid and gaseous fuels were measured using the difference in weight between before and after cooking from a hanging balance, whilst electricity consumption was measured using a plug-in electricity meter (Figure 2). Gas is the hardest fuel to measure by weight, as the weight of gas used in each meal is relatively small compared to the total weight of the cylinder.

Table 1: Measurement techniques for energy consumption during each heating event.

Technique	Equipment	Accuracy	Installation	Procedure
Weight	Hanging balance	5-10g	Metal frame Fixed hanging point far from walls found to ensure hanging object does not touch when being weighed.	Hang bag of biomass, whole kerosene stove or whole LPG cylinder (detaching regulator) before cooking and again after cooking.
kWh metering	Plug-in electric meter	0.001kWh	Plug-in meter plugged into socket, appliances plugged into meter.	Zero meter before cooking, read kWh value after cooking.

Figure 2: a) (left) Plug-in energy meters and b) hanging balance used to measure the total energy consumption of each heating event.

For the first 2 weeks of the study, baseline data was captured on how households currently cooked. Before cooking, the cook would record the time and an energy reading by weighing the fuels they planned to use. After cooking, they would again record time and energy, plus details of what they cooked and how they cooked it. Data was recorded on paper forms (*Appendix C: Cooking diary form and* Appendix D: Daily summary form*)*, which were collected by the enumerators. The first day of data was validated by the enumerators, who described the meal that was recorded to the participant from the recorded data, noting and correcting any inconsistencies. Initially, participants were visited every day, however once they were recording good quality data, the visits gradually decreased to around once a week.

In the second part of the experiment, the households were asked to transition to using solely electricity for cooking. Many households were already using electricity for a significant portion of their cooking, so already owned several appliances, in particular rice cookers and red insulated frying pans. Rice cookers and induction stoves were purchased for all households who didn't already have one. Several participating households also trialled thermo-pots and Electric Pressure Cookers (EPCs). They received basic training on how to use each appliance. The appliances were plugged into a plug-in energy meter (Figure 2), with an extension cable, where necessary. Participants were also able to continue using any electrical appliances that they already owned, as long as they were plugged into the plug-in meter so that energy consumption data could be captured. Data was recorded for a further 4 weeks, allowing participants time to adapt their cooking practices around the new appliances.

The study finished with an exit survey, asking participants about their experience with cooking with different electric appliances *(Appendix E: Cooking diaries exit survey).* Participants were also invited to share their energy-efficient cooking practices by participating in the Chicken Curry eCooking Challenge.

A prize was offered to the participant who could cook half kg of chicken curry using the least energy possible, whilst the enumerators observed and recorded their cooking practices to understand exactly where energy was being saved/wasted.

Paper records kept by participants were transcribed into digital form by the enumerators. An Excel worksheet was designed to mimic the paper form, with a macro to copy data from each 'sheet' into a separate column in the database. Subsequent analysis of the complete database was performed in both SPSS and Excel.

The cooking diaries protocols offer a more complete guide to this methodology for those looking to replicate the cooking diaries study: www.mecs.org.uk/working-papers/

3 Results

3.1 Typical Myanmar foods

An overview of typical preparation techniques for popular Myanmar foods is given below, based upon observations made of cooks during the cooking diaries study. Dishes are categorised into 4 groups according to their compatibility with efficient electric cooking appliances and the potential energy and time savings available: 'heavy', 'staple', 'quick fry' and 'long fry and deep fry' foods.

'Heavy' foods generally require boiling for 60 minutes or more. They are easy to cook on an EPC, which can offer significant energy & time savings over uninsulated appliances (hotplates, induction stoves or infra-red stoves) or a rice cooker with moderate energy savings.

- **Beans** - assumed that other unnamed cereals (peas, lentils, green grams) may well have been put in this category. Usually stewed. Typically dry, so require rehydrating as well as cooking - some people soak before cooking, others just cook for longer. Many people will pre-cook (boil) in bulk and wet fry portions throughout the week.
- **Meat/fish/egg/veg curry** – Stewed meat with a thick sauce. Chicken/fish/egg/veg curries generally cooked for a lot less time than meat, but difficult to separate out without going through the quantity field one by one.
- **Dry fish** - requires rehydrating as well as cooking. Often stewed. Big dried fish take several hours to cook and need long boiling, little dried fish (kapenta), would fit much better in the 'quick fry' category.

'***Staple'*** foods and water that require boiling for 15 minutes or more can also be cooked on an EPC or rice cooker, with moderate energy & time savings.

- **Noodles, Coconut milk noodles, Myanmar vermicelli -** Boiled and then often stir fried
- **Rice** - Usually just boiled. Sticky rice categorised separately below.
- **Soup –** Just boiled**.**

'Quick fry' foods can also be cooked on an EPC or rice cooker, but some households may be reluctant to try and/or there are limited energy savings.

- **Eggs** - Often boiled, but can also be fried.
- **Other meat/fish/tofu** - Typically stir fried.
- **Other veg** - Can be dry fried or wet fried. Some are boiled or blanched beforehand.

'Long fry and deep fry' foods are very difficult to cook on an EPC or rice cooker, as they require precise temperature control.

- ***Pancakes*** - Shallow fried one by one in a shallow pan, as they must be flipped and swapped over many times. Requires low heat evenly distributed throughout the pan.
- ***French fries*** - Deep fried. If oil too hot, they burn, if too cold, they go soggy.
- **Sticky rice** - Boil like normal rice and then shallow fry with low, even heat.

3.2 Overview of data

3.2.1 Overview of participants

AT THE TIME OF WRITING, REGISTRATION SURVEY DATA HAD NOT YET BEEN PROCESSED

3.2.2 Identifying valid records

Paper records kept by participants were transcribed into digital form using an Excel worksheet. Data from each heating event was entered into a separate column. Any given column could cover multiple heating events e.g. an early morning record could include breakfast, preparing food for a baby, and heating water (3 events). Participants created a total of 6,000 records. However, participants were prompted to record details of events in seven periods of the day: early morning, breakfast time, mid-morning and so on, so diligent participants created a large number of records in which no activity took place.

Even if no details were recorded for a particular heating event, participants were asked to indicate why this was the case. Results in Table 2 show that in one third of these cases, no food was eaten. However, it turned out that in some cases, participants gave a reason for not recording data, and also recorded information on a heating event. Examples include:

- participants did not eat but they prepared a meal for lunch and/or dinner (especially in morning periods);
- participants ate food prepared earlier without reheating, but they heated water for tea;
- participants bought food, but only part of the meal (e.g. rice), so they recorded cooking details for the rest of the meal.

Therefore, many cases flagged as having no data do actually contain valid data on heating events.

Table 2 Reasons no heating data recorded

	Frequency	Percent (n=6000)
Forgot to fill in a form	2	0%
Bought food	476	7.9%
Ate food prepared earlier without reheating	1479	24.7%
Ate at friend/family members' place	92	1.5%

Did not eat	2199	36.7%

Before continuing with the analysis, the dataset should be reduced to contain on records with valid data. But what constitutes valid data?

One third of cases are flagged as involving one or more heating event (breakfast, lunch, dinner, heating water, snack, food for baby, and other) – see Table 3. There were additional records, not allocated to any heating event, that contained valid information on foods cooked, and/or water heated. Valid data has been selected to capture all of these records:

- A heating event was specified;
- Detail of food was recorded (Dish 1);
- Any water heating event was recorded (for bathing, purifying drinking water, making hot drinks, or other).

On this basis, and after duplicate records were removed, the analysis has proceeded with a dataset of 1,938 valid records.

There was a substantial number of cases in which food that did not require heating was recorded (mostly bought), but no detail of the food was recorded, nor was it allocated to a specific heating event (e.g. lunch).

Table 3 Number of heating events recorded in each case

		Frequency	Percent
Valid	1.00	1412	23.5
	2.00	315	5.3
	3.00	187	3.1
	4.00	53	.9
	5.00	1	.0
	Total	1968	32.8
Missing	System	4032	67.2
Total		6000	100.0

3.2.3 Description of valid data records

One quarter of data records covered multiple heating events (see Table 4).

Table 4 Number of heating events captured (valid records)

		Frequency	Percent
Valid	1.00	1401	72.3
	2.00	288	14.9
	3.00	159	8.2
	4.00	53	2.7
	5.00	1	.1
	Total	1902	98.1
Missing	System	36	1.9
Total		1938	100.0

Cooking dinner is the most common single heating event (Table 5), closely followed by lunches. The number of breakfasts in the data set is lower because people often bought breakfast (typically mohinga[1]). The breakdown of heating events represented by those records relating to only a single heating event was similar (see Table 6), although water was less often heated on its own as a single event. N.B. of the 1401 cases with a single heating event, 30% included a water heating event (n=422). Only 86 of these were allocated to 'Heat water' as the heating event, which means that 336 single heating events actually included some 'hidden' water heating. These have been filtered out of most calculations in order not to inflate energy consumption figures.

[1] a rice noodle and fish soup from Myanmar and is an essential part of Burmese cuisine (Wikipedia).

Table 5 Number of heating events[2]

Heating event	Frequency	Percent (n=1938)
Breakfast	634	32.7%
Lunch	819	42.3%
Dinner	845	43.6%
Snack	31	1.6%
Baby food	2	0.1%
Heat water	331	17.1%
Other	9	0.5%

Table 6 Breakdown of heating events (single heating event records only)

Heating event	Frequency	Valid Percent
Breakfast	379	27.1
Lunch	421	30.0
Dinner	497	35.5
Heat water	88	6.3
Snack	16	1.1
Total	1401	100.0

[2] N.B. multiple heating events in each record means that total sums to more than 100%.

Myanmar is characterised by cheap electricity:

> *"Myanmar has some of the lowest electricity rates in the world."*[3]

Table 7 Residential electricity tariffs

Consumption (kWh/month)	Kyats/kWh	USD/kWh
0-100	35	0.022
101-200	40	0.025
201+	50	0.031

Residential tariffs (Table 7) are subsidised. Most rural consumers, and half of urban consumers pay only 2.2 US cents/kWh:

> *"Households accessing electricity from private suppliers reported spending 2.2% of total consumer expenditures on electricity, which was also consistent across the income distribution. Low spending is the result of low tariffs and a generous lifeline tariff, coupled with low electricity consumption. A substantial number of (public electricity) households consume below the lifeline tariff (currently set at 100 kWh/month): in urban areas, 30% of households consumed 50 kWh/month or less, and 66% consumed 100 kWh/month or less. In rural areas, 53% of households consumed 50 kWh/month or less, and 88% consumed 100 kWh/month or less."*[4]

Consequently, cooking with electricity is relatively common, especially in urban areas. 35% of households in peri-urban areas are estimated to cook with electricity[5]. Therefore, it is no surprise to find that a high proportion of study participants already cooked with electricity prior to the transition phase of the study. Some of these participants were given energy efficient cooking devices (induction hobs or electric pressure cookers) as a means of transitioning to more efficient style of electric cooking, and

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[3] https://www.mmtimes.com/news/real-cost-myanmars-electricity.html

[4] http://pubdocs.worldbank.org/en/828391449242905722/pdf/Myanmar-National-Electrification-Project-P152936-PAD-for-disclosure.pdf

[5] https://cleancookstoves.org/binary-data/RESOURCE/file/000/000/404-1.pdf

others already had such devices in their homes prior to the study. A five point classification of records was, therefore, considered:

1. Using mainly biomass or LPG (2 participants using LPG, 2 using charcoal, 2 using wood)
2. transitioned to using mainly electricity (5 participants)
3. using mainly electricity (baseline) (10 participants)
4. transitioned to include efficient electrical devices (10 participants)
5. previously equipped with efficient electrical devices (no transition) (5 participants).

The original design of the study was intended to make comparisons between cooking with biomass/LPG and cooking with electricity. The prevalence of participants using electricity prior to the study held out the promise of enabling a further comparison between cooking with 'standard' devices and cooking with energy efficient devices.

An analysis of per capita energy consumptions for the four categories of electricity use cases shows little difference (Table 8). Consumptions among those who transitioned from biomass or LPG (category 2) was similar to those who used popular electrical cooking devices (Category 3). There was no clear reduction in energy consumption when those using electrical devices (category 3) started using efficient devices (category 4). There is some evidence that consumptions were lower among those with experience of using efficient devices (category 5). The range of median per capita electrical energy consumptions for each participant meant that there was a good deal of overlap between all categories.

Table 8 Per capita consumptions for electric heating events

Category	Description	Participants	Cases	Average Per capita energy consumption (median) (MJ/event/person)
2	transitioned to using mainly electricity	4[6]	49	0.43
3	using mainly electricity (baseline)	10	447	0.43
4	transitioned to include efficient electrical devices	10	450	0.42
5	previously equipped with efficient electrical devices (no transition)	5	289	0.40

It was, therefore, proposed to use a simpler classification of cases based on the type of fuel used:

- Category 1: Biomass / LPG (including cases when fuel was used in conjunction with electricity).
- Category 2: Electricity only.

[6] 1 outlier omitted

The five point classification was not able to clearly highlight differences in electrical energy consumptions at the participant level, but analysis of electric heating cases (category 2 in the two point classification) will be able to identify differences in energy consumptions at the device level.

Table 9 shows that this classification splits the sample roughly one third to two thirds.

Table 9 Classification of heating event records

		Frequency	Percent
Valid	uses biomass/LPG	593	30.6
	uses electricity only	1292	66.7
	Total	1885	97.3
Missing	System	53	2.7
Total		1938	100.0

Table 10 shows that biomass and LPG were more likely to be used when preparing breakfast (than electricity), while lunches were more likely to be prepared using electricity.

Table 10 Breakdown of heating events by category (single heating event records only)

Heating event	**Biomass/LPG (Category 1)**		**Electricity only (Category 2)**	
	Frequency	**Valid Percent**	**Frequency**	**Valid Percent**
Breakfast	172	45.5%	197	19.9%
Lunch	72	19.0%	340	34.4%
Dinner	114	30.2%	370	37.4%
Heat water	16	4.2%	70	7.1%
Snack	4	1.1%	11	1.1%
Total	378	100.0%	988	100.0%

Energy consumption is proportional to the number of people being cooked for. Overall, the mean number of adults per heating event was 3.8, and the mean number of children was 1.4 (n=791). If children are weighted the same as adults, then the mean number of persons per heating event was 4.4 (n=1875). Most cases catered for 2 to 6 household members – see the distribution in Figure 3.

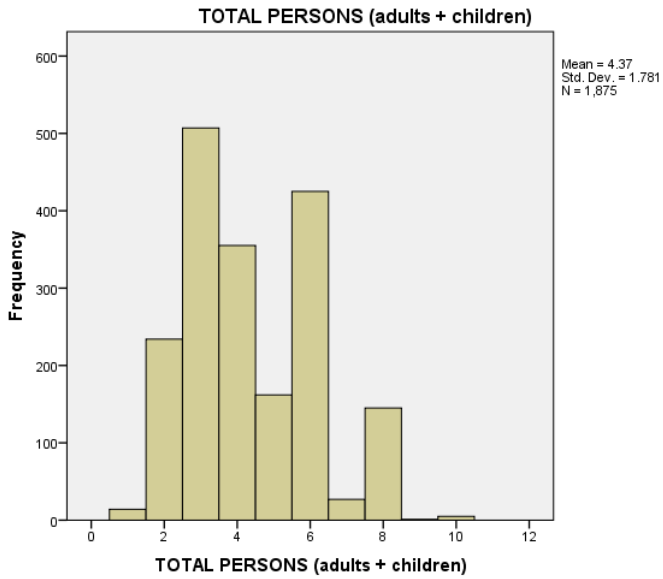

Figure 3 Distribution of persons per heating event

3.3 Energy consumptions

For each of the four dominant fuels, energy consumptions have been calculated from deduced fuel consumptions (based on the before and after readings e.g. weight of wood (kg)) and the calorific values given in Table 11.

Table 11 Calorific values[7]

Fuel	Calorific value
Wood	15.9 MJ/kg
Charcoal	29.9 MJ/kg
LPG	44.8 MJ/kg
Electricity	3.6 MJ/kWh

[7] Source: World Bank (BLG14 Cooking Costs by Fuel Type.xlsx)

3.3.1 Mix of fuels

The mix of fuels used in Category 1 cases is presented in Figure 4. This shows that wood and charcoal account for the majority of energy consumed (91%). Only electricity was consumed in the Category 2 cases.

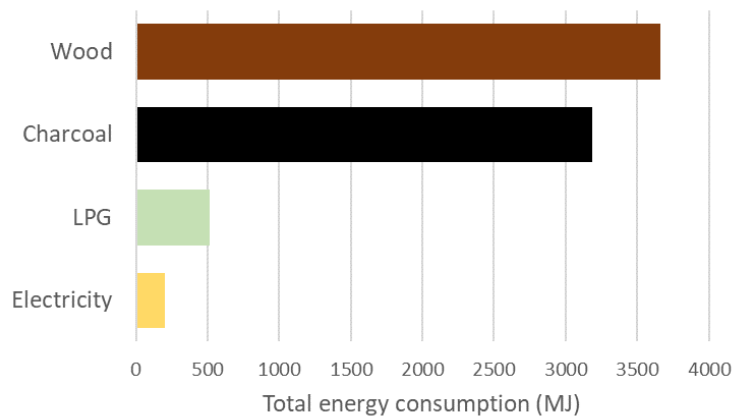

Figure 4 Energy content of fuels used in Category 1 (n=593)

Table 12 shows that in over one quarter of cases, biomass or LPG was used in conjunction with another fuel. Table 13 shows that only three participants used LPG, and among participants who used biomass, one third used both wood and charcoal

Table 12 Number of fuels used in single heating event

	Category 1		Category 2	
	Frequency	Percent	Frequency	Percent
1	427	72.0%	1292	100.0%
2	166	28.0%		
Total	593	100.0%	1292	100.0%

Table 13 Use of fuels by participants (both categories)

	Electricity	LPG	Charcoal	Wood
1	x			
2	x	x		
3	x		x	x
4	x		x	

5	x			x
6	x		x	
7	x			x
8			x	x
9	x		x	x
10	x		x	x
11	x	x		
12	x			x
13	x		x	
14	x			
15	x			
16	x		x	
17	x	x	x	
18	x			
19	x			
20	x			
22	x			

3.3.2 Per capita consumptions

It has already been pointed out that energy consumption depends on the number of people being cooked for. Per capita energy consumptions have been calculated simply by dividing the energy consumption for the heating event by the number of people that the meal was cooked for. Note that adults and children have been given an equal weighting when calculating per capita consumptions.

Among Category 1 records, different participants used different fuels, so per capita energy consumption values will depend on the fuel being used. A single fuel was used in most heating events (Table 12), so per capita consumptions for heating events using a single fuel only have been calculated (Table 14). This table presents data from 418 out of 593 heating events in Category 1. Totals indicate that cooking with charcoal uses roughly seven times as much energy as cooking with electricity (in Category 2), and cooking with wood uses over eight times as much energy. Even though the number of records and households is small, figures indicate that LPG uses twice as much energy as electricity.

Table 14 Per capita energy consumptions and number of people cooked for – single fuels only

Participant ID	Category 1									Category 2		
	LPG			Charcoal			Wood			Electricity		
	Median	People (mean)	N	Median	People (mean)	N	Median	People (mean)	N	Median	People (mean)	N
1										0.92	2.0	81
2	1.94	3.0	16							0.69	3.0	18
3							2.2	5.9	46	0.25	6.0	67
4				2.5	6.0	7				0.21	5.9	138
5							2.7	6.0	46	0.16	6.0	11
6				2.6	8.0	5				0.16	8.0	121
7							3.2	3.0	45	0.30	2.9	64
8				3.1	6.0	38						
9				2.5	6.0	29				0.47	6.0	14
10												
11	0.75	3.8	6							0.52	5.0	39
12							6.7	2.7	64	1.11	2.0	26
13				3.0	5.0	28				0.23	5.1	36
14										0.50	3.1	184
15										0.60	3.9	50
16				6.4	4.0	14				0.29	4.0	65
17	0.67	4.0	62	3.3	4.0	8				0.40	4.0	6
18										0.58	3.0	190
19										0.47	2.8	34
20										0.25	4.9	71
22										0.75	2.9	44
Total	0.75	3.8	84	2.8	5.5	131	3.2	4.2	203	0.38	4.3	1261

* results shown only for participants with 5 or more cases.

The main fuels used other than electricity were wood and charcoal; Figure 5 and Figure 6 plot median per capita energy used against the mean number of people for each, but only for heating events where only wood or only charcoal was used. A regression analysis shows that per capita wood energy consumption goes down when cooking for larger numbers of people ($\beta = -0.935$, $p < 0.001$), as does the per capita consumption of charcoal ($\beta = -0.883$, $p < 0.001$).

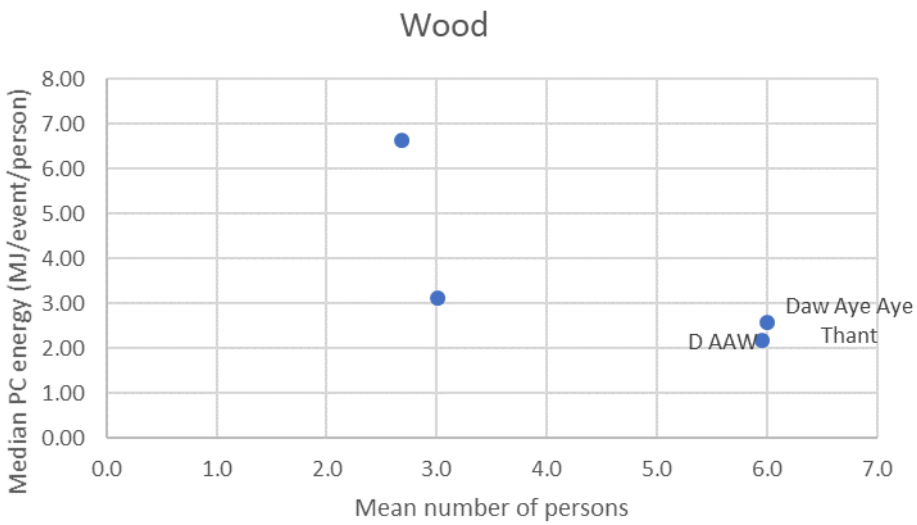

Figure 5 Relationship between per capita energy consumption and number of people – Category 1 Wood

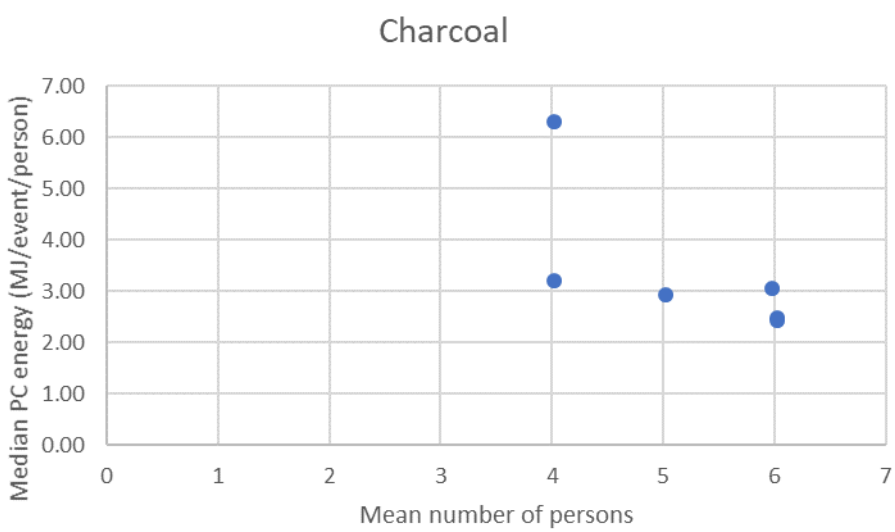

Figure 6 Relationship between per capita energy consumption and number of people – Category 1 Charcoal

Figure 7 presents consumption data for Category 2 records, but only those heating events where only electricity was used. Note the difference in scales between Figure 5 / Figure 6 and Figure 7. Regression analysis shows that per capita electrical energy consumption also goes down with the number of people cooked for ($\beta = -0.114$, $p < 0.001$).

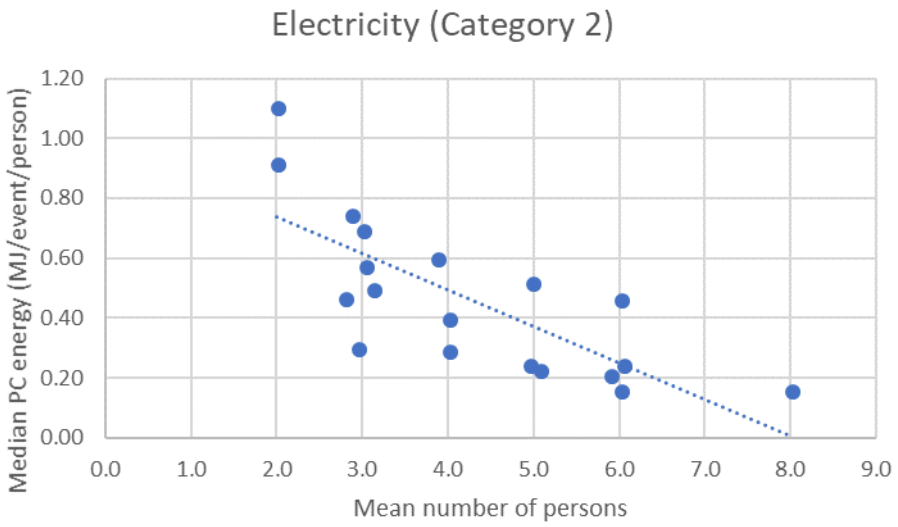

Figure 7 Relationship between per capita energy consumption and number of people – Category 2 Electricity

These findings suggest that economies of scale can be achieved when using all three fuels. This might be expected when cooking with biomass fuels – the size of the fire required to cook being almost independent of the amount of food being cooked. However, it is somewhat surprising to find the same effect when cooking with electricity, especially given the widespread use of energy efficient electrical devices, notably rice cookers.

3.3.3 Energy consumption by heating event

Summing the energy consumed in all Category 1 records shows a huge amount of energy used to cook breakfasts, most of which was wood (see Figure 8), however, wood was hardly used for lunches. LPG was not used for cooking breakfasts.

The mix of fuels used for different events in Category 1 cases is also illustrated in Figure 9. Note that this chart presents the number of occasions (or cases) in which fuels were used – it does not reflect the amount of energy used, which is presented in Figure 8. It shows that for participants not using electricity as their main cooking fuel:

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- Wood was the dominant fuel of choice for breakfasts, yet it was not used at all for lunches (on its own)
- charcoal was the fuel of choice for lunches;
- LPG was not used for dinners (on its own).

The median per capita energy consumptions for each type of heating event illustrate differences in the overall conversion efficiencies associated with different fuels (Figure 10). Figures in Table 15 to Table 18 show inconsistencies in the way different fuels are used for different meals. Breakfasts are most energy intensive when cooking with charcoal, and dinners when cooking with wood (on a per capita basis).

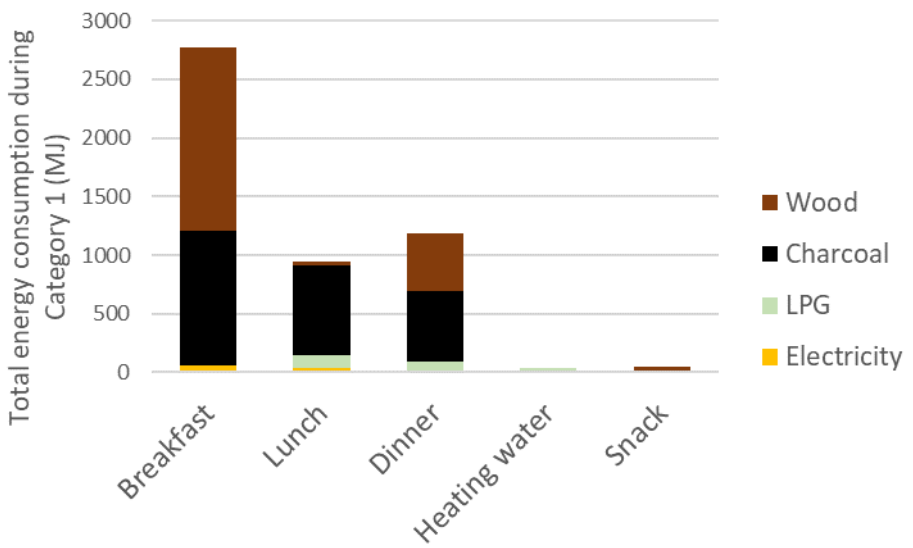

Figure 8 Total energy consumption by heating event (Category 1)

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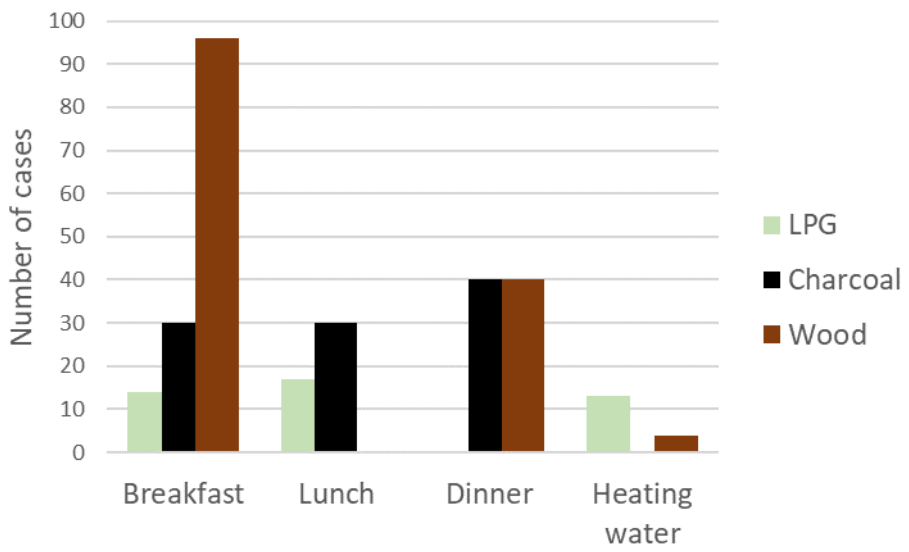

Figure 9 Choice of fuels for heating events (Category 1) single fuel only

Table 15 Per capita energy consumption by heating event – Category 1 LPG only

Heating event	Frequency	Mean (MJ/pers/event)	Median (MJ/pers/event)	Std.dev.	25% Quartile	75% Quartile
Breakfast						
Lunch	13	0.79	0.67	0.36	0.54	1.02
Dinner	17	0.74	0.67	0.30	0.59	0.79
Heating water	13	0.54	0.55	0.17	0.45	0.59
Snack						
Food for baby						

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Table 16 Per capita energy consumption by heating event – Category 1 Charcoal only

Heating event	Frequency	Mean (MJ/pers/event)	Median (MJ/pers/event)	Std.dev.	25% Quartile	75% Quartile
Breakfast	15	5.72	5.98	2.19	3.49	7.48
Lunch	27	3.45	2.62	2.82	1.94	3.49
Dinner	32	2.34	1.99	0.97	1.50	2.99
Heating water						
Snack						
Food for baby						

Table 17 Per capita energy consumption by heating event – Category 1 Wood only

Heating event	Frequency	Mean (MJ/pers/event)	Median (MJ/pers/event)	Std.dev.	25% Quartile	75% Quartile
Breakfast	19	3.07	2.65	0.97	2.12	3.98
Lunch						
Dinner	21	2.02	1.86	0.86	1.33	2.57
Heating water						
Snack	3	6.10	**6.76**	2.65	3.18	.
Food for baby						

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Table 18 Per capita energy consumption by heating event – Category 2 Electricity only

Heating event	Frequency	Mean (MJ/pers/event)	Median (MJ/pers/event)	Std.dev.	25% Quartile	75% Quartile
Breakfast	96	0.27	0.21	0.15	0.16	0.32
Lunch	318	0.56	0.43	0.45	0.25	0.72
Dinner	306	0.29	0.20	0.56	0.14	0.28
Heating water	56	0.58	0.41	0.44	0.26	0.91
Snack	10	0.31	0.27	0.17	0.20	0.50

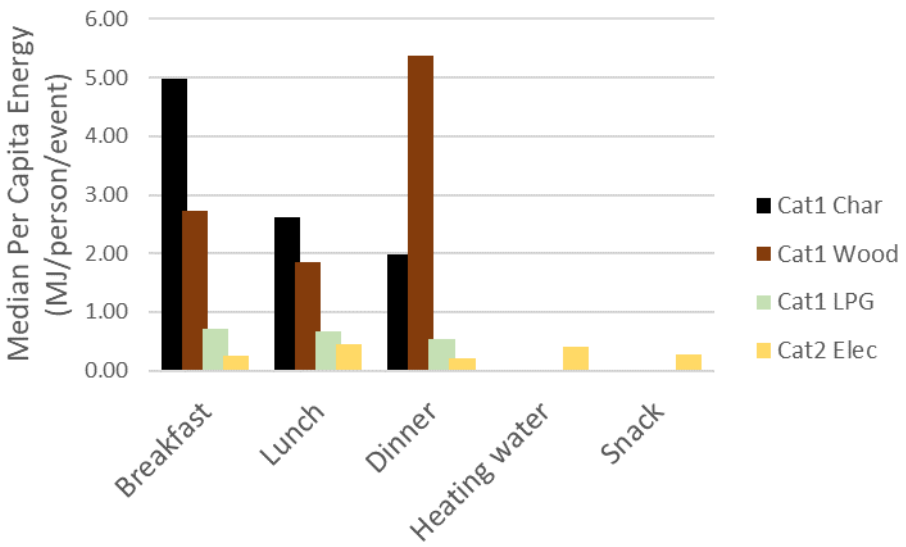

Figure 10 Per capita energy consumptions for different heating events

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3.3.4 Energy consumption per day

The total energy consumed per day has been calculated as the sum of the energy consumption of all heating events on a given date. Data has been calculated for 426 Category 1 person-days, and 676 Category 2 person-days.

In order to compare the energy required by different fuels to meet daily household needs, an analysis has been conducted on only those days in which a single fuel was used for all heating events recorded in a day. Not all meals are necessarily prepared each and every day (and neither are other heating events). Table 19 shows that dinners and lunches were prepared most days, and breakfasts only on around half of days (N.B. these values will be skewed towards the patterns of behaviour of those participants who submitted records for a greater number of days.

Daily household energy consumptions, based on these daily patterns of heating events, are presented in Table 20. Note that these values have not been normalised for the number of people catered for – rather, they show the range of total daily energy consumptions at the household level, which is dependent on the number of people that each meal was prepared for. The mean number of household members catered for has been calculated for each day (across however many meals were prepared), and the table presents the mean of these means. This indicates that wood and charcoal energy consumption is an order of magnitude higher than the energy required when cooking with electricity. The table also shows a nuancing of fuels chosen to cook different meals (category 1 records) – participants who cooked with only LPG throughout the day prepared lunches almost all days, and few breakfasts; those who cooked only with wood almost cooked breakfasts almost all days. N.B. any participant may appear in different rows, e.g. they may cook with charcoal only on some days, and wood only on other days (e.g. when the charcoal has run out).

Table 19 Participant-days in which heating events were flagged

	Frequency	Percent (n=953)
Breakfast	624	66%
Lunch	766	80%
Dinner	799	84%
Heating water	240	25%

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Table 20 Total daily energy consumption (MJ/household/day) – use of single fuel in a day

	Daily energy consumption (MJ/household/day)					Proportion of days with heating event				Household members (mean of means)
	n	Mean	Q1	Median	Q3	Breakfast	Lunch	Dinner	Water heating	
LPG (Category 1)	26	7.2	4.5	7.2	9.5	19%	92%	89%	65%	3.3
Charcoal (Category 1)	26	35.4	28.4	32.1	44.5	89%	8%	92%	0%	5.9
Wood (Category 1)	62	24.4	18.2	23.9	31.8	98%	57%	92%	31%	4.2
Electricity (Category 2)	476	4.0	2.4	3.7	5.1	57%	87%	77%	20%	4.0

Many participants cooked with electricity throughout the survey, and few made a discernible transition from biomass / LPG to electricity. It is not possible, therefore, to plot daily load profiles for individual fuels. Instead, the following figures present profiles for an illustrative mix of households:

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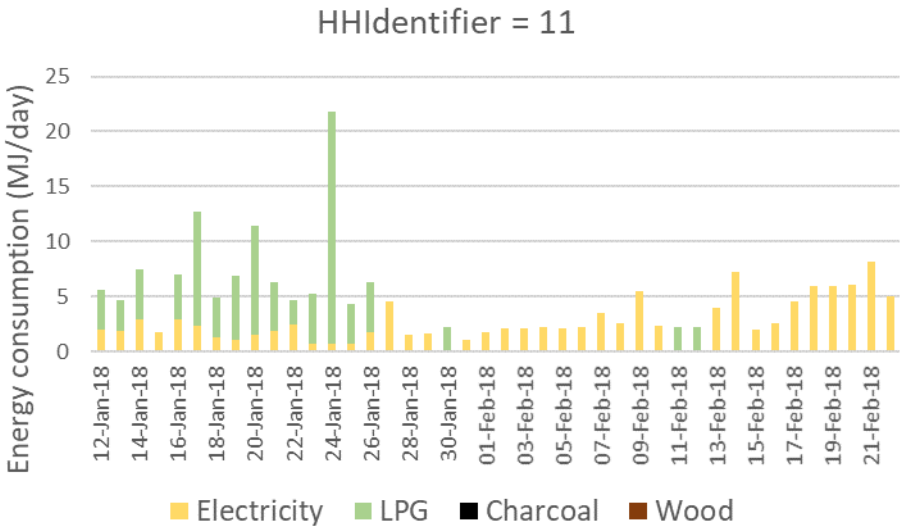

Figure 11 Daily load profiles - LPG/electric transition to all electric

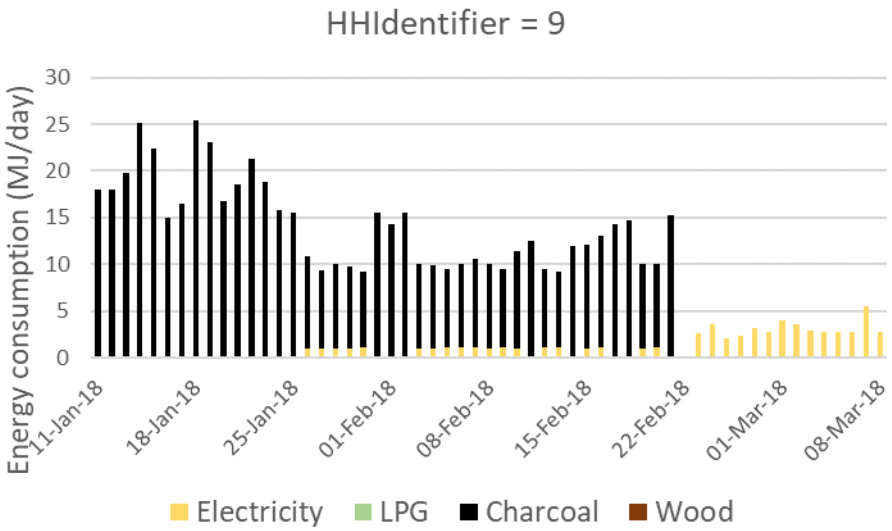

Figure 12 Daily load profiles - Charcoal/electric transition to all electric

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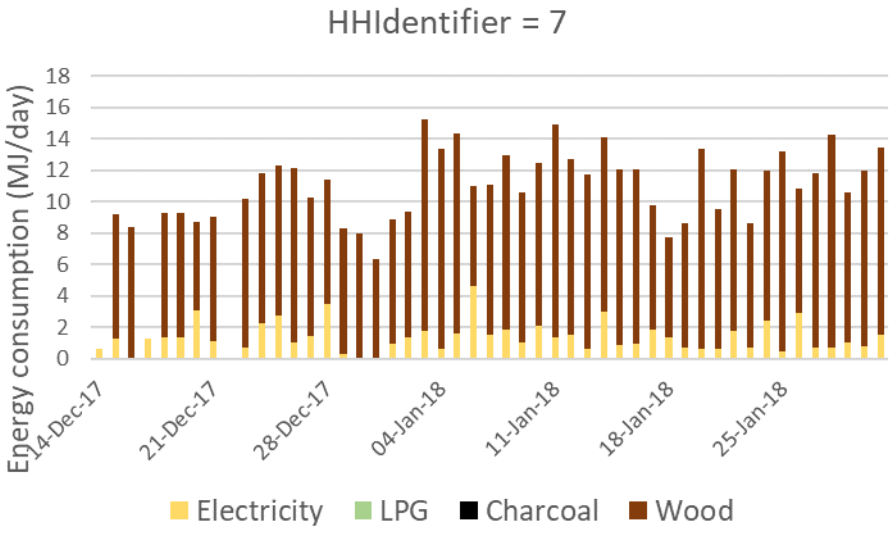

Figure 13 Daily load profiles - Wood/electric (no transition)

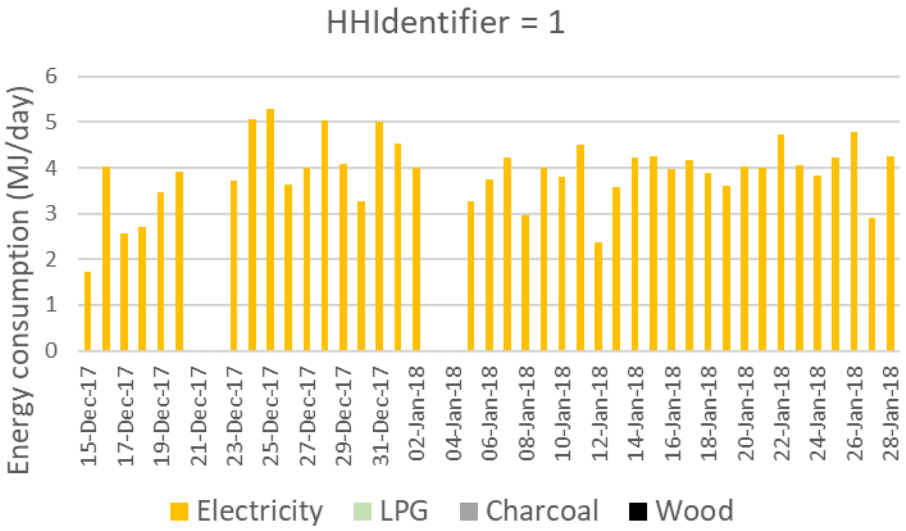

Figure 14 Daily load profiles – All electric (no transition)

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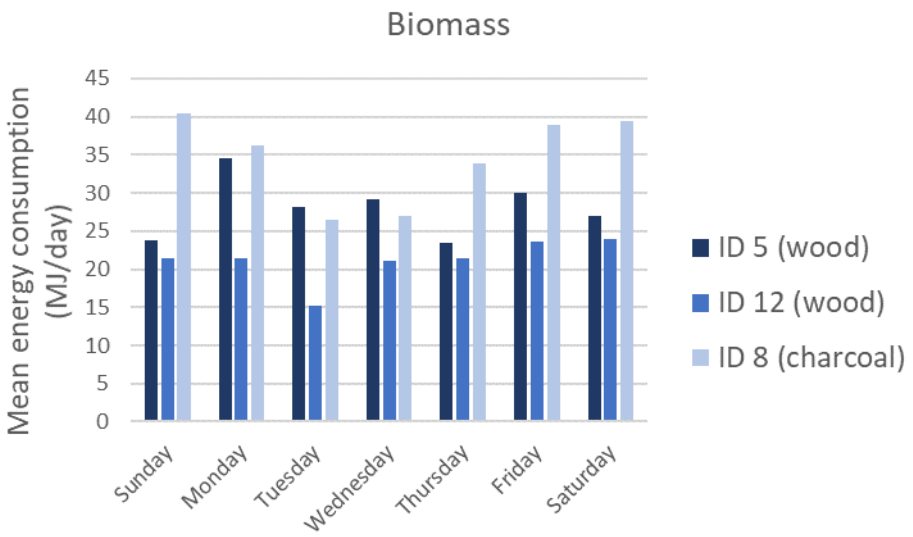
Daily energy demand profiles in Figure 11 to Figure 14 show wide fluctuations in daily energy consumption. Mean energy consumptions by day of the week for example participants using biomass are presented in Figure 15. These show a trend of slightly lower consumptions during the middle of the week. Note that these figures typically represent the means of only 3 to 5 days. This is not so clear among participants using electricity (Figure 15).



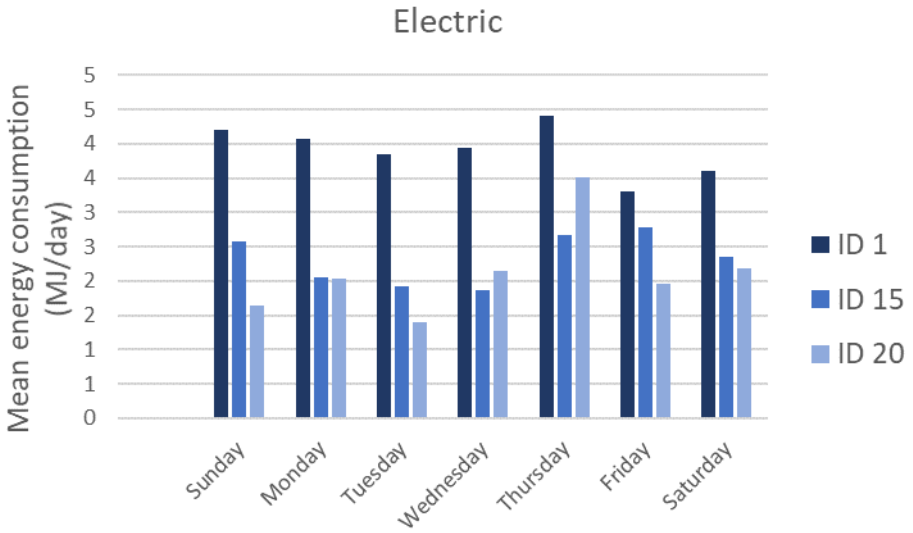


Figure 15 Mean daily energy consumption by day of the week

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3.3.5 24 hour electricity load profiles

The energy consumption for any given day has been estimated from records for multiple heating events (e.g. breakfast, lunch, dinner, heating water) – see Table 20. For each heating event, average power consumption has been calculated for the time period during which the meal was prepared by dividing the energy consumption by the time duration of the heating event (both start and end times for the preparation of the meal were recorded for each heating event). Load patterns have been added together for multiple heating events occurring on the same date to create a 24 hour load profile for each day, for each household.

Two types of chart have been created:

- A multiple line chart showing 24 hour profiles for seven days (not necessarily consecutive days making up a week); this illustrates how much the shape of daily load profiles changes from day to day;
- A single line chart in which all daily load profiles have been aggregated together to give a smoother 'average' profile.

While these load profiles give a good idea of the overall patterns of consumption, they are conservative, in that they do not include all electricity consumed. There are several reasons for this:

- Some records were omitted because they had incomplete (or nonsensical) electricity meter readings.
- Many records had incomplete start/end times for the heating event
- Some combinations of energy consumption and event duration give unreasonably high power levels, so a filter has been used to include only those records with an average power of 2.5 kW or less.

The load profiles in Figure 16 suggest that loads from most household exhibit two peaks, one for preparing breakfast and another for preparing an evening meal e.g. Household ID 1,5. Others show three distinct peaks e.g. Household ID 6, 18.

When loads from all households are aggregated together, the combined effect is for an early morning peak, as all households prepare breakfasts, and more diluted peaks in late morning and evening – see Figure 17.

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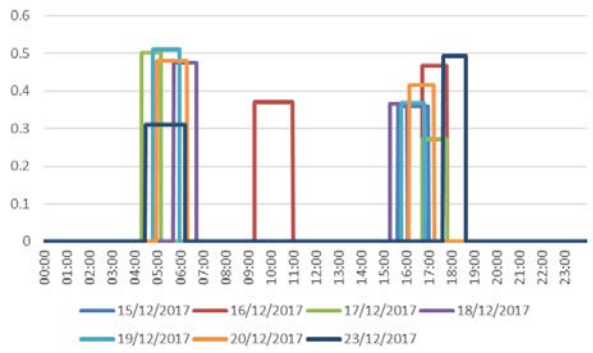
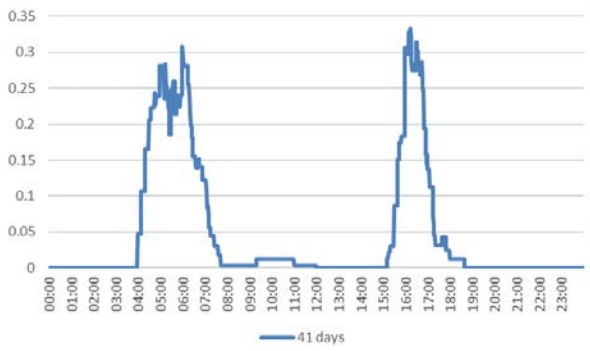
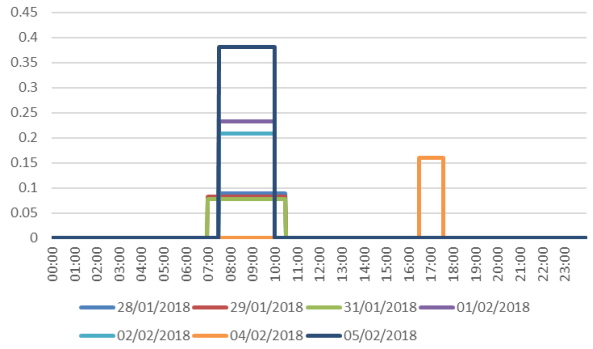
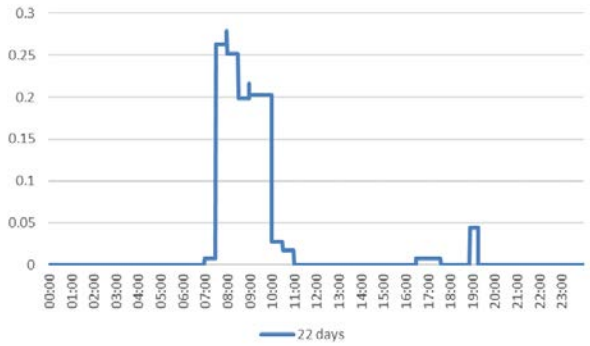
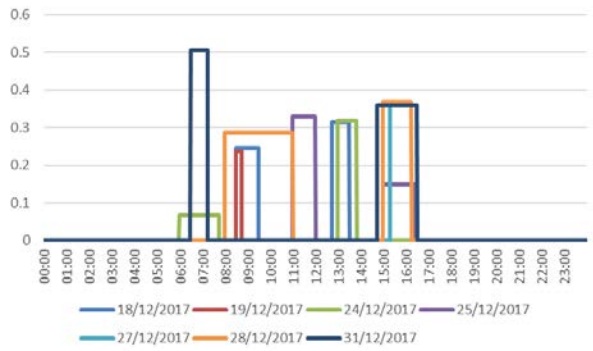
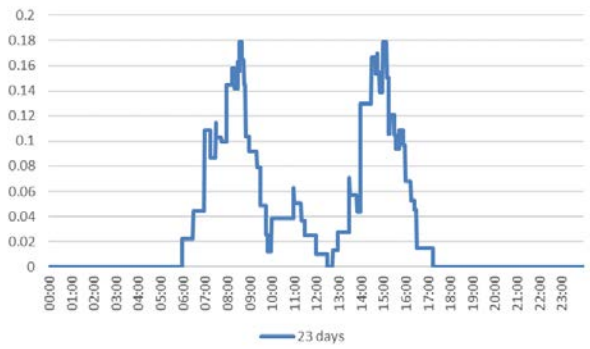
1		
2		
3		

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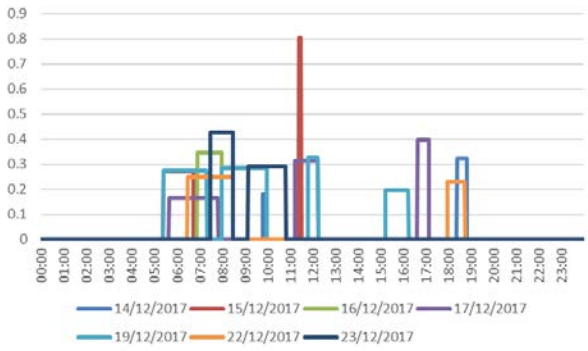
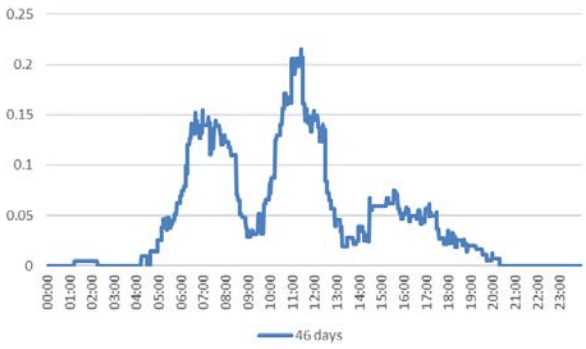
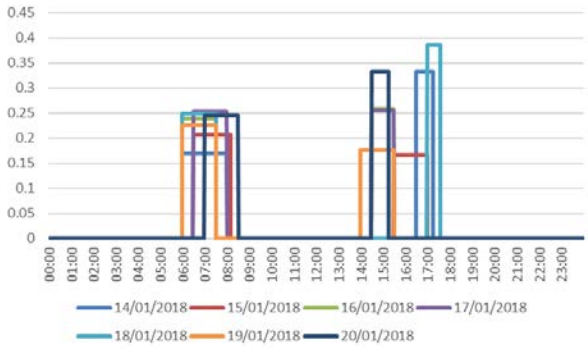
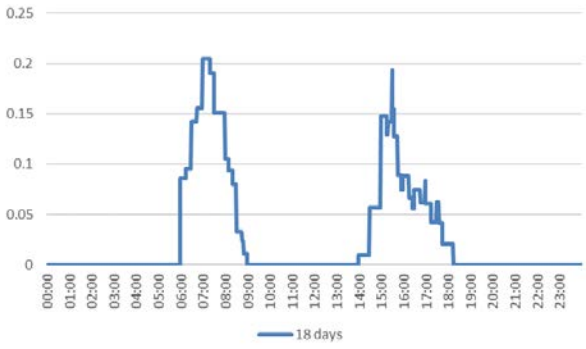
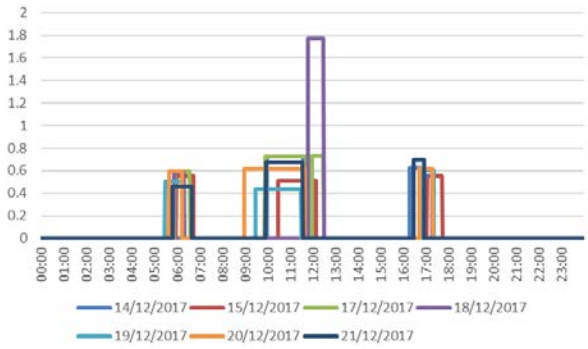
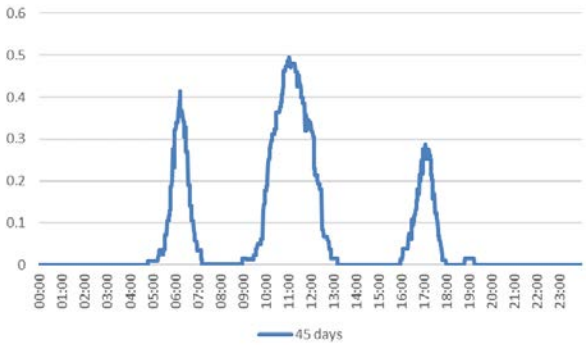
4		
5		
6		

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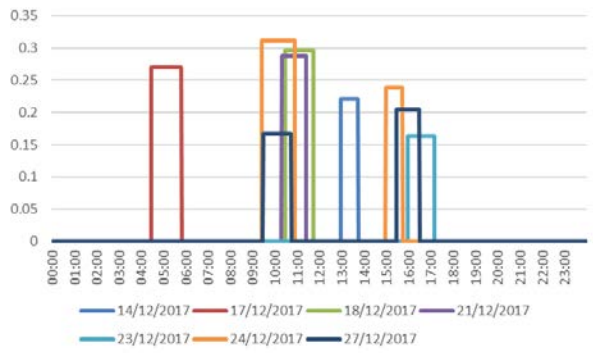
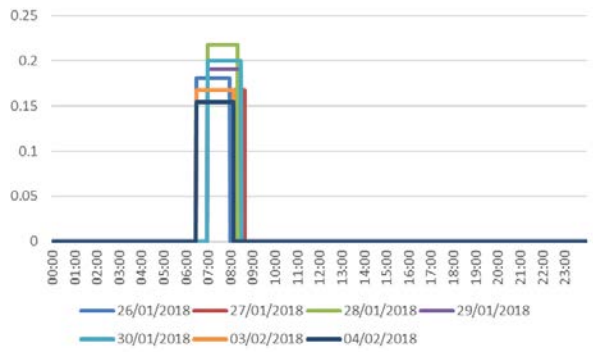
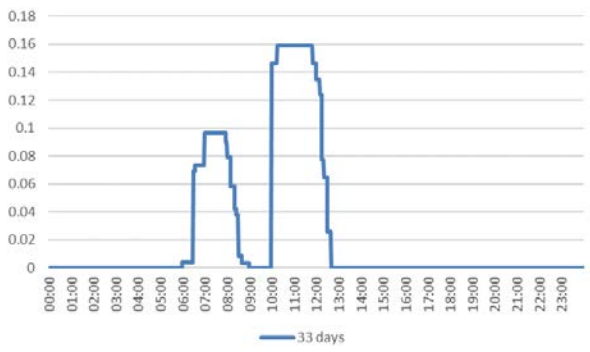
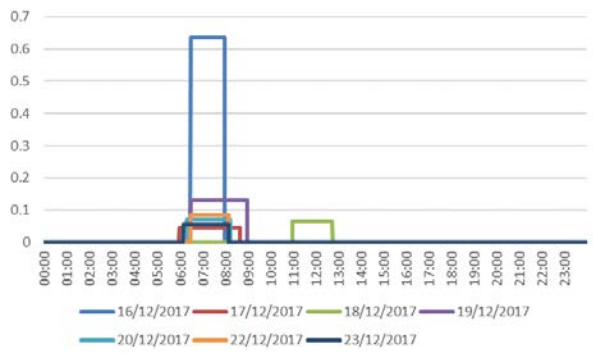
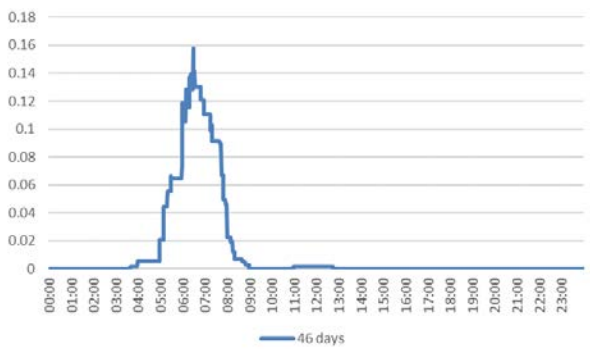
ID	7 day chart	Aggregate chart (all records)
7		
9		
10		

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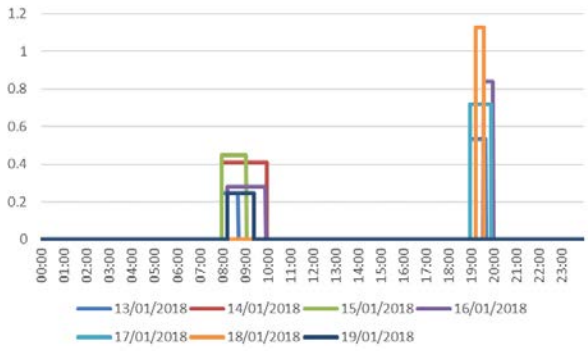
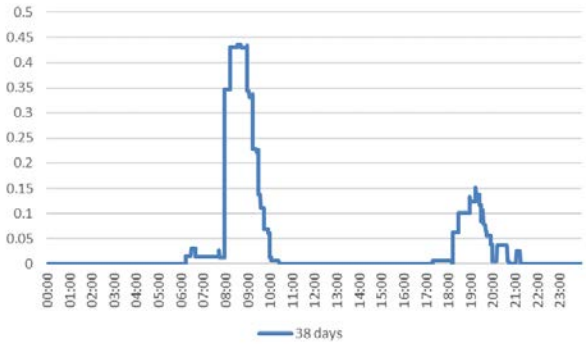
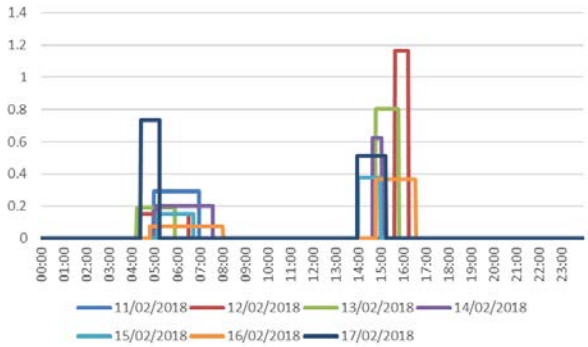
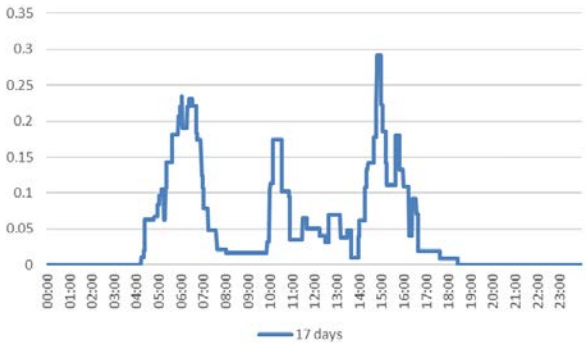
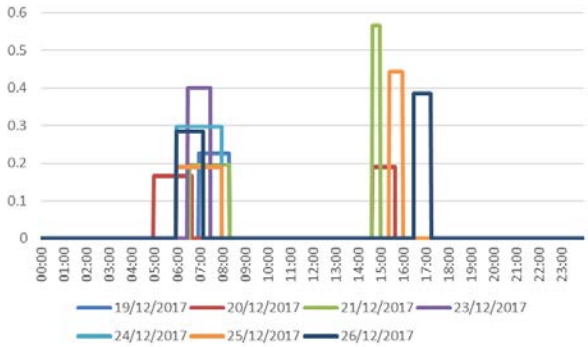
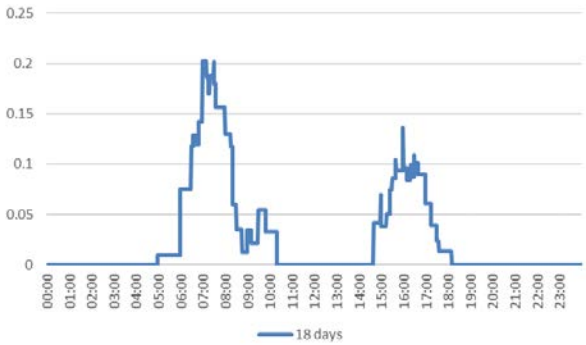
ID	7 day chart	Aggregate chart (all records)
11		
12		
13		

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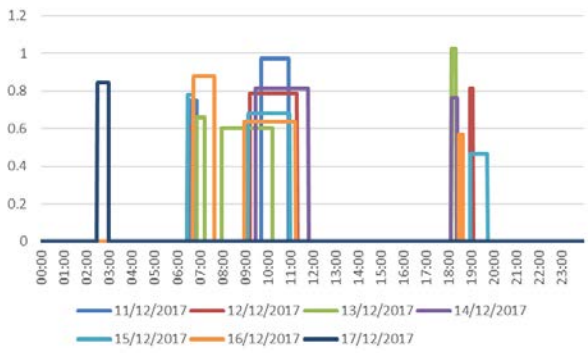
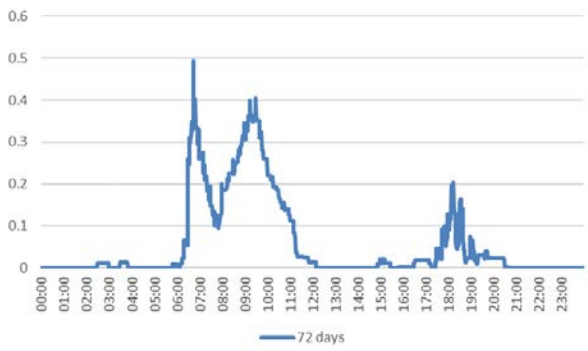
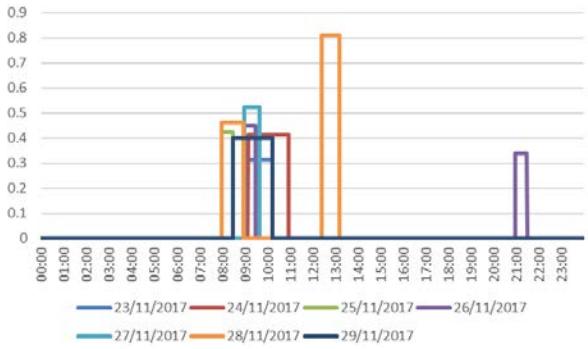
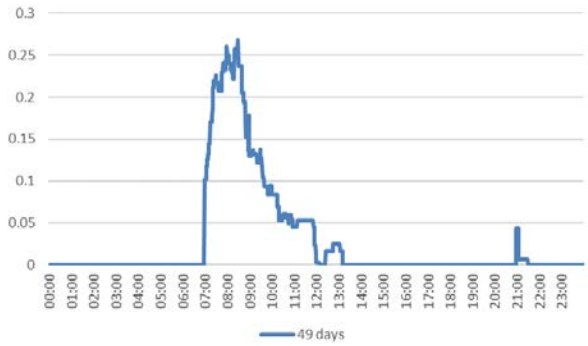
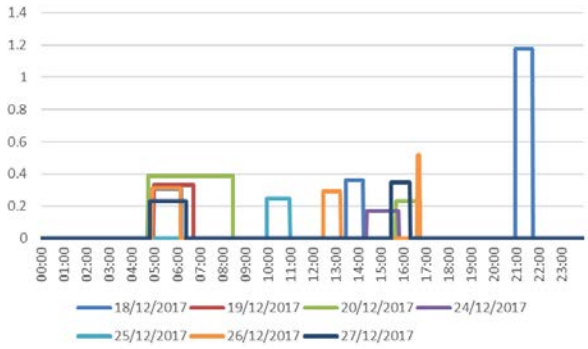
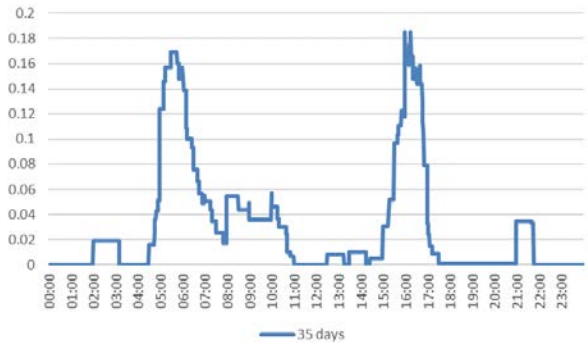
ID	7 day chart	Aggregate chart (all records)
14		
15		
16		

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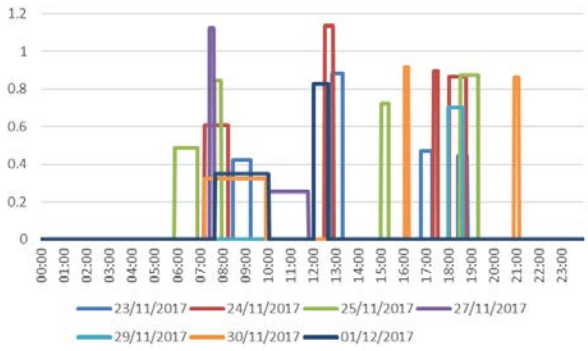
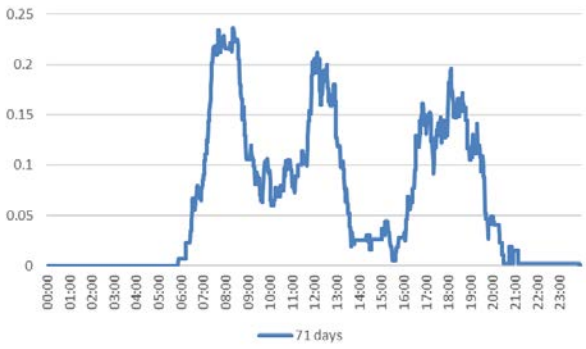
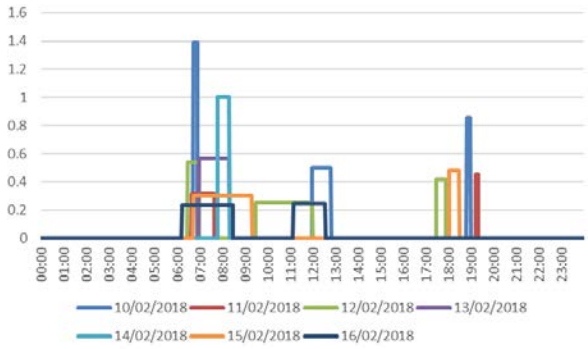
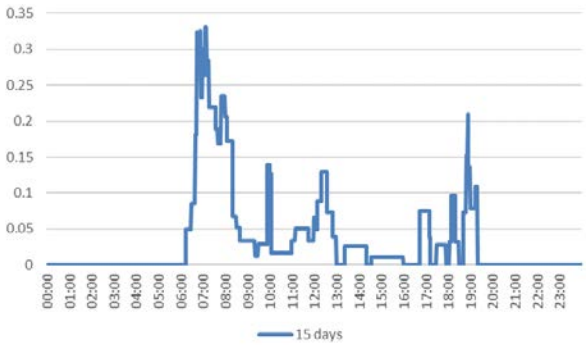
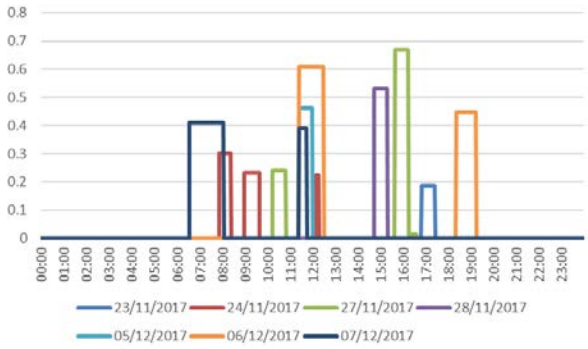
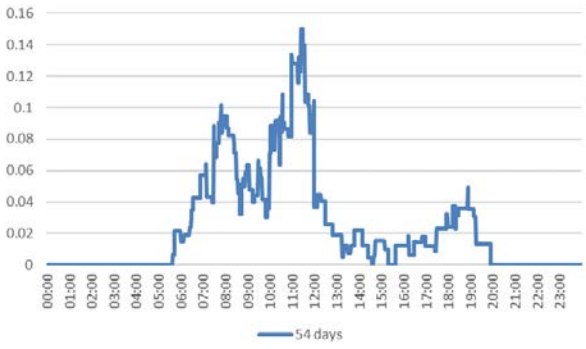
ID	7 day chart	Aggregate chart (all records)
18		
19		
20		

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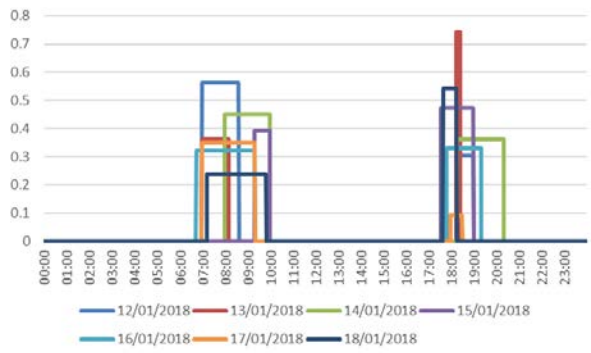
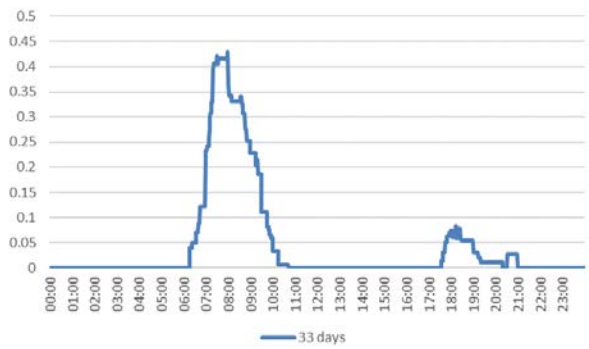
ID	7 day chart	Aggregate chart (all records)
22		

Figure 16 24 hour load profiles (all households Category 2 only)

Figure 17 24 hour load profile – aggregated from all households (Category 2 only)

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3.4 Meals cooked

3.4.1 Food types cooked

Separating out foods cooked for breakfast, lunch or dinner only, Table 21 shows a good degree of consistency in the mix of foods cooked in both categories i.e. cooking with electricity did not cause participants to change what they cooked. There are a couple of exceptions e.g. when cooking with electricity, participants were less likely to cook rice and curries in particular. Overall, category 2 meals cooked with electricity had less of most food types, which is consistent with the finding in Table 22 that meals cooked with electricity tended to be simpler, comprising fewer dishes.

N.B. food information was submitted in almost all records.

Table 21 Number of meals containing food types (Breakfast, lunch and dinner heating events only)

	Category 1 N = 564		Category 2 N = 1187	
	Frequency	Percent	Frequency	Percent
Sticky rice	8	1.4%	8	0.7%
Rice	525	93.1%	865	72.9%
Eggs	56	9.9%	88	7.4%
Dry fish	52	9.2%	31	2.6%
Myanmar vermicelli	8	1.4%	8	0.7%
French fries	1	0.2%	3	0.3%
Coconut milk noodels	1	0.2%	1	0.1%
Meat/fish/egg/veg curry	271	48.0%	396	33.4%
Other meat/fish/tofu	64	11.3%	93	7.8%
Other veg	122	21.6%	179	15.1%
Beans	43	7.6%	41	3.5%
Noodles	3	0.5%	16	1.3%
Soup	82	14.5%	106	8.9%
Other	212	37.6%	281	23.7%

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Table 22 Number of foods included in a heating event (Breakfast, lunch and dinner heating events only)

Number of food types in meal	Category 1		Category 2		Total
	Frequency	Percent	Frequency	Percent	
1	108	19%	489	42%	597
2	158	28%	453	39%	611
3	200	36%	154	13%	354
4	72	13%	56	5%	128
5	23	4%	7	1%	30
6	2	0%	0	0%	2
Total	563	100%	1159	100%	1722

It can be seen from Table 23 that some foods tend to be eaten on their own, such as rice and noodles. Others, such as dry fish and beans are more likely to be eaten in complex meals (4 or more food types).

Table 23 Occurrence of foods in meals by number of foods in the meal (all heating events, Phase 1, 2 and 3)

Food type	Number of food types in meal					
	1	2	3	4	5	6
Sticky rice	2	4	1	1	0	0
Rice	452	479	325	125	29	2
Eggs	9	64	38	25	8	1
Dry fish	2	22	24	28	8	0
Myanmar vermicelli	2	6	6	2	1	0
French fries	0	0	2	3	0	0
Coconut milk noodels	0	0	1	0	0	0
Meat/fish/egg/veg curry	61	287	219	90	15	1
Other meat/fish/tofu	8	67	46	31	7	1
Other veg	17	99	116	54	18	2
Beans	7	12	32	21	12	1
Noodles	5	10	5	0	0	0
Soup	23	37	63	42	23	2
Other	25	151	193	98	29	2

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3.4.2 Reheating food

For each food item prepared (up to a maximum of four dishes per meal), participants were asked if each dish was freshly cooked or reheated. If all dishes in a meal were reheated, then the meal was classified as reheated, if all were freshly cooked, then the meal was classified as fresh, and if only some of the dishes in the meal were reheated then the meal was classified as partially cooked. Results for all those records that contained only a single heating event are presented in Table 24. This shows that few meals are reheated in any way. When cooking with electricity, dinners were the meal that most commonly included some reheated dishes, but when cooking with other fuels, it was lunches.

Table 24 Number of meals fresh or reheated (single heating event records only)

Category 1								
	Fresh		Reheated		Partially cooked		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Breakfast	171	99%	0	0%	1	1%	172	100%
Lunch	64	89%	0	0%	8	11%	72	100%
Dinner	104	94%	0	0%	7	6%	111	100%
Heating water	1	100%	0	0%	0	0%	1	100%
Snack	4	100%	0	0%	0	0%	4	100%
Category 2								
	Fresh		Reheated		Partially cooked		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Breakfast	161	93%	3	2%	9	5%	173	100%
Lunch	325	96%	4	1%	10	3%	339	100%
Dinner	313	85%	45	12%	10	3%	368	100%
Heating water	0		0		0		0	
Snack	9	90%	1	10%	0	0%	10	100%

To find out which foods were most commonly reheated, cases in which a food was cooked in a meal were tagged as either fresh or reheated (where information was available). Results collated across all four dishes are presented in Table 25 and show that vermicelli and curries (and other meat/fish/tofu) were most commonly reheated (in terms of proportion of times they were cooked).

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Table 25 Food types most commonly reheated (individual dishes, cooked as part of meals)

	Fresh		Reheated		Total
	Frequency	Percent	Frequency	Percent	Frequency
Sticky rice	12	100%	0	0%	12
Rice	1431	98%	26	2%	1457
Eggs	142	98%	3	2%	145
Dry fish	82	99%	1	1%	83
Myanmar vermicelli	16	89%	2	11%	18
French fries	5	100%	0	0%	5
Coconut milk noodels	1	100%	0	0%	1
Meat/fish/egg/veg curry	741	91%	69	9%	810
Other meat/fish/tofu	153	91%	15	9%	168
Other veg	313	98%	5	2%	318
Beans	83	94%	5	6%	88
Noodles	20	95%	1	5%	21
Soup	177	94%	11	6%	188
Other	606	95%	34	5%	640

Reheating food for a meal might be expected to take less energy than preparing a meal from scratch (fresh). There are not enough Category 1 records available to make a meaningful comparison between fresh and reheated food using charcoal. Data from meals prepared using LPG are presented in Table 26 and suggest that partially cooked lunches use slightly less energy than lunches cooked fresh (this difference is not evident for the small number of dinners cooked using LPG).

Data from meals prepared using only electricity are presented in Table 27. This confirms that reheating dinners takes less energy than cooking fresh (roughly one half), although partially cooked meals appear to use more energy, a finding that can be seen across all three types of meals.

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Table 26 Per capita energy consumption by heating event and reheating (MJ/pers/event) – Category 1 LPG only

Heating event	Frequency	Mean	Std.dev.	25% Quartile	Median	75% Quartile
Breakfast						
Fresh						
Partially cooked						
Lunch						
Fresh	7	0.80	0.44	0.45	0.75	1.03
Partially cooked	6	0.78	0.29	0.57	0.67	1.06
Dinner						
Fresh	8	0.80	0.43	0.49	0.68	1.05
Partially cooked	6	0.72	0.06	0.67	0.71	0.77

Table 27 Per capita energy consumption by heating event and reheating (MJ/pers/event) – Category 2 electricity only

Heating event	Frequency	Mean	Std.dev.	25% Quartile	Median	75% Quartile
Breakfast						
Fresh	95	0.26	0.15	0.16	0.20	0.32
Partially cooked						
Reheated						
Lunch						
Fresh	304	0.55	0.41	0.26	0.43	0.72
Partially cooked	9	1.08	1.01	0.21	0.64	1.88
Reheated	4					
Dinner						
Fresh	254	0.30	0.60	0.14	0.21	0.29
Partially cooked	8	0.49	0.40	0.18	0.37	0.71
Reheated	42	0.20	0.22	0.11	0.14	0.18

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3.4.3 Energy to cook food types

In this section we identify the energy required to cook various food types and meal combinations. Category 1 participants may have used multiple fuels. In order to meaningfully compare the specific energy used to cook different foods and combinations, only records using a single fuel have been included in Table 28 to Table 30. Furthermore, records in which food was reheated or precooked for eating later have been omitted from the results.

Electrical energy consumption is broken down further in Section 3.5.4 where the efficiency of different electrical devices is discussed.

Table 28 Specific energy consumptions (MJ/pers/event) - single food meals

Food	Frequency	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Category 1 Wood						
Rice	3	1.41	1.33	0.40	1.06	.
Category 1 Charcoal						
Rice	27	2.09	1.79	0.61	1.50	2.99
Category 2 Electricity						
Eggs	4	0.22	0.14	0.23	0.06	0.45
Meat/fish/egg/veg curry	4	0.36	0.26	0.30	0.14	0.68
Noodles	2	0.48	0.48	0.21	0.33	.
Other	8	0.28	0.26	0.17	0.18	0.33
Other veg	5	0.24	0.15	0.20	0.12	0.40
Rice	97	0.21	0.21	0.06	0.17	0.23
Soup	6	0.51	0.48	0.13	0.40	0.63

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Table 29 Specific energy consumptions (MJ/pers/event) - two food meals

Food	Frequency	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Category 2 Electricity						
Eggs Other	2	0.38	0.38	0.13	0.28	.
Meat/fish/egg/veg curry Other	7	0.36	0.35	0.14	0.24	0.51
Other meat/fish/tofu Other	3	0.66	0.74	0.19	0.44	.
Other veg Other	7	0.32	0.24	0.17	0.20	0.51
Rice Eggs	5	0.35	0.32	0.06	0.31	0.41
Rice Meat/fish/egg/veg curry	4	0.52	0.52	0.27	0.26	0.77
Rice Other	4	2.67	0.55	4.47	0.29	7.16
Soup Other	4	0.30	0.30	0.07	0.24	0.36

Table 30 Specific energy consumptions (MJ/pers/event) - three food meals

Food	Frequency	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Category 2 Electric						
Meat/fish/egg/veg curry Other veg Other	3	0.52	0.53	0.01	0.51	.
Other meat/fish/tofu Soup Other	2	0.75	0.75	0.30	0.54	.
Rice Meat/fish/egg/veg curry Other	2	0.75	0.75	0.35	0.50	.
Rice Other meat/fish/tofu Other	3	0.72	0.72	0.13	0.59	.
Rice Soup Other	2	1.38	1.38	0.15	1.28	.

The meals (food combinations) most commonly cooked are presented in Table 31[8]

[8] Meals representing >=2.5% of all meals (breakfast, lunch, dinner, or snack).

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Table 31 Most commonly prepared meals

Meal description	Frequency	Percent	Single fuel Frequency	Only electricity Frequency	Only LPG Frequency	Only charcoal Frequency	Only wood Frequency	Median per capita electricity energy consumption
Rice	302		291	250	8	28	5	0.17
Rice Meat/fish/egg/veg curry	100		96	90	3	1	2	0.47
Rice Meat/fish/egg/veg curry Other	47		35	21	4	5	5	0.54
Rice Other	25		23	21	1	0	1	0.47
Meat/fish/egg/veg curry	52		50	49	0	1	0	0.27
Rice Other veg	21		20	18	0	0	2	0.24
Rice Eggs	22		21	14	0	2	6	0.32

3.5 Cooking devices

3.5.1 Detail on how participants cook

Participants were asked to record the following information on how they cooked:

- Cooking device used i.e. what type of stove.
- Type of cooking pot / utensil.
- How they used the lid.
- Cooking process used e.g. fry, boil, bake etc.

The cooking appliances used to cook individual foods are presented in Table 32. Note that any single record (or meal) can contain information on up to four foods, so the table includes each separate food–appliance combination. This shows that 11% of foods were cooked with electricity in Category 1 records. When cooking with electricity, the most commonly use devices were rice cookers and electric frying pans. Table 33 shows that participants mostly used non-electric fuels for boiling, and electricity was mostly used for steaming. Category 2 records in Table 34 appear to be incomplete, which probably reflects the high use of electric frying pans and rice cookers, neither of which require a pot. Participants were more likely to use lids when cooking with electricity only (see Table 35), again, this may reflect the high use of rice cookers, which must be closed in order to work.

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Table 32 Appliances used to cook foods – across four dishes (frequencies)

	Category 1	Category 2 (electric only)
Biomass stove	1036	4
Gas stove	205	1
Electric hotplate		8
Induction hotplate	3	290
Infrared stove		131
Electric frying pan	39	684
Electric pressure cooker	1	51
Microwave		10
Rice cooker	109	886
Other		1
Total	1393	2067

Table 33 Cooking processes used to cook foods (frequencies)

	Category 1	Category 2 (electric only)
Fry	243	437
Boil	806	546
Grill	25	
Steam	104	740
Bake		1
Microwave		8
Pressure cooking	1	41
Other	1	
Total	1180	1773

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Table 34 Utensils used to cook foods (frequencies)

	Category 1	Category 2 (electric only)
Bowl/plate		6
Frying pan	204	66
Pot: Big	30	27
Pot: Med	799	561
Pot: Small	162	138
Other	14	
Total	1209	798

Table 35 Use of lid when cooking foods (frequencies)

	Category 1	Category 2 (electric only)
No	261	352
Some	879	738
Yes	234	943
Total	1374	2033

3.5.2 Characteristics of different cooking devices

Among participants who cooked with non-electric fuels, both charcoal and gas were mostly used for cooking rice. Biomass was more often used for cooking curries and vegetables, including beans (Table 36).

Table 37 shows that electric frying pans were most commonly used for all foods other than rice. Curries were the food type most commonly cooked in pressure cookers but use was low.

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Table 36 Cooking devices used to cook different food types - Category 1 (frequencies)

	biomass stove	Gas stove
Rice	338	89
Eggs	32	7
Dry fish	29	4
Myanmar vermicelli	2	4
Meat/fish/egg/veg curry	222	37
Other meat/fish/tofu	18	28
Other veg	71	6
Beans	33	0
Noodles	2	0
Soup	30	5
Other	51	24

Table 37 Cooking devices used to cook different food types - Category 2 (frequencies)

	Electric hotplate	Induction hotplate	Infrared stove	Electric frying pan	Electric pressure cooker	Microwave	Rice cooker
Sticky rice	0	0	0	6	0	0	6
Rice	0	3	1	26	3	3	855
Eggs	2	18	5	47	0	0	0
Dry fish	0	5	3	21	0	0	0
Myanmar vermicelli	0	1	1	3	0	0	0
French fries	0	0	1	0	0	0	0
Coconut milk noodels	0	0	0	1	0	0	0
Meat/fish/egg/veg curry	5	75	4	254	25	0	5
Other meat/fish/tofu	0	11	4	44	3	1	0
Other veg	0	23	2	100	3	1	5
Beans	0	8	3	15	3	1	1
Noodles	0	2	3	8	0	0	1
Soup	0	12	17	39	1	0	2
Other	1	38	5	73	3	3	8

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Table 38 shows that both biomass and gas stoves are used mostly for boiling, but also for frying. It also shows that people who cooked with non-electrical fuels (Category 1), also made some use of electric rice cookers.

Frying and steaming were more commonly used when cooking with electricity (Category 2) – see Table 39. This reflects ownership of dedicated electrical devices, notably rice cookers and electric frying pans. Note that baking does not appear to be part of cooking in Myanmar.

Table 38 Cooking processes used with different cooking devices - Category 1 (frequencies)

	Fry	Boil	Grill	Steam
biomass stove	194	651	21	14
Gas stove	36	116	4	1
Electric frying pan	12	15	0	1
Rice cooker	0	21	0	88

Table 39 Cooking processes used with different cooking devices - Category 2 (frequencies)

	Fry	Boil	Steam	Bake	Microwave	Pressure cooking
Electric hotplate	2	6	0	0	0	0
Induction hotplate	89	150	3	0	0	0
Infrared stove	46	77	5	1	0	0
Electric frying pan	293	196	4	0	0	0
Electric pressure cooker	2	3	3	0	0	41
Microwave	0	0	2	0	8	0
Rice cooker	4	112	720	0	0	0

3.5.3 Fuel stacking

The number of cooking devices used in preparing each meal (or case) is presented in Table 40 and shows that multiple devices were more commonly used when cooking with electricity. When cooking with non-electric fuels and using multiple devices, Table 41 shows that biomass stoves were most commonly used in conjunction with rice cookers, but also electric frying pans and gas stoves.

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

Table 40 Number of cooking devices used in preparing meals

	Category 1		Category 2	
	Frequency	Valid Percent	Frequency	Valid Percent
1	349	61%	641	54%
2	187	33%	492	42%
3	38	7%	44	4%
4	1	0%	2	0%
Total	575	100%	1179	100%

Table 41 Cooking devices used by participants who use multiple devices preparing single meal (Category 1)

Cooking device	Frequency
Biomass stove	209
Gas stove	25
Electric hotplate	1
Induction hotplate	3
Infrared stove	
Electric frying pan	31
Electric pressure cooker	1
Microwave	
Rice cooker	106

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

3.5.4 Energy used by different electrical appliances (Phase 2)

Per capita electrical energy figures in Table 42 indicate that 'efficient' electrical devices such as rice cookers and pressure cookers use less energy than electric frying pans and hotplates. Note that while rice cookers were used to cook mostly rice, electric frying pans and hobs (both induction and infrared) were used to cook a range of foods including complex meals such as curries (see Table 43). Note that the figures in Table 42 are based on all meals i.e. including reheated and precooked foods, so specific energy consumptions will be lower for devices most commonly used to reheated meals (e.g. 9 out of 10 curries cooked on induction hobs were reheated).

In order to make more meaningful comparisons, the specific energy consumption for different foods and combinations prepared fresh and not precooked are presented in Table 43. However, the sub-sample sizes are small, and the different devices appear to be used to prepare different meals, so it is not really possible to compare like for like energy consumptions for cooking specific meals using different devices.

Table 42 Per capita energy consumption (MJ/pers/event) of meals cooked using single electrical device (Category 2)

Cooking device	Frequency	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Induction hotplate	76	0.34	0.30	0.23	0.15	0.47
Infrared stove	37	0.41	0.25	0.34	0.16	0.53
Electric frying pan	114	0.40	0.33	0.36	0.20	0.46
Electric pressure cooker	5	0.28	0.22	0.16	0.16	0.42
Rice cooker	260	0.20	0.17	0.15	0.14	0.22

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

Table 43 Detail of per capita energy consumption (MJ/pers/event) of meals cooked using single electrical device – fresh and not precooked (Category 2)

Food(s)	Frequency	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Induction hob						
Noodles	2	0.48	0.48	0.21	0.33	.
Other	3	0.41	0.36	0.19	0.26	.
Other veg	2	0.12	0.12	0.03	0.10	.
Meat/fish/egg/veg curry Other	4	0.40	0.41	0.13	0.27	0.51
Other meat/fish/tofu Other	2	0.59	0.59	0.21	0.44	.
Other veg Other	2	0.37	0.37	0.32	0.14	.
Rice Other	2	0.55	0.55	0.04	0.52	.
Soup Other	2	0.30	0.30	0.08	0.25	.
Infrared stove						
Soup	4	0.48	0.48	0.11	0.37	0.58
Other veg Other	5	0.30	0.24	0.12	0.21	0.41
Soup Other	2	0.30	0.30	0.09	0.24	.
Meat/fish/egg/veg curry Other veg Other	2	0.53	0.53	0.00	0.53	.
Other meat/fish/tofu Soup Other	2	0.75	0.75	0.30	0.54	.
Electric frying pan						
Eggs	3	0.26	0.20	0.25	0.05	.
Meat/fish/egg/veg curry	2	0.15	0.15	0.03	0.13	.
Other	3	0.15	0.16	0.10	0.05	.
Other veg	3	0.32	0.22	0.23	0.15	.
Soup	2	0.56	0.56	0.20	0.42	.
Meat/fish/egg/veg curry Other	2	0.22	0.22	0.04	0.19	.
Rice cooker						
Other	2	0.27	0.27	0.00	0.26	.
Rice	96	0.21	0.21	0.06	0.17	0.23

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

3.6 Time taken

3.6.1 Time taken to cook food types

The times taken to cook individual food types using only wood, charcoal or LPG (Category 1) are presented in Table 44 (ranked by median). Note that this includes times taken to cook individual foods when prepared as part of a multi-dish meal. There is a good deal of consistency in the time take to cook specific foods, with the exception of eggs, which take only 10 minutes, and rice, which takes around 40 minutes.

Table 45 presents times taken to cook using electricity (Category 2). When comparing the most common food types (Figure 18) there is little difference in cooking times using biomass and electricity, whereas those who cook with LPG appear to be able to cook most foods faster.

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Table 44 Time taken to cook food types using biomass/LPG – Category 1 (minutes) (n>=5)

Food	N	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Wood						
Eggs	12	12.0	10.0	7.3	6.25	15
Other meat/fish/tofu	5	29.4	20.0	28.5	13.5	50
Other veg	35	24.3	25.0	11.4	15	32
Meat/fish/egg/veg curry	92	27.9	28.0	15.0	15.5	32
Beans	18	42.0	30.0	30.9	18	64
Soup	9	28.3	30.0	8.3	22.5	32.5
Rice	198	38.4	40.0	7.8	34.75	45
Charcoal						
Eggs	12	15.7	10.0	9.4	10	27.5
Other meat/fish/tofu	7	14.3	10.0	9.3	10	15
Soup	10	24.7	20.0	10.7	16.5	30
Other veg	12	22.5	22.5	7.8	16.25	30
Beans	7	23.3	25.0	11.0	13	30
Dry fish	8	26.9	30.0	10.7	17.5	30
Meat/fish/egg/veg curry	56	32.3	30.0	28.3	20	35
Rice	106	43.4	40.0	11.3	35	45
LPG						
Meat/fish/egg/veg curry	37	13.6	10.0	11.2	7	15
Other meat/fish/tofu	22	10.0	10.0	6.6	5	10.5
Soup	5	20.0	10.0	25.5	5	40
Other veg	6	12.0	12.5	4.5	8.75	15.5
Rice	67	35.1	35.0	5.4	31	40

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Table 45 Time taken to cook food types using electricity only – Category 2 (minutes) (n>=5)

Food	N	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Eggs	72	10.4	10.0	6.9	5	15
Myanmar vermicelli	5	20.4	15.0	7.9	14.5	29
Other veg	135	19.7	19.0	13.5	10	28
Beans	31	27.4	20.0	20.4	10	42
Sticky Rice	12	29.3	22.5	16.2	15.5	45
Dry fish	28	22.1	25.0	12.3	10	30
Other meat/fish/tofu	64	29.1	25.0	19.8	16.25	35
Noodles	14	25.4	26.0	14.6	13.75	41.25
Soup	71	26.1	26.0	11.1	20	34
Meat/fish/egg/veg curry	368	32.4	30.0	19.3	20	41
Rice	896	40.5	37.0	17.2	30	50

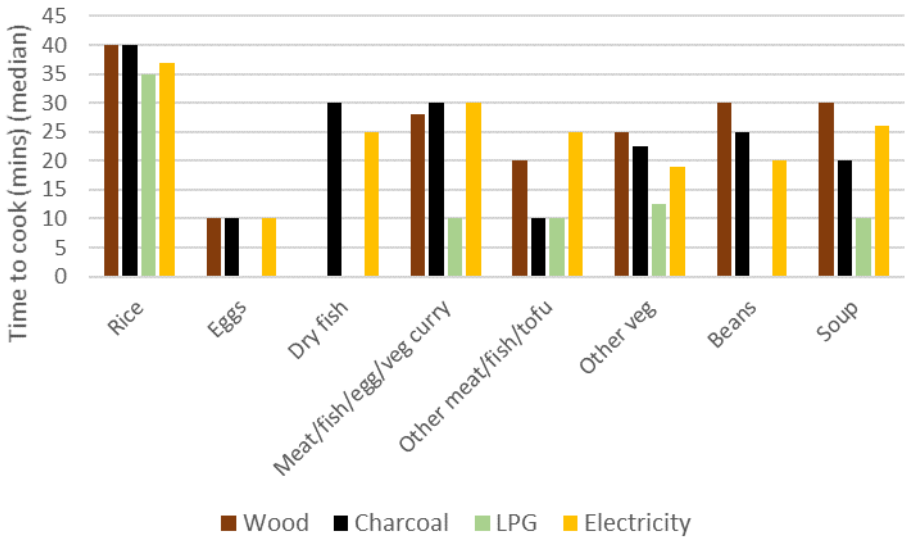

Figure 18 Time taken to cook common food types - different fuels (N>=5)

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3.6.2 Time taken to prepare meal

When using biomass or LPG (Category 1), breakfasts took longer to cook than lunches and dinners (Table 46). However, when people cooked with electricity (Table 47) it was lunches that took longer to prepare than breakfasts or dinners.

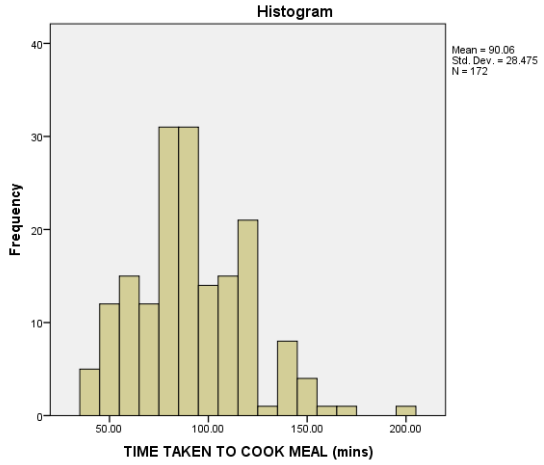
A small proportion of breakfasts cooked with electricity were reheated (or partially cooked) (7%) while all were fresh in Category 1. The single meal most commonly cooked for breakfast when cooking with biomass/LPG was rice, curry, whereas over half of breakfasts cooked with electricity were rice only.

Table 46 Duration of heating events – Category 1 (minutes) (single heating events only)

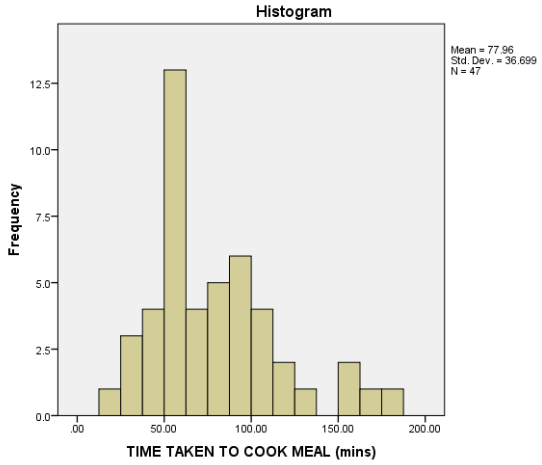
Heating event	N	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Breakfast	172	90	90	28	70	110
Lunch	47	78	70	37	55	95
Dinner	98	62	60	28	45	75
Water heating	0					

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

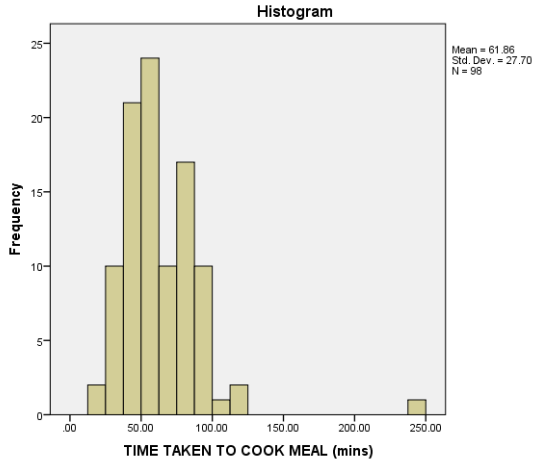
Breakfast



Lunch



Dinner



Heating water

Figure 19 Distributions of durations of heating events (minutes) – Category 1 (single heating events only)

Table 47 Duration of heating events – Category 2 (minutes) (single heating events only)

Heating event	N	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Breakfast	196	66	53	42	35	90
Lunch	334	78	75	41	47	105
Dinner	368	50	46	36	28	65
Water heating	68	31	25	27	15	38

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

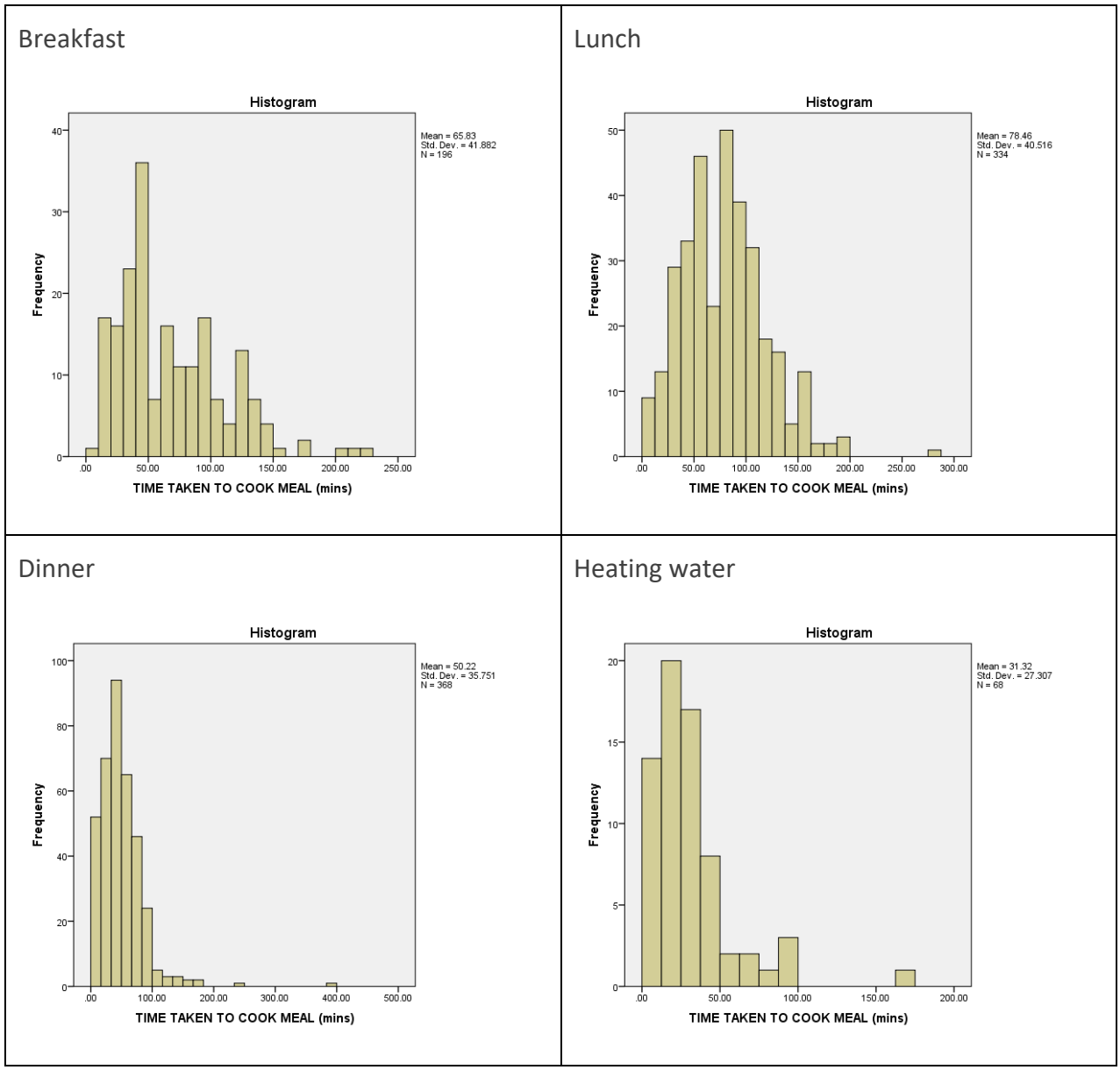


Figure 20 Distributions of durations of heating events (minutes) – Category 2 (single heating events only)

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3.6.3 Time of day

There is a good deal of consistency in the time of day at which participants using biomass/LP and those using electricity started to prepare each of the three types of meals (see Table 48 and Table 49).

Table 48 Time of day to start preparing meal –Category 1 (multiple fuels) (single heating events only)

Heating event	N	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Breakfast	172	6.24	6.30	0.39	6.00	6.45
Lunch	72	9.45	10.00	1.24	8.18	10.50
Dinner	114	16.15	16.00	2.46	15.00	16.48

Table 49 Time of day to start preparing meal – Category 2 (electricity only) (single heating events only)

Heating event	N	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Breakfast	197	6.21	6.27	0.56	5.54	6.52
Lunch	340	9.51	9.55	1.50	8.30	11.00
Dinner	370	16.13	16.20	2.23	15.16	17.55

There are a few instances in which participants cooking with electricity started cooking early in the morning, but indicated that they were preparing dinner (an evening meal) (Figure 21); this may be a strategy that is found more among households with working women. This feature is not as clearly seen when people cook with biomass/LPG.

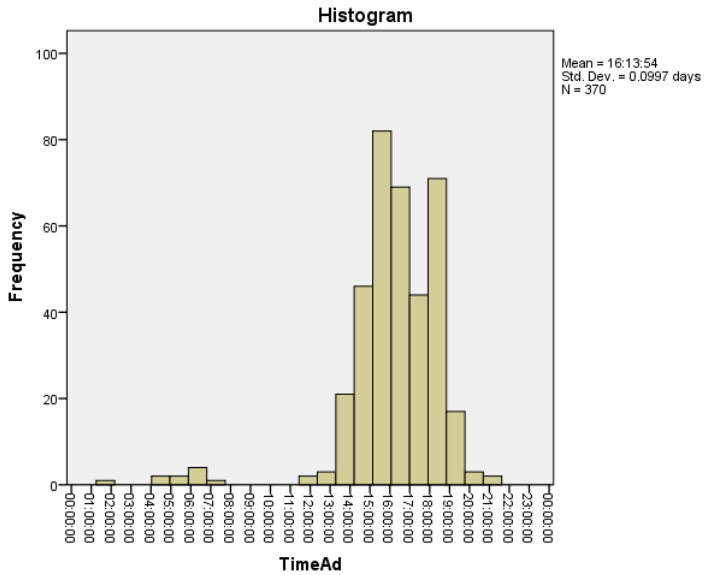

Figure 21 Time of day when dinners started to be prepared – electricity users (Category 2) (single heating events only)

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Water is heated throughout the day, with a clear peak at around 17.00 in the evening. An early morning peak at around 6.00 can also be seen in Figure 22. There were insufficient Category 1 data points to create a clear chart.

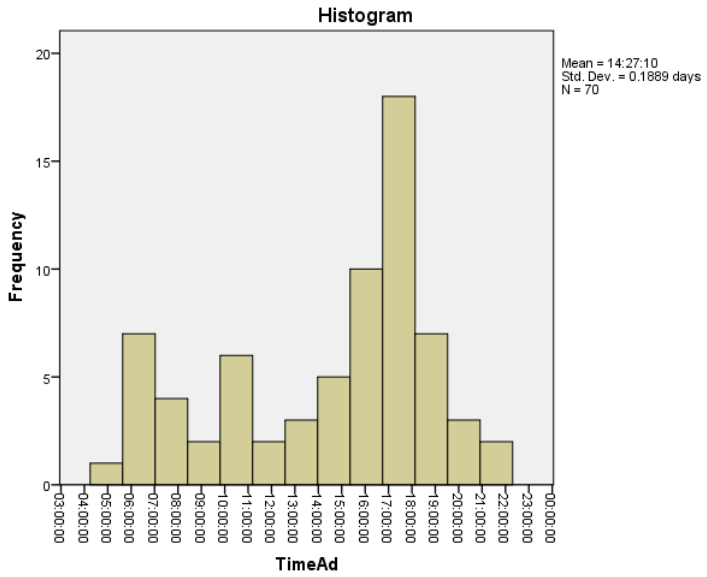

Figure 22 Time of day when water heating started – electricity users (Category 2) (single heating events only)

Comparing these meal preparation start times with solar insolation times (Figure 23) shows that dinners are mostly prepared just before sunset.

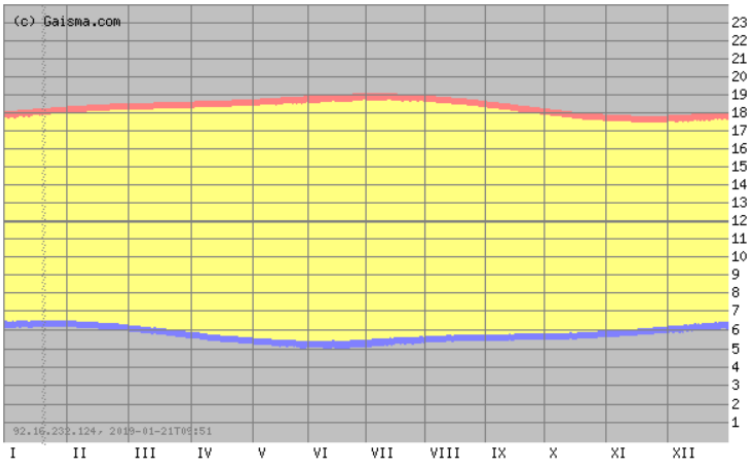

Figure 23 Solar insolation times[9]

[9] https://www.gaisma.com/en/location/rangoon.html

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

3.7 Water heating

Water heating was usually heated for a single purpose (Table 50), and the most common use of hot water was for making hot drinks (Table 51). Water was usually heated as part of a heating event rather than being heated on its own (heating water event). Table 52 shows that water was most commonly heated as part of preparing breakfasts, and that at breakfasts, it was used mainly for hot drinks.

Table 50 Number of purposes for heated water (max 4)

		Frequency	Valid Percent
Valid	1.00	786	94.8
	2.00	41	4.9
	3.00	2	.2
	Total	829	100.0
Missing	System	1109	
Total		1938	

Table 51 Purposes for heated water

Purpose of heating water	Frequency	Percent (n=829[10])
Purifying drinking water	178	21.5%
Bathing	81	9.8%
Tea / coffee	601	72.5%
Other	14	1.7%

[10] Number of cases in which water heating event was recorded.

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Table 52 Purpose of water heating (including multiple purposes) by heating events (single heating event only)

Heating event	Purify drinking	Bathing	Hot drinks	Other	
Breakfast	64	7	143	2	216
Lunch	6	3	20	1	30
Dinner	17	4	72	1	94
Snack	1		1		2
Heating water	2	30	63		95
	90	44	299	4	437

The energy consumption for heating water for different purposes can only be deduced from those records that pertain only to the heating of water (heating event), and only for a single purpose. This restricts the analysis to a small sub-set of cases so it has only been possible to compare energy consumptions between Category 1 and Category 2 records for making tea/hot drinks, and even then only when LPG was used in Category 1 records. This indicates that roughly twice as much energy is used when heating water with LPG. The amount of energy used to heat bathing water is roughly three times that used to boil water for tea.

Table 53 Per capita energy consumed by heating water for different purposes (MJ/pers/event) – Category 1 and 2 (single use of water in water heating events only)

	Frequency	Mean (MJ/event)	Median	Std.dev.	25% Quartile	75% Quartile
Bathing						
Category 2 Electricity	14	0.88	0.93	0.31	0.72	1.01
Tea/hot drinks						
Category 1 LPG	12	0.50	0.55	0.11	0.45	0.56
Category 2 Electricity	33	0.29	0.28	0.14	0.20	0.36

Even in when participants were cooking with biomass/LPG (Category 1), 16% of water heating events used electric kettles (Table 54). When cooking with electricity (Category 2), kettles were mostly used for hot drinks and for purifying water, and infrared stoves for heating bathing water (Table 55). These tables show the devices used for heating water for different purposes in all records, irrespective of number of heating events, fuels, or water heating purposes included in the record.

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Table 54 Devices used to heat water – cooking with biomass/LPG (Category 1)

	Bathing water	Purify water	Tea/hot drinks	Other	Total
Biomass Stove	2	125	123	5	255
Gas stove	3	0	48	2	53
Electric kettle	0	6	55	0	61
Other	0	0	2	0	2
Total	5	131	228	7	371

Table 55 Devices used to heat water – cooking with electricity (Category 2)

	Bathing water	Purify water	Tea/hot drinks	Other	Total
Biomass Stove	0	1	0	0	1
Electric hotplate	0	0	0	1	1
Induction hotplate	5	0	10	2	17
Infrared stove	55	0	86	0	141
Electric kettle	5	39	257	2	303
Other[11]	6	0	15	2	23
Total	71	40	368	7	486

3.7.1 Responses to exit survey questions

AT THE TIME OF WRITING, EXIT SURVEY DATA HAD NOT YET BEEN PROCESSED

[11] Mostly rice cookers.

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4 Evaluation

Whilst this cooking diaries study has enabled us to shed new light on what everyday cooks in Myanmar really do in their kitchens, the following section seeks to understand the limitations in the data obtained and offer constructive recommendations for the next round of cooking diaries, both in Myanmar and internationally.

4.1 Data limitations

4.1.1 Dish level data

Because of the meal level resolution of data collection, it was very difficult to make meaningful comparisons between fuels and appliances. It was hoped that dishes could be categorised according to their energy and time signatures, facilitating the transferability of the results to other contexts. For example, parallel research in the kitchen laboratory for the eCookBook in Kenya clearly showed that 'heavy foods' such as beans take several hours and several kWh to boil on an uninsulated cooking appliance, yet can be cooked for roughly half the time and 10-40% of the energy using an EPC. Attempts were made to group these dishes together during the data analysis phase based upon their energy and time signatures, however this was not successful because insufficient data points were available and it was suspected that many participants had misinterpreted the reheating (simply warming up again), pre-cooking (boiling the beans for storage) and partially cooked (combining pre-cooked beans with a freshly made sauce) options.

APPLIANCE LEVEL SUB-METERING, 'UN-STACKING' BY APPLIANCE DURING PHASE 2 & OR FIXED MENUS COULD ENABLE MUCH BROADER DISH-LEVEL COMPARISONS ACROSS FUELS & APPLIANCES.

The data collection forms are set up to record a before and after energy reading for every meal, however, data is also collected on how each dish that composes that meal is cooked. As a result, whilst making comparisons between meals is easy, as a lot of data exists, making comparisons between individual dishes is difficult. Dish level energy data is limited to the meals where only a single dish is cooked. For some single pot meals like matoke (banana stew), this may happen reasonably often, but for others like ugali, this is relatively uncommon as it is a staple that usually accompanies another dish. The data for electric appliances is subdivided even further because three appliances were available, each of which is likely to use a different amount of energy.

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The solution for electric appliances is relatively straight forward – sub meter each appliance and ask users to record dish level energy data. However, this would be more challenging for kerosene, as it would require multiple weight measurements whilst the stove is hot, and even more so for LPG, as many people use multi-burner stoves. However, the biggest challenge would be for charcoal, as charcoal is burned during lighting and continues to burn after cooking has finished. As a result, cooking three dishes independently (i.e. lighting and allowing the remaining charcoal to burn out each time) would consume more charcoal than cooking a three dish meal in one go. Perhaps the only way to achieve dish level energy measurements with charcoal is to have the stove sitting on top of a flat scale throughout cooking, taking measurements of the empty stove, after filling with the first load of charcoal, after starting cooking, then after each dish is completed and finally of any remaining charcoal that can be resused. This has obvious practical challenges, but it would allow the decomposition of dish level data if the charcoal burned during lighting and burn out were divided evenly between each dish.

Another way to increase the amount of dish level data for each fuel/appliance is to 'unstack' them, by asking participants to spend a set periods of time cooking solely on one fuel. This could also occur in Phase 2, with participants spending a two week period cooking solely on a single (or perhaps pair of identical) appliance. This would be challenging for some appliances (e.g. kettles), but perhaps an agreement could be made with participants, whereby it is decided beforehand which dishes will be cooked on which appliance during which period. It may also be worth including a quantitative metric of user satisfaction with how each dish turned out, so as to pinpoint what the strengths and weaknesses of each fuel/appliance are.

Finally, more directly comparable data could be obtained by setting fixed menus. These could be decided in advance by each participant, or by the group as a whole, and data collection would involve cycling though a daily or weekly menu with each fuel/appliance a sufficient number of times to allow enough data points to be collected. However, this would then create a slightly less realistic dataset, as whilst some households may have regular menus that they stick to quite closely, others will not and for some of those it simply won't be possible at all due to participant's other commitments (e.g. having to work late unexpectedly).

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4.2 Enumerator visits & digitisation of data

Many issues with the dataset were only discovered long after data collection had finished due to the slow pace of follow up visits, digitisation of the data and analysis of the dataset. Enumerators were contracted to visit the households daily and asked to digitise the paper forms as soon as they were collected. However with 10 households for each enumerator to visit, this was simply not possible, even though households had been selected based upon their proximity to the enumerators home. What is more, the sheer volume of data recorded on paper forms meant that it often was not digitised until months later. As a result, issues that could easily have been corrected at the time, such as faulty meters, other cooks in the household not recording data properly or not recording during blackouts, often went undetected, resulting in data having to be corrected or excluded.

DIGITISING DATA COLLECTION & REDUCING THE NUMBER OF HHS MONITORED BY EACH ENUMERATOR COULD GREATLY INCREASE THE QUALITY OF THE DATA SET.

To increase the quality of the dataset, it is recommended that if collecting data as detailed as this in the future, each enumerator monitor just 5 households and a digital data collection system be created. Although most participants (15/17) stated that enumerator visits were helpful and frequent enough, more frequent visits could greatly increase the quality of the data, as small issues could be corrected on the day, rather than having to correct of completely remove questionable data at a later date. It was noticed that many participants were writing down the key bits of information (time, energy & basic information about the dish) on a notepad during cooking. They would later transcribe this onto the full diary form when they had more time available. This suggests that if an enumerator were to visit each day, they could sit down with the participant and enter the data from the notepad into a digital form, for example using a tablet with a specially designed questionnaire in a data collection app such as Kobo Collect. This data would be uploaded to the server by each enumerator at the end of each day, then downloaded and checked by the lead researcher the following day. This would also help to reduce the errors in the transcription phase, as the participant would be able to remember any missing details (except energy readings) from that same day. Digitising the paper forms was often done in bulk under extreme time pressure, making the possibility of errors during transcription high.

THIS STUDY HAS OFFERED AN INITIAL EXPLORATION OF MYANMAR COOKING. FOLLOW UP STUDIES SHOULD EXPLORE THE DIFFERENCES BETWEEN URBAN/RURAL, POOR/WEALTHY & DIFFERENT REGIONS OF THE COUNTRY.

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

4.3 Sample diversity

This study used convenience sampling as a means to get some initial data as quickly as possible. As a result, most participants were middle class and all were urban. Future studies in Myanmar should seek to understand how different sectors of society cook, in particular poorer households and rural households, and identify regional differences in cooking.

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

5 Conclusion

The cooking diaries study in Myanmar has shown that cooking with electricity is compatible with Myanmar cuisine and that modern energy-efficient appliances are highly desirable to everyday cooks. In particular, the rice cooker, electric frying pan, thermo-pot and Electric Pressure Cooker (EPC) are prime candidates for future eCook products. Insulation not only significantly reduces the energy demand for cooking, but also mitigates the impact of short blackouts and low voltage, simply by stopping heat from escaping from the cooking pot.

In Myanmar, electricity is already the aspirational fuel, however the grid is heavily overloaded, placing severe restrictions on how people cook with electricity. Many of the participants from the cooking diaries study could only cook at certain times of the day, as at peak times, the voltage regularly sags to levels where it is unusable without a voltage stabiliser (<150V). As a result, integrating battery-storage into cooking appliances is likely to be beneficially from both a user and grid-stability perspective. For the user, it would enable cooking throughout the day and predictable performance, as the voltage would be much more stable. Plus it would also allow them to use other low power appliances by also connecting them to the battery. For the grid operator, it would smooth out the load profile, as the battery could be trickle charged at off-peak times and discharged at meal times, effectively time shifting cooking loads into times when spare generating capacity is available.

LPG is not yet popular in Myanmar, as the market was extremely restricted under military rule. However if the market develops, it may well become an attractive option to consumers. Nonetheless, as grid electricity is so cheap in Myanmar and electric appliances such as the rice cooker and electric frying pan are already so embedded within kitchen routines, it is unlikely that many households would completely switch over from electricity to LPG. Instead, a fuel stacking scenario with LPG and electric appliances seems much more attractive for modern cooks in Myanmar wanting to mitigate the highly unstable nature of electricity from the national grid. This scenario would have the additional advantage of combining the manual control of LPG and automatic control of electricity to enable both fine control for specific dishes and multi-tasking.

The findings from this study will be combined with those from the other activities that have been carried under the eCook Myanmar 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/ and www.MECS.org.uk.

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6 Appendix

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

6.1.1 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[12] 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

[12] 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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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 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

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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.

6.1.2 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 24 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[13] (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

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

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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.

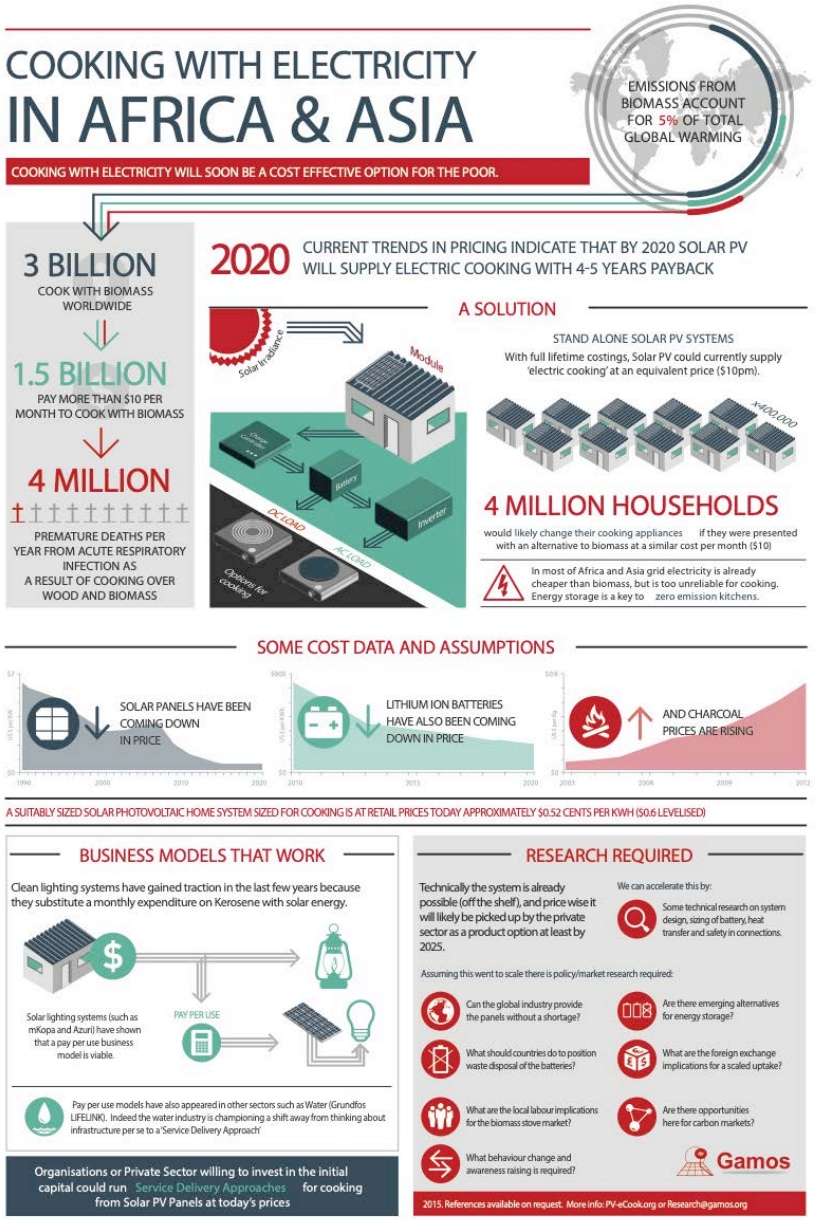

Figure 24 Infographic summarising the concept in order to lobby research and policy actors.

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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.

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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6.1.3 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.

6.1.4 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[14]. 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[15]. 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)[16]. 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

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

[15] 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

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

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warming globally – residential solid fuel burning accounts for up to 25 percent of global black carbon emissions[17]. 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[18].

Africa's cities are growing – another Nigeria will be added to the continent's total urban population by 2025[19] 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[20]. 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.

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

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

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

[20] 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.

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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[21]. Despite some improvements in recent years, this cross-cutting sector continues to struggle to reach scale and remains the least likely SE4All target to be achieved by 2030[22], 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

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[21] 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.

[22] 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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consumers. Figure 25 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.

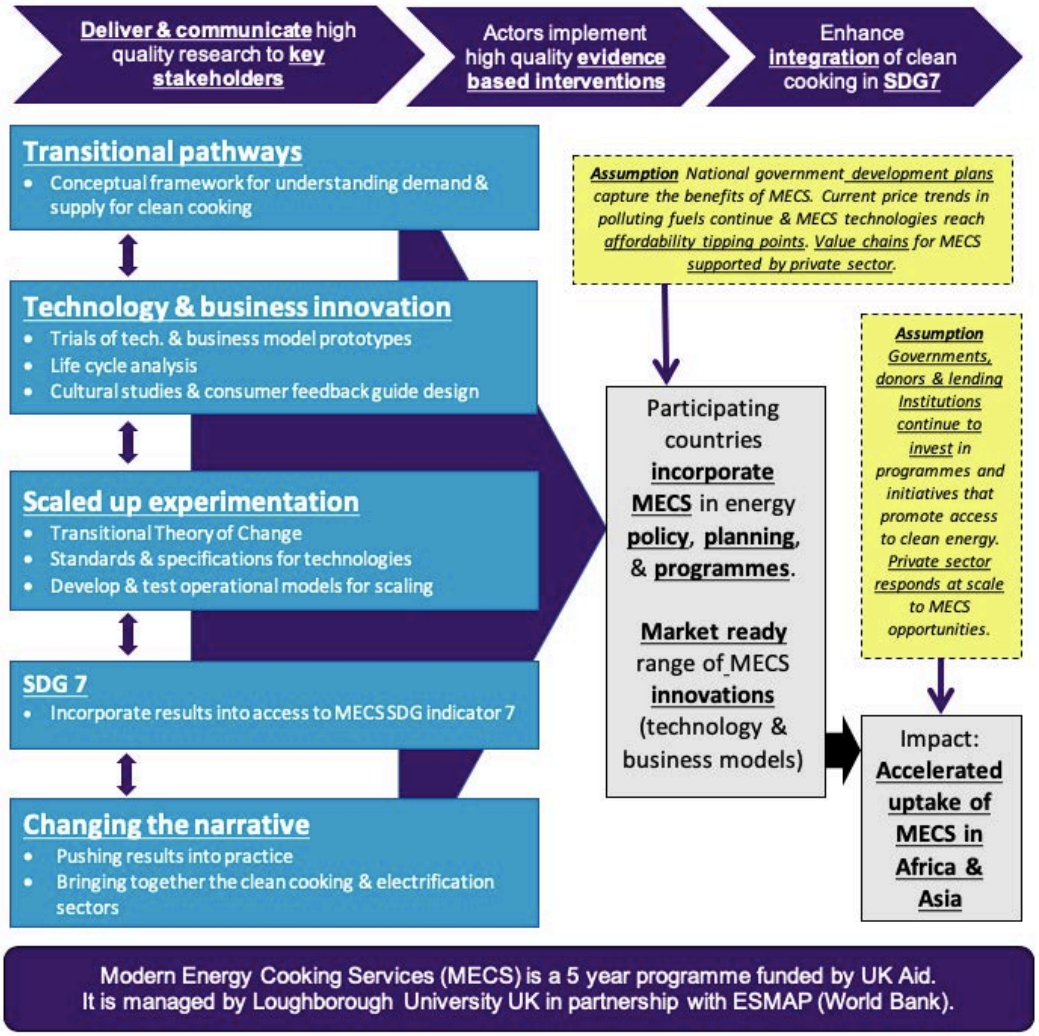

Figure 25: Overview of the MECS programme.

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6.2 Appendix B: Cooking diaries registration form

6.2.1 Checklist for enumerators

6.2.1.1 Household selection

Whilst any household that has an electricity supply good enough to cook on can in theory participate in the cooking diary study, the best households are:

- Households where there is one main cook, as many cooks require more training and often only some see the value in participating in the research study. This main cook should be:
    - Interested in the findings of the research study, as this will motivate them to record high quality data.
    - Well organized and literate.
- Households where the main cook volunteers to participate, rather than the head of their household volunteering them.
- Households that cook 2-3 times a day, rather than regularly buying food out or eating at a friend/family member's place.

We are looking for a range of households in the following categories:

- Large (>9 people), medium (5-8 people) and small (1-4 people) households.
- Households that cook on electricity, gas, charcoal or a mixture.

6.2.1.2 What to take to each household

- Clipboard & 2x pens
- 2x energy meters
- 2x plug adaptors (1x 3 pin square to 2 pin round, 1x multiplug to 3 pin square)
- Printed forms:
    - 1x registration form
    - 5x meal/water heating form
    - 1x daily summary form
- Tape measure
- Solid fuel or gas users:
    - Digital weighing scale

6.2.1.3 Registration process

Complete consent form and registration survey

- Please fill in 2 copies, leaving one with the participant and taking one
- Remember to fill in your contact details
- If the household is unsure about whether they want to sign up or not, suggest a trial for one night

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Talk through cooking diary forms:

- Meal/water heating form:
  - Cooks should fill out one form every time they use a cooking appliance.
    - A cooking appliance is defined as a device that cooks food or heats water.
  - Fill out sample form for the last meal you cooked and last time you used a cooking appliance in between meals to demonstrate
  - Ask participant to fill out sample form from last meal they cooked and last time you used a cooking appliance in between meals whilst you are there to help
    - Make sure they are aware of the fuel measurements, which must be collected both BEFORE and AFTER each time they use a cooking appliance
- Daily summary form
  - Cooks fill out one form at the end of each day.

Practice taking fuel measurements

- Electricity:
  - The aim is to work out how much energy was used by cooking appliances during that meal
  - We need TIME and ENERGY both BEFORE and AFTER cooking
  - Readings must be taken BEFORE cooking appliances are turned on
- Solid fuel:
  - The aim is to calculate the weight of charcoal, wood etc. burnt during that meal
  - We need the weigh of the bag of fuel BEFORE and AFTER the meal
  - We will subtract the AFTER weight from the BEFORE to calculate the charcoal burnt on the stove
  - Ask people to show you the bag they store their fuel in
    - If it is a box or a big sack, ask the household to put more charcoal out than they think they will use into a plastic bag and weigh this before and after cooking
    - Make sure they know to put any remaining charcoal that has not gone onto the fire back into the bag before weighing
  - Gas:
    - If a household has a big gas cylinder that is too heavy to weigh, we should purchase a small cylinder and ask them to use that instead.
    - Weigh the cylinder before and after cooking, as with solid fuel.
    - Make sure the hose does not pull or push the cylinder, altering the weight readings. If you think it will be a problem, ask the household to detach the regulator and weigh the cylinder by itself.

Remember to measure and photograph pots/pans/buckets/kettles and photograph all cooking appliances, taking measurements of all hotplate diameters and noting the power rating of all electrical cooking appliances.

6.2.2 Cooking Diaries Registration Form

Good (morning/afternoon). My name is _____ from the Renewable Energy Association Myanmar (REAM). We are doing a project with Loughborough University and Gamos (UK)

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on cooking practices in low income countries (in both Africa and Asia). I understand you have kindly volunteered to participate in the household cooking survey. This is part of an international research programme that aims to promote a transition from hazardous and polluting biomass fuels to clean, modern cooking fuels.

How you can assist:

- You will be asked some basic information on your household as part of this registration process.
- You will be asked to keep a diary of all you cook and how you cook it over the next 6 weeks.
- During the first two weeks, please cook as you always do and simply record what you are doing in the data sheets.
- After two weeks, you will be asked to try cooking only with electricity in order to see how quickly you can adapt, and how practical this is. If you are already cooking solely with electricity, we may ask you to change your practices in some way.
- At the end of the exercise, a short exit survey will ask you how you got on.

How we will support you:

- I will visit tomorrow and then at least once a week (at a time that suits you) to see how you are getting on, answer any questions you may have, and collect the data sheets. If you are able to send copies of the data sheets to us electronically using WhatsApp or equivalent, we can offer remote assistance.
- If you do not own an electric hob, we will provide one for the second part of the trial.
- We will pay for any additional electricity that you use for cooking during the survey.

The project meets the criteria for ethical research contained within the Code of Practice of Loughborough University's Ethical Advisory Committee. Your name will not appear in any data that shall be made publicly available and the information you provide will be strictly used for research purposes. It is up to you to decide whether to take part or not. Choosing not to take part or withdrawing at any point will not disadvantage you in any way. If there are questions that you would prefer not to answer then we respect your right not to answer them.

*Do you consent to be part of this study? (Yes/No)*_____

We will produce reports, guidance materials and academic papers detailing the findings from the research, which will be used to inform manufacturers and policy-makers in Myanmar and internationally.

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Do you consent to any photos taken during the course of this study being used in such publications? (Yes/No) _____

Name: _____ Signature: _____ Contact No.: _____

Date: _____ Location:_____

Enumerator to give the participant details of who to contact with queries (or complaints).

Enumerator name: _____ Enumerator phone number: _____

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DETAILS OF PARTICIPANT

1. Name of participant:…….
2. Age:……
3. Gender: ☐ Male ☐ Female ☐ Other
4. What is the highest level of school you have attended?

   ☐ None ☐ Incomplete primary ☐ Completed primary ☐ Incomplete secondary ☐ Completed secondary ☐ Higher than secondary

INFORMATION ON YOUR HOUSEHOLD

5. Type of area:

   ☐ Urban ☐ Peri-urban ☐ Rural

6. How many people live in the household? _____
7. How many rooms in the dwelling? _____
8. Type of dwelling (options to be edited to suit country context):

   ☐ Compound house ☐ Flat/apartment ☐ Semi-detatched house ☐ Separate house

9. Construction
   a. Walls

   ☐ Wood / mud / thatch ☐ Mud bricks (traditional) ☐ Corrugated iron sheet ☐ Cement block (plastered or unplastered) ☐ Bricks (burnt) ☐ Other…….

   b. Roof

   ☐ Thatch/palm leaf ☐ Wood ☐ Corrugated iron / cement sheet ☐ Cement ☐ Tiles

   ☐ Other _____

   c. Floor

   ☐ Dirt/Mud/Dung ☐ Cement screed ☐ Tiles ☐ Wood ☐ Other _____

10. Where is the kitchen located?
    - ☐ Outdoor ☐ Indoor, no outdoor area for solid fuel stoves ☐ Indoor, with outdoor area for solid fuel stoves
11. Where do you cook?

    ☐ Indoors ☐ Outdoors ☐ Sometimes indoors, sometimes outdoors

12. Please indicate how many of the following appliances are owned (even if not used).

    Please take a photo of all appliances.

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Cooking device		No. owned & brand name/s	When is it used?	What do you usually use it for? e.g. blackouts, barbecue	How many hotplates/burners does it have? What is their diameter (cm)?	Power rating (W) (electrical only)
3 stone fire			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
Basic biomass cookstove			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
Improved biomass cookstove			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
LPG cylinder-top stove			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
LPG stove			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
LPG stove (burners & oven)			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
Electric hotplate (portable)			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
Electric cooker (portable hotplate & grill)			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
Electric cooker (hotplates & oven)			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
Kettle			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
Microwave			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
Electric pressure cooker			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
Rice cooker			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
Electric frying pan			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	
Other cooking appliance/s (please specify)			☐ Regularly ☐ Occasionally ☐ Never		No. hotplates/burners ..... Diameter/s (cm)	

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

- Measurement of pots/pans/pressure cookers/kettles

  Please take a photo of all pots/pans/pressure cookers/kettles

Is it a pressure cooker, kettle or a big/medium/small pot or pan?	Diameter (cm) and Height (cm) OR Volume (litres)

13. Fuel Measurements

Charcoal/pellets/wood/LPG users & fuel stackers only:

	Charcoal	Pellets	Wood	LPG
How often do you usually buy charcoal/pellets/wood/LPG?				
What quantity do you usually purchase (viss)?				

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How much does this cost (kyats)?

All households:

- What is your average monthly electricity bill? _____
- Do you know how many units this is? _____
- Are there different rates according to how many units you purchase?

Units	Rate

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6.3 Appendix C: Cooking diary form

အိမ်ထောင်စုမှအစားအစာချက်ပြုတ်သူ ..... နေ့စွဲ..... **ဟင်းချက်သည့်ကိရိယာတစ်ခုအသုံးပြုတိုင်းသီးခြားပုံစံတစ်စောင်စီဖြည့်စွက်ရန်** Myanmar v171121

1 ဟင်းချက်ကိရိယာကိုမည်သည့်အချိန်တွင်အသုံးပြုသနည်း	☐ နံနက်စောစော ☐ နံနက်စာစားချိန် ☐ နေ့လည်စာမတိုင်မီ ☐ နေ့လည်စာစားချိန် ☐ မွန်းလွဲချိန် ☐ ညစာစားချိန် ☐ ညစာစားပြီးနောက်ပိုင်း
1.1 ဟင်းချက်ကိရိယာဖြင့် သင်ဘာချက်သလဲ	☐ နံနက်စာ ☐ နေ့လည်စာ ☐ ညစာ ☐ သွားဧေစာ ☐ ကလေးအစားအစာ ☐ ဧေနွေးတည်ရန် ☐ အခြား။ _____

2 ဟင်းချက်ကိရိယာကိုစတင်အသုံးမပြုမီ		
2.1 လောင်စာအသုံးပြုမှု တိုင်းတာခြင်းကို မည်သည့်အချိန်တွင် စတင်သနည်း။ အချိန်။ _____		
2.1.1	လျှပ်စစ်သုံးလျှင်။	မီတာစမှတ်သည့်အမှတ်။ မီတာ၁။ _____ kWh: မီတာ၂။ _____ kWh: မီတာ၃။ _____ kWh
2.1.2	ဂက်စ်သုံးလျှင်။	မချက်ပြုတ်မီတိုင်းတာသည့်ဂက်စ်အိုးအလေးချိန်။ _____ဝိုသာ
2.1.3	လောင်စာတုံးသုံးလျှင်။ (မီးသွေး၊ထင်းစသည်)	လောင်စာတောင့်အမျိုးအစား။ ☐ မီးသွေး ☐ ထင်း ☐ လောင်စာတောင့်/ခဲ ☐ စပါးခွံ မချက်ပြုတ်မီတိုင်းတာသည့်လောင်စာတုံးအလေးချိန်။ _____ ဝိုသာ/စည်း/အိတ် (ချက်ပြုတ်ဂုဏ်တွင်အသုံးပြုမည့် လောင်စာစုစုပေါင်းအလေးချိန်ကိုသာချင့်တွယ်တိုင်းတာရန်) မီးမွှေးရန်ကြာသည့်အချိန် (မီးမွှေးသည့်အချိန်မှအိုးအားမီးဖိုပေါ်တင်ပြီးသည်အထိကြာချိန်) _____ မိနစ် ☐ မီးမွှေးထားပြီးသား

3 ဟင်းချက်ကိရိယာအားသုံးပြုနေစဉ် (သို့) သုံးပြီးတဆောင့်အကြာ						
3.1 လူဦးရေမည်မျှစားသုံးဂုဏ်ချက်ပြုတ်သနည်း။ လူကြီးဦးရေ။ _____ ကလေးဦးရေ။_____						
3.2 ချက်ပြုတ်ဂုဏ်မလိုသည့်အစားအစာများစားသုံးခဲ့ပါသလား။ ☐ မစားခဲ့ပါ။ ☐ချက်ပြုတ်ဂုဏ်မလိုသည့်အစားအစာအားစားခဲ့သည်။စားခဲ့သည့်အစာအားဖော်ပြပါ။ (ဥပမာ-ပေါင်မုန့် _____) ☐ အဂင်ထဲကချက်ပြုတ်ပြီးသားအစာများအားပြန်မွှေးပဲစားသည်။ ၎င်းအစားအစာအားဖော်ပြပါ။_____ ☐ အပြင်မှဝယ်စားသည်။အလျှမ္ပရိ. သောအစားအစာများစားသည်။ (ဥပမာ - ခေါက်ဆွဲ) ၎င်းအစားအစာအားဖော်ပြပါ။ _____					
3.3 နောက်မှစားဂုဏ်အစားအစာများသင်ပြင်ဆင်ချက်ပြုတ်ခဲ့ပါသလား။ ☐ မပြင်ဆင်ခဲ့ပါ။ ☐ တချို့ တဝက်ပြင်ခဲ့သည်။ ☐ အားလုံးပြင်ဆင်ခဲ့သည်။						
3.4 သင်ဟင်းများချက်ခဲ့ပါသလား အစားအစာတစ်မျိုးစီအတွက် လိုင်းတစ်လိုင်းကိုသာအသုံးပြုပါ။ ကျန်သော ကော်လံများကိုလည်းဖြည့်ပေးပါ။	အရေအတွက် (ဥပမာ - ကြက်ဝမြစ်း ၁ဝီသာ၊ ၁ခွက်)	ဟင်းချက်သည့်ကိရိယာများ (အသုံးပြုသမျှအားအမှန်ခြစ်ပေးပါ)	သီးခြားဒယ်အိုးဒန့်ခွက်များအားအ အသုံးပြုခဲ့ပါသလား (အသုံးပြုသမျှအားအမှန်ခြစ်ပေးပါ)	လတ်ဆတ်အစာ (သို့) ပြန်ွန်ွေ့ ေ သောသောအစာ	ချက်ပြုတ်နည်း (အသုံးပြုသမျှအမှန်ခြစ်ခစ် ပေးပါ)	ဟင်းချက်ချိန်
DISH 1	☐ ဘိန်းမုန့် ☐ ကောက်ညှင်းပေါင်း ☐ ထမင်း ☐ ကြက်/ဘဲဥ ☐ ငါးခြောက် ☐ မုန့်, ဟင်းခါး ☐ ကြာဇံချက် ☐ အာလူးကြော် ☐ အုန်းနို့ ခေါက်ဆွဲ ☐ အသားငါးဥ၊ဟင်းသီးဟင်းဂွက်ဟင်း ☐ အခြားအသားငါး၊ကိုဟူး ☐ ဘွပ်ပြုတ် ☐ အခြား _____		☐ မီးသွေးမီးဖို ☐ ဂက်စ်မီးဖို ☐ မုန့်ဖုတ်မီးဖို ☐ လျှပ်စစ်မီးဖို ☐ Induction hotplate ☐ လျှပ်စစ်ဒယ်နီ ☐ လျှပ်စစ်ဧေနွေးခဏား ☐ Electric pressure cooker ☐ Microwave ☐ ထမင်းအပါင်းအိုး ☐ အခြား _____	အိုးအရွယ် ☐ ကြီး / ☐ လတ် / ☐ သေး ☐ ပန်းကန်လုံး/ပြား ☐ ဒယ်ပြား ☐ ဧေနွေးအိုး ☐ အခြား _____ *အိုးအားအဖုံးအုပ်သလား?* ☐ မအုပ် ☐ အုပ် ☐ တချို့သောအချိန်တွင်သာအုပ်သည်	☐ လတ်ဆတ် ☐ ပြန်ွန်ွေ့ ေ သောသောအစာ	☐ ကြော် ☐ ပြုတ် ☐ ကင် ☐ ပေါင်း ☐ ဖုတ် ☐ Microwave ☐ Pressure cooking ☐ အခြား _____	___ နာရီ ___ မိနစ်

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More information on this research can be found here: www.PV-eCook.org
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အိမ်ထောင်စုမှအစားအစာချက်ပြုတ်သူ ..... နေ့စွဲ..... ဟင်းချက်သည့်ကိရိယာတစ်ခုအသုံးပြုတိုင်းသီးခြားပုံစံတစ်စောင်စီဖြည့်စွက်ဂုန် Myanmar v171121

DISH 2	☐ ဘိန်းမုန် ☐ ကောက်ညှင်းပေါင်း ☐ ထမင်း ☐ ကြက်/ဘဲဥ ☐ ငါးခြောက် ☐ မုန့်, ဟင်းခါး ☐ ကြာဇံချက် ☐ အာလူးကြော် ☐ အုန်းနို့ ခေါက်ဆွဲ ☐ အသားငါးဥဟင်းသီးဟင်းဂျက်ဟင်း ☐ အခြားအသားငါးတိုဟူး ☐ စွပ်ပြုတ် ☐ အခြား _____		☐ မီးသွေးမီးဖို ☐ ဂက်စ်မီးဖို ☐ မုန်ဖုတ်မီးဖို ☐ လျှပ်စစ်မီးဖို ☐ Induction hotplate ☐ လျှပ်စစ်ဒယ်နီ ☐ လျှပ်စစ်ဂေနွေးခဲဂုး ☐ Electric pressure cooker ☐ Microwave ☐ ထမင်းပေါင်းအိုး ☐ အခြား _____	အိုးအရွယ် ☐ ကြီး / ☐ လတ် / ☐ သေး ☐ ပန်းကန်လုံး/ပြား ☐ ဒယ်ပြား ☐ ဂေနွေးအိုး ☐ အခြား _____ *အိုးအားအဖုံးအုပ်သလား?* ☐ မအုပ် ☐ အုပ် ☐ တချို့သောအချိန်တွင်သာအုပ်သည်	☐ လတ်ဆတ် ☐ ပြန်ခြောက် ခြောက်: သေ သောအစာ	☐ ကြော် ☐ ပြုတ် ☐ ကင် ☐ ပေါင်း ☐ ဖုတ် ☐ Microwave ☐ Pressure cooking ☐ အခြား _____	___ နာရီ ___ မိနစ်
DISH 3	☐ ဘိန်းမုန် ☐ ကောက်ညှင်းပေါင်း ☐ ထမင်း ☐ ကြက်/ဘဲဥ ☐ ငါးခြောက် ☐ မုန့်, ဟင်းခါး ☐ ကြာဇံချက် ☐ အာလူးကြော် ☐ အုန်းနို့ ခေါက်ဆွဲ ☐ အသားငါးဥဟင်းသီးဟင်းဂျက်ဟင်း ☐ အခြားအသားငါးတိုဟူး ☐ စွပ်ပြုတ် ☐ အခြား _____		☐ မီးသွေးမီးဖို ☐ ဂက်စ်မီးဖို ☐ မုန်ဖုတ်မီးဖို ☐ လျှပ်စစ်မီးဖို ☐ Induction hotplate ☐ လျှပ်စစ်ဒယ်နီ ☐ လျှပ်စစ်ဂေနွေးခဲဂုး ☐ Electric pressure cooker ☐ Microwave ☐ ထမင်းပေါင်းအိုး ☐ အခြား _____	အိုးအရွယ် ☐ ကြီး / ☐ လတ် / ☐ သေး ☐ ပန်းကန်လုံး/ပြား ☐ ဒယ်ပြား ☐ ဂေနွေးအိုး ☐ အခြား _____ *အိုးအားအဖုံးအုပ်သလား?* ☐ မအုပ် ☐ အုပ် ☐ တချို့သောအချိန်တွင်သာအုပ်သည်	☐ လတ်ဆတ် ☐ ပြန်ခြောက် ခြောက်: သေ သောအစာ	☐ ကြော် ☐ ပြုတ် ☐ ကင် ☐ ပေါင်း ☐ ဖုတ် ☐ Microwave ☐ Pressure cooking ☐ အခြား _____	___ နာရီ ___ မိနစ်
DISH 4	☐ ဘိန်းမုန် ☐ ကောက်ညှင်းပေါင်း ☐ ထမင်း ☐ ကြက်/ဘဲဥ ☐ ငါးခြောက် ☐ မုန့်, ဟင်းခါး ☐ ကြာဇံချက် ☐ အာလူးကြော် ☐ အုန်းနို့ ခေါက်ဆွဲ ☐ အသားငါးဥဟင်းသီးဟင်းဂျက်ဟင်း ☐ အခြားအသားငါးတိုဟူး ☐ စွပ်ပြုတ် ☐ အခြား _____		☐ မီးသွေးမီးဖို ☐ ဂက်စ်မီးဖို ☐ မုန်ဖုတ်မီးဖို ☐ လျှပ်စစ်မီးဖို ☐ Induction hotplate ☐ လျှပ်စစ်ဒယ်နီ ☐ လျှပ်စစ်ဂေနွေးခဲဂုး ☐ Electric pressure cooker ☐ Microwave ☐ ထမင်းပေါင်းအိုး ☐ အခြား _____	အိုးအရွယ် ☐ ကြီး / ☐ လတ် / ☐ သေး ☐ ပန်းကန်လုံး/ပြား ☐ ဒယ်ပြား ☐ ဂေနွေးအိုး ☐ အခြား _____ *အိုးအားအဖုံးအုပ်သလား?* ☐ မအုပ် ☐ အုပ် ☐ တချို့သောအချိန်တွင်သာအုပ်သည်	☐ လတ်ဆတ် ☐ ပြန်ခြောက် ခြောက်: သေ သောအစာ	☐ ကြော် ☐ ပြုတ် ☐ ကင် ☐ ပေါင်း ☐ ဖုတ် ☐ Microwave ☐ Pressure cooking ☐ အခြား _____	___ နာရီ ___ မိနစ်

3.5 ဂေဟာ အပူပေး ပါသလား။ (အသုံးပြုသည့် လိုင်းများအားလုံး ဖုံးဖြည့်ပေးဂုန်)	အပူပေးဂုန်အတွက်မည်သည့်မီးဖို/ကိရိယာကို သုံးပါသလဲ	သီးခြားအိုး/ခွက်အသုံးပြုခဲ့ပါသလား (အသုံးပြုသမျှအားအမှန်ခြစ်ပေးပါ)	ဂေဘယ်လောက်လဲ လဲ ဖြည့်သလဲ	ဘယ် လောက် ပူလဲ	အချို့ကိုမတ်ဘူးထဲ တွင်သိမ်းထား သေး သးသလား	☁ **လောင်စာ တောင့်သုံ ုံးပါကမီးဖိုတွင် နောက် ဂ်ဆုံးကျွန်ရှိသော ဂ လောင်စာကုန်သည့်အ အထိ ဂေဟိုဆက်အပူပေး ပးထားခဲ့သလား**
☐ ဂေရျိုးဂုန်	☐ မီးသွေးမီးဖို ☐ ဂက်စ်မီးဖို ☐ Microwave ☐ လျှပ်စစ်မီးဖို ☐ Induction hotplate ☐ လျှပ်စစ်ဂေနွေးခဲဂုး ☐ အခြား _____	အိုးအရွယ် - ☐ ကြီး / ☐ လတ် / ☐ သေး *သင်အုံးအားအသုံးပြုသလား?* ☐ မပြု ☐ တချို့သောအချိန်တွင်သာသုံးသည် ☐ အချိန်တိုင်းသုံးသည်	☐ ၁/၄ ☐ ၁/၂ ☐ ၃/၄ ☐ အပြည့် ☐ ၂ဆ ☐ ၄ဆ ☐ အခြား _____	☐ နွေး ☐ ပူ ☐ ဆူ	☐ မသိမ်းပါ ☐ တချို့ကိုသိမ်းသည် ☐ အားလုံးသိမ်းသည်။ ဘာအတွက်သိမ်းသနည်း _____	☐ ဟုတ်တယ် ☐ မဟုတ်ဘူး

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အိမ်ထောင်စုမှုအစားအစာချက်ပြုတ်သူ ..... နေ့စွဲ..... **ဟင်းချက်သည့်ကိရိယာတစ်ခုအသုံးပြုတိုင်းသီးခြားပုံစံတစ်စောင်စီဖြည့်စွက်ရန်** Myanmar v171121

☐ သောက်သုံးရန်	☐ မီးသွေးမီးဖို ☐ ဂက်စ်မီးဖို ☐ Microwave ☐ လျှပ်စစ်မီးဖို ☐ Induction hotplate ☐ လျှပ်စစ်ဂေဒန်းခဂုး ☐ အခြား _____	အိုးအရွယ် - ☐ ကြီး / ☐ လတ် / ☐ သေး *သင်အသုံးအားအသုံးပြုသလား?* ☐ မပြု ☐ တချို့သောအချိန်တွင်သာသုံးသည် ☐ အချိန်တိုင်းသုံးသည်	☐ ၁/၄ ☐ ၁/၂ ☐ ၃/၄ ☐ အပြည့် ☐ ၂ဆ ☐ ၄ဆ ☐ အခြား _____	☐ နေ့ ☐ ပူ ☐ ဆူ	☐ မသိမ်းပါ ☐ တချို့ကိုသိမ်းသည် ☐ အားလုံးသိမ်းသည်။ ဘာအတွက်သိမ်းသနည်း _____	☐ ဟုတ်တယ် ☐ မဟုတ်ဘူး
☐ ကော်ဖီ၊ လဖက်ရည်၊ မိုင်လို	☐ မီးသွေးမီးဖို ☐ ဂက်စ်မီးဖို ☐ Microwave ☐ လျှပ်စစ်မီးဖို ☐ Induction hotplate ☐ လျှပ်စစ်ဂေဒန်းခဂုး ☐ အခြား _____	အိုးအရွယ် - ☐ ကြီး / ☐ လတ် / ☐ သေး *သင်အသုံးအားအသုံးပြုသလား?* ☐ မပြု ☐ တချို့သောအချိန်တွင်သာသုံးသည် ☐ အချိန်တိုင်းသုံးသည်	☐ ၁/၄ ☐ ၁/၂ ☐ ၃/၄ ☐ အပြည့် ☐ ၂ဆ ☐ ၄ဆ ☐ အခြား _____	☐ နေ့ ☐ ပူ ☐ ဆူ	☐ မသိမ်းပါ ☐ တချို့ကိုသိမ်းသည် ☐ အားလုံးသိမ်းသည်။ ဘာအတွက်သိမ်းသနည်း _____	☐ ဟုတ်တယ် ☐ မဟုတ်ဘူး
☐ အခြား _____	☐ မီးသွေးမီးဖို ☐ ဂက်စ်မီးဖို ☐ Microwave ☐ လျှပ်စစ်မီးဖို ☐ Induction hotplate ☐ လျှပ်စစ်ဂေဒန်းခဂုး ☐ အခြား _____	အိုးအရွယ် - ☐ ကြီး / ☐ လတ် / ☐ သေး *သင်အသုံးအားအသုံးပြုသလား?* ☐ မပြု ☐ တချို့သောအချိန်တွင်သာသုံးသည် ☐ အချိန်တိုင်းသုံးသည်	☐ ၁/၄ ☐ ၁/၂ ☐ ၃/၄ ☐ အပြည့် ☐ ၂ဆ ☐ ၄ဆ ☐ အခြား _____	☐ နေ့ ☐ ပူ ☐ ဆူ	☐ မသိမ်းပါ ☐ တချို့ကိုသိမ်းသည် ☐ အားလုံးသိမ်းသည်။ ဘာအတွက်သိမ်းသနည်း _____	☐ ဟုတ်တယ် ☐ မဟုတ်ဘူး

4 ဟင်းချက်ကိရိယာကိုအသုံးပြုပြီး	
4.1 လောင်စာအသုံးပြုမှုတိုင်းတာခြင်းကိုမည်သည့်အချိန်တွင်အဆုံးသတ်သနည်း။ အချိန်။ _____	
4.2 လျှပ်စစ်သုံးလျှင်။	**မီတာဆုံးသည့်အမှတ်။** **မီတာ၁။** _____ kWh; **မီတာ၂။** _____ kWh; **မီတာ၃။** _____ kWh သင်ဟင်းချက်ပြုတ်ဂုတွင်မည်သည့်ကိရိယာသည်စွမ်းအင်အများဆုံးသုံးစွဲသနည်း (tick ALL used at any one time)? ☐ မီးသွေးမီးဖို ☐ ဂက်စ်မီးဖို ☐ မှန်ဖုတ်မီးဖို ☐ လျှပ်စစ်ဂေဒန်းခဂုး ☐ Microwave ☐ လျှပ်စစ်မီးဖို ☐ Induction hotplate ☐ လျှပ်စစ်ဒယ်နီ ☐ Electric pressure cooker ☐ ထမင်းပေါင်းအိုး ☐ အခြား _____
4.3 ဂက်စ်သုံးလျှင်။	**ချက်ပြုတ်ပြီးချိန်တိုင်းတာသည့်ဂက်စ်အိုးအလေးချိန်။** _____ ဝိသာ
4.4 လောင်စာတုံးသုံးလျှင်။	**ချက်ပြုတ်ပြီးချိန်တိုင်းတာသည့်လောင်စာတုံးအလေးချိန်။** _____ ဝိသာ/စည်း/အိတ် ကျန်ရှိသည်မီးသွေး၊ထင်းအစရှိသည့်လောင်စာတောင့်များအားပြောဖြစ်သည်အထိဆက်လက်လောင်ကျွမ်းစေသလား ☐ လောင်ကျွမ်းစေသည် ☐ မလောင်ကျွမ်းစေပါ၊တချို့တဝက်ကိုနောက်တစ်ကြိမ်ပြန်လည်အသုံးပြုနိုင်ဂန်ငြိမ်းသတ်သိမ်းဆည်းထားသည်။
4.5 အခြားဂျာဖွေဆန်းစစ်ချက် (သို့) ခြားချက်များရှိပါသလား ဥပမာ - သင် တစ်ခုခု မီးသုံးသေးလား။ မီးမ္ဘေးတဲ့အချိန်ကပုံမှန်ထက်ပိုကြာသွားသလား။ သင့်သူငယ်ချင်းလာလည်သလား။ ဒီနေ့တနေကုန်မီးပြတ်နေသလား။ အကြောင်းဂုင်းကိုဂွင်းပြပါ။	_____ _____

For any queries, comments or complaints, please contact: am.ream@gmail.com, jon.k.leary@gmail.com or the Principal Investigator, Dr. Ed Brown, E.D.Brown@lboro.ac.uk
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Household Identifier ..... Date:..... PLEASE FILL IN A SEPARATE FORM EVERY TIME YOU USE A COOKING APPLIANCE Myanmar v171121

1 When did you use the cooking appliance?	☐ Early morning ☐ Breakfast time ☐ Mid-morning ☐ Lunch time ☐ Mid-afternoon ☐ Dinner time ☐ Late evening
1.1 What are you using the cooking appliance for?	☐ Breakfast ☐ Lunch ☐ Dinner ☐ Snack ☐ Food for baby/child ☐ Heating water ☐ Other: _____

2 Before using cooking appliance		
2.1 When did you take the fuel measurements? TIME: _____		
2.1.1	If using electricity:	Plug in meters: METER 1 UNITS: _____ kWh; METER 2 UNITS: _____ kWh; METER 3 UNITS: _____ kWh
2.1.2	If using LPG:	INITIAL CYLINDER WEIGHT: _____kg
2.1.3	If using solid fuel:	FUEL TYPE: ☐ Charcoal ☐ Firewood ☐ Pellets/briquettes ☐ Rice husk INITIAL BAG WEIGHT: _____kg (total weight of bag charcoal/wood is taken from during cooking) How long did it take to light the fire (time from striking the match to putting the pot on the stove)?_____ mins ☐ Already lit

3 Whilst using cooking appliance (or shortly after)	
3.1 How many people did you cater for? Adults: _____ Children: _____	
3.2 Did you serve any foods that you did not cook? ☐ No ☐ Yes, some foods didn't require cooking (e.g. bread or salad). If so, which? _____ ☐ Yes, I cooked some foods earlier & did not reheat them. If so, which? _____ ☐ Yes, I purchased/was given some foods that had already been cooked (e.g. pre-cooked noodles)? If so, which food/s? _____	
3.3 Were you preparing food to be eaten at a later time? ☐ No, none of it ☐ Yes, some of it ☐ Yes, all of it	

	3.4 Did you cook any dishes? Please use one row for each dish and then complete all other columns for that dish	Quantity eg. half a chicken, 3 cups, 1 viss	Cooking devices? Please tick all that apply	Did you use separate pots/pans/plate/bowl? Please tick all that apply:	Fresh or re-heated food?	Processes? Please tick all that apply	Cooking time
DISH 1	☐ Pancakes ☐ Sticky rice ☐ Rice ☐ Eggs ☐ Dry fish ☐ Myanmar vermicelli ☐ Kyer zan chat ☐ French fries ☐ Coconut milk noodles ☐ Meat/fish/egg/veg curry ☐ Other meat/fish/tofu ☐ Other veg ☐ Beans ☐ Noodles ☐ Soup ☐ Other_____		☐ Charcoal stove ☐ Gas stove ☐ Grill/oven ☐ Electric hotplate ☐ Induction hotplate ☐ Electric frying pan ☐ Electric kettle ☐ Electric pressure cooker ☐ Microwave ☐ Rice cooker ☐ Other _____	Pot: ☐ Big / ☐ Med / ☐ Small ☐ Bowl/plate ☐ Frying pan ☐ Kettle ☐ Other _____ *Did you put a lid on the pot?* ☐ No ☐ Yes ☐ Some of the time	☐ Fresh ☐ Re-heated	☐ Fry ☐ Boil ☐ Grill ☐ Steam ☐ Bake ☐ Microwave ☐ Pressure cooking ☐ Other _____	___ hrs ___ mins
DISH 2	☐ Pancakes ☐ Sticky rice ☐ Rice ☐ Eggs ☐ Dry fish ☐ Myanmar vermicelli ☐ Kyer zan chat ☐ French fries ☐ Coconut milk noodles ☐ Meat/fish/egg/veg curry ☐ Other meat/fish/tofu ☐ Other veg ☐ Beans ☐ Noodles ☐ Soup ☐ Other_____		☐ Charcoal stove ☐ Gas stove ☐ Grill/oven ☐ Electric hotplate ☐ Induction hotplate ☐ Electric frying pan ☐ Electric kettle ☐ Electric pressure cooker ☐ Microwave ☐ Rice cooker ☐ Other _____	Pot: ☐ Big / ☐ Med / ☐ Small ☐ Bowl/plate ☐ Frying pan ☐ Kettle ☐ Other _____ *Did you put a lid on the pot?* ☐ No ☐ Yes ☐ Some of the time	☐ Fresh ☐ Re-heated	☐ Fry ☐ Boil ☐ Grill ☐ Steam ☐ Bake ☐ Microwave ☐ Pressure cooking ☐ Other _____	___ hrs ___ mins
DISH 3	☐ Pancakes ☐ Sticky rice ☐ Rice ☐ Eggs ☐ Dry fish ☐ Myanmar vermicelli ☐ Kyer zan chat ☐ French fries ☐ Coconut milk noodles ☐ Meat/fish/egg/veg curry ☐ Other meat/fish/tofu ☐ Other veg ☐ Beans ☐ Noodles ☐ Soup ☐ Other_____		☐ Charcoal stove ☐ Gas stove ☐ Grill/oven ☐ Electric hotplate ☐ Induction hotplate ☐ Electric frying pan ☐ Electric kettle ☐ Electric pressure cooker ☐ Microwave ☐ Rice cooker ☐ Other _____	Pot: ☐ Big / ☐ Med / ☐ Small ☐ Bowl/plate ☐ Frying pan ☐ Kettle ☐ Other _____ *Did you put a lid on the pot?* ☐ No ☐ Yes ☐ Some of the time	☐ Fresh ☐ Re-heated	☐ Fry ☐ Boil ☐ Grill ☐ Steam ☐ Bake ☐ Microwave ☐ Pressure cooking ☐ Other _____	___ hrs ___ mins

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This research was funded by DfID/UK Aid through the Innovate UK Energy Catalyst

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Household Identifier ..... Date:..... PLEASE FILL IN A SEPARATE FORM EVERY TIME YOU USE A COOKING APPLIANCE Myanmar v171121

DISH 4						
☐ Pancakes ☐ Sticky rice ☐ Rice ☐ Eggs ☐ Dry fish ☐ Myanmar vermicelli ☐ Kyer zan chat ☐ French fries ☐ Coconut milk noodles ☐ Meat/fish/egg/veg curry ☐ Other meat/fish/tofu ☐ Other veg ☐ Beans ☐ Noodles ☐ Soup ☐ Other_____	☐ Charcoal stove ☐ Gas stove ☐ Grill/oven ☐ Electric hotplate ☐ Induction hotplate ☐ Electric frying pan ☐ Electric kettle ☐ Electric pressure cooker ☐ Microwave ☐ Rice cooker ☐ Other _____	Pot: ☐ Big / ☐ Med / ☐ Small ☐ Bowl/plate ☐ Frying pan ☐ Kettle ☐ Other _____ *Did you put a lid on the pot?* ☐ No ☐ Yes ☐ Some of the time	☐ Fresh ☐ Re-heated	☐ Fry ☐ Boil ☐ Grill ☐ Steam ☐ Bake ☐ Microwave ☐ Pressure cooking ☐ Other _____	____ hrs ____ mins

3.5 Did you heat water? Please complete **all rows that apply**	Which appliance/s did you use?	Did you use separate pots/pans? Please tick **all** that apply	How full was it?	How hot?	Did you save any in a flask?	**If using solid fuel**, did you heat the water on the last of the fire?
☐ Bathing	☐ Charcoal stove ☐ Gas stove ☐ Microwave ☐ Electric hotplate ☐ Induction hotplate ☐ Electric kettle ☐ Other _____	Pot: ☐ Big / ☐ Med / ☐ Small *Did you use a lid?* ☐ No ☐ Some of the time ☐ All the time	☐ ¼ ☐ ½ ☐ ¾ ☐ Full ☐ 2x ☐ 4x ☐ Other _____	☐ Warm ☐ Hot ☐ Boiling	☐ None ☐ Some ☐ All. If so, what for?_____	☐ Yes ☐ No
☐ Drinking/ purifying	☐ Charcoal stove ☐ Gas stove ☐ Microwave ☐ Electric hotplate ☐ Induction hotplate ☐ Electric kettle ☐ Other _____	Pot: ☐ Big / ☐ Med / ☐ Small *Did you use a lid?* ☐ No ☐ Some of the time ☐ All the time	☐ ¼ ☐ ½ ☐ ¾ ☐ Full ☐ 2x ☐ 4x ☐ Other _____	☐ Warm ☐ Hot ☐ Boiling	☐ None ☐ Some ☐ All. If so, what for?_____	☐ Yes ☐ No
☐ Tea/coffee/ cocoa/milo	☐ Charcoal stove ☐ Gas stove ☐ Microwave ☐ Electric hotplate ☐ Induction hotplate ☐ Electric kettle ☐ Other _____	Pot: ☐ Big / ☐ Med / ☐ Small *Did you use a lid?* ☐ No ☐ Some of the time ☐ All the time	☐ ¼ ☐ ½ ☐ ¾ ☐ Full ☐ 2x ☐ 4x ☐ Other _____	☐ Warm ☐ Hot ☐ Boiling	☐ None ☐ Some ☐ All. If so, what for?_____	☐ Yes ☐ No
☐ Other _____	☐ Charcoal stove ☐ Gas stove ☐ Microwave ☐ Electric hotplate ☐ Induction hotplate ☐ Electric kettle ☐ Other _____	Pot: ☐ Big / ☐ Med / ☐ Small *Did you use a lid?* ☐ No ☐ Some of the time ☐ All the time	☐ ¼ ☐ ½ ☐ ¾ ☐ Full ☐ 2x ☐ 4x ☐ Other _____	☐ Warm ☐ Hot ☐ Boiling	☐ None ☐ Some ☐ All. If so, what for?_____	☐ Yes ☐ No

4	**After using cooking appliance**	
4.1	**When did you take the fuel measurements?** TIME: _____	
4.2	**If using electricity:**	Plug in meters: : **METER 1 UNITS:** _____ kWh: **METER 2 UNITS:** _____ kWh: **METER 3 UNITS:** _____ kWh What is the maximum power you used to cook with (tick ALL used at any one time)? ☐ Charcoal stove ☐ Gas stove ☐ Grill/oven ☐ Electric kettle ☐ Microwave ☐ Electric hotplate ☐ Induction hotplate ☐ Electric frying pan ☐ Electric pressure cooker ☐ Rice cooker ☐ Other _____
4.3	**If using LPG:**	**FINAL CYLINDER WEIGHT**: _____kg
4.4	**If using solid fuel:**	**FINAL BAG WEIGHT**: _____kg Did you let the fire burn out i.e. all charcoal/wood turned to ash? ☐ Yes ☐ No, I saved some unused charcoal/wood for re-use later
4.5	**Any other observations?** For example: Did you burn anything? Did the fire take longer than usual to light? Did friends come to visit? Did the power go out at all today? etc. If so, please explain why?	_____ _____

For any queries, comments or complaints, please contact: am.ream@gmail.com, jon.k.leary@gmail.com or the Principal Investigator, Dr. Ed Brown, E.D.Brown@lboro.ac.uk
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6.4 Appendix D: Daily summary form

အိမ်ထောင်စုစာရင်းပြုစုသူ ..... နေ့စွဲ:..... Myanmar v171121

ချက်ပြုတ်မှုဒိုင်ယာရီ အနှစ်ချုပ်ပုံစံ

မနက်စာစားပါသလား	☐ ဟုတ် စားတယ်၊ချက်တယ်၊ပြန်နွေးတယ်၊ပုံစံဖြည့်တယ်။ ☐ ဟုတ် ချက်တယ်၊ပြန်နွေးတယ်၊ပုံစံဖြည့်ဖို့ မေ့သွားလို့ မှတ်မိသလောက် ဖြည့်ပါတယ်။ ☐ ဟုတ် စောစောက ချက်ထားတာ မနွေးဘဲ စားပါတယ်။ ☐ ဟုတ် ဝယ်စားတယ်။ ☐ ဟုတ် သူငယ်ချင်း(သို့)တစ်ခြားတစ်ယောက်အိမ်မှာစားတယ်။ ☐ မစားပါ။
နေ့လည်စာစားသလား	☐ ဟုတ် စားတယ်၊ချက်တယ်၊ပြန်နွေးတယ်၊ပုံစံဖြည့်တယ်။ ☐ ဟုတ် ချက်တယ်၊ပြန်နွေးတယ်၊ပုံစံဖြည့်ဖို့ မေ့သွားလို့ မှတ်မိသလောက် ဖြည့်ပါတယ်။ ☐ ဟုတ် စောစောက ချက်ထားတာ မနွေးဘဲ စားပါတယ်။ ☐ ဟုတ် ဝယ်စားတယ်။ ☐ ဟုတ် သူငယ်ချင်း(သို့)တစ်ခြားတစ်ယောက်အိမ်မှာစားတယ်။ ☐ မစားပါ။
ညစာစားသလား	☐ ဟုတ် စားတယ်၊ချက်တယ်၊ပြန်နွေးတယ်၊ပုံစံဖြည့်တယ်။ ☐ ဟုတ် ချက်တယ်၊ပြန်နွေးတယ်၊ပုံစံဖြည့်ဖို့ မေ့သွားလို့ မှတ်မိသလောက် ဖြည့်ပါတယ်။ ☐ ဟုတ် စောစောက ချက်ထားတာ မနွေးဘဲ စားပါတယ်။ ☐ ဟုတ် ဝယ်စားတယ်။ ☐ ဟုတ် သူငယ်ချင်း(သို့)တစ်ခြားတစ်ယောက်အိမ်မှာစားတယ်။ ☐ မစားပါ။
ဒီနေ့ မနက်စာ၊ နေ့လည်စာ၊ ညစာ အပြင် အခြားချက်ပါ သေးသသလား ။ ရေနွေး တည်ပါသေးသလား	---------- ---------- ----------

ယနေ့ ပြီးသမျှ ပုံစံများအရေအတွက်: _____

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Household Identifier ..... Date:..... Myanmar v171121

Cooking Diary Daily Summary Form

Did you use a cooking appliance **early in the morning**?	☐ **Yes and I filled in a form at the time.** ☐ **Yes, but I forgot to fill in a form at the time. If so, please go back and fill in a form now with the details you can remember.** ☐ No, I did not.
Did you eat **breakfast**?	☐ **Yes, I cooked/reheated it and filled in a form at the time.** ☐ **Yes, but I forgot to fill in a form at the time. If so, please go back and fill in a form now with the details you can remember.** ☐ Yes, I bought food for breakfast. ☐ Yes, I ate breakfast at a friend or family member's place. ☐ No, I did not eat breakfast.
Did you use a cooking appliance **mid-morning**?	☐ **Yes and I filled in a form at the time.** ☐ **Yes, but I forgot to fill in a form at the time. If so, please go back and fill in a form now with the details you can remember.** ☐ No, I did not.
Did you eat **lunch**?	☐ **Yes, I cooked/reheated it and filled in a form at the time.** ☐ **Yes, I cooked/reheated it, but I forgot to fill in a form at the time. If so, please go back and fill in a form now with the details you can remember.** ☐ Yes, I ate food that I prepared earlier, but I did not reheat it. ☐ Yes, I bought food for lunch. ☐ Yes, I ate lunch at a friend or family member's place. ☐ No, I did not eat lunch.
Did you use a cooking appliance **mid-afternoon**?	☐ **Yes and I filled in a form at the time.** ☐ **Yes, but I forgot to fill in a form at the time. If so, please go back and fill in a form now with the details you can remember.** ☐ No, I did not.
Did you eat **dinner**?	☐ **Yes, I cooked/reheated it and filled in a form at the time.** ☐ **Yes, I cooked/reheated it, but I forgot to fill in a form at the time. If so, please go back and fill in a form now with the details you can remember.** ☐ Yes, I ate food that I prepared earlier, but I did not reheat it. ☐ Yes, I bought food for dinner. ☐ Yes, I ate dinner at a friend or family member's place. ☐ No, I did not eat dinner.
Did you use a cooking appliance **late evening**?	☐ **Yes and I filled in a form at the time.** ☐ **Yes, but I forgot to fill in a form at the time. If so, please go back and fill in a form now with the details you can remember.** ☐ No, I did not.

Total no. forms completed today: _____

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6.5 Appendix E: Cooking diaries exit survey

COOKING DIARY MYANMAR- EXIT INTERVIEW

Name: _____ HH ID:_____Date: _____ Location:_____

Fuel/s before survey:.....

Pressure cooker (electric or not) before survey:.....

As we come to the end of the survey, we take this opportunity to thank you for your endurance throughout the period. We are glad that all went well from our side, however we wish to hear from you with a few questions below.

Before we get on with the questions, I would like to ask that you prepare the chicken with potatoes and pressure cooker for the Chicken Curry Challenge I had informed you about some weeks back. The competition is judged solely on energy use, so as long as the chicken are judged by the enumerator/s to be as tasty as they expect chicken to be (i.e. soft and accompanied by the usual pounded onion, garlic with chilli powder and oil), then the winning household is simply the one that uses the lowest number of units to cook 0.25 viss of chicken. You are permitted to marinate them an hour or overnight.

Your experience of cooking with electricity

1. How did the induction stove, rice cooker, therma-pot and pressure cooker suit the way you cook in your home?

(score:1 = strongly disagree; 2 = disagree; 3 = no opinion; 4 = agree; 5 = strongly agree)

	Induction Stove					Rice Cooker					Pressure Cooker					Therma -Pot					
QUESTION	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Comment
It was easy to control heat																					
Ecooker could cook fast enough																					
Long cooking dishes were cooked much faster																					
Ecooker was hot enough																					
Ecooker burnt the food																					
My pots didn't fit on the ecooker																					
Curries/rice/tea cooked on electric stoves just didn't																					

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taste the same																					
Food cooked using the ecooker tasted better than usual																					
I missed the smokey flavor of food																					
Pots were unstable on electric stoves																					
The ecooker didn't make the pots dirty																					
The ecooker looked good in my kitchen																					
There is nowhere to put the ecooker																					
Operating the ecooker was easy																					
Ecooker was safe to use																					
I prefer to use an electric kettle for water boiling																					

2. How many hobs (rings) do you need for cooking?

   [ ] 1 [ ] 2 [ ] 3 [ ] 4

3. What were the best things about cooking with electricity?

……

……

……

……

4. And what were the worst things about cooking with electricity?

……

……

……

……

5. What do you like most about cooking with charcoal/ firewood?

……

……

……

……

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6. What do you like most about cooking with LPG?

……
……
……
……

7. What are the best things about not cooking with charcoal/ firewood?

……
……
……
……

8. What are the best things about not cooking with LPG?

……
……
……
……

9. Did you change your cooking behavior? If yes, how and why?

……
……
……
……
……

10. **Your feeling about cooking with electricity in comparison to other fuels** Do you think electric cooking is affordable?

……
……
……
……
……

11. Do you think cooking with electricity is cheaper or more expensive than cooking with the fuels you normally use?

……
……
……
……

12. Were there times when the electricity was off and you wanted to cook or heat water? If so, what did you do?

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……

……

……

……

13. Do you feel that cooking with the electric cooker is safer or more dangerous than cooking with your normal stove, and why? (e.g. risk of fires, burns)

Induction Stove ……
……

Rice cooker……
……

Therma-Pot ……
……

Pressure cooker……
……

14. How easy is it to learn to cook on an electric stove?

Induction Stove ……
……

Rice cooker……
……

Therma-Pot ……
……

Pressure cooker……
……

15. Would people need training on how to use an ecooker, or would they be able to learn by themselves?

Induction Stove ……
……

Rice cooker……
……

Therma-Pot ……
……

Pressure cooker……
……

16. Would you ever cook using only electricity and no other fuels - and explain why?

……

……

……

……

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17. What would you change about the design of the electric stoves you have been using?

Induction Stove ……
……

Rice cooker……
……

Therma-Pot ……
……

Pressure cooker……
……

18. We are done with our survey and are leaving the cookers with you. Will you continue using the e-cookers or will you switch back to your old stove?

Induction Stove ……
……

Rice cooker……
……

Therma-Pot ……
……

Pressure cooker……

……

19. We are not going to ask you to pay for the cooker. Would you buy this cooker if you saw one in a shop now? If so, how much would you be prepared to pay for this cooker (Myanmar Kyat)?

Induction Stove ……
……

Rice cooker……
……

Therma-Pot ……
……

Pressure cooker……

……

Missing data

We have tried our best to learn as much as we can about how you cook, but we appreciate that the tools we are using are limited. Please help us to understand what we may have missed.

20. Are there any meals that were cooked in your household since the beginning of the study that were not recorded on the forms you have given to us?

……

……

……

……

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21. Is there anything else that you think is important about the way you cook that we have not yet captured?

……

……

……

……

How you feel about the survey

22. In the table below, tick where appropriate, where 1 is the lowest and 5 being the highest

QUESTION	1(Low)	2	3	4	5(High)
Overall cooking survey					
Choice of appliance to trial (induction stove)					
Choice of appliance to trial (pressure cooker)					
Choice of appliance to trial (rice cooker)					
Choice of appliance to trial (therma-pot)					
Training on how to use induction stove					
Training on how to use pressure cooker					
Training on how to use rice cooker					
Training on how to use therma-pot					
Relevance of questions					
Duration of survey					

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23. When you were approached to be part of the electric cooking survey were you hesitant? Has it been different to what you expected?
……
……
……
……
……..
24. At the beginning of the e-cooking, what was your expectation and was it met?
……
……
……
……
……
25. What do you think we could have done better in the survey?
……
……
……
……
……
26. Were the enumerator's visits helpful or did you feel it was too much or too little?

……

……

……

……

……

27. If we were to do another similar survey in the future would you be willing to be part of it?

……

……

END OF QUESTIONS

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Chicken Curry eCooking Challenge

Wait for the chicken curry to be completed and then note down the total number of units used and the key energy saving tips the households used.

Total units used to cook 0.25 viss of chicken with 0.2 viss of potatoes and pounded garlic, onion, chilli powder and oil: _____kWh

Energy saving techniques employed:

1. ☐ Marinating meat
2. ☐ Adding correct amount of salt at beginning to allow it to soften ingredients as much as possible
3. ☐ Avoiding frying
4. ☐ Putting a lid on the pan and turning the heat down to simmer rather than boil
5. ☐ Avoid having to thicken the sauce by adding the correct amount of water from the beginning
6. ☐ Choosing quicker cooking breed of chicken/variety of potatoes
7. ☐ Using hot/warm water from the kettle (or other appliance) that had been boiled for something else (please make a note if they boil the kettle especially for the chicken curry, as this energy should ne included in the total)
8. ☐ Chopping up the ingredients as small as possible
9. ☐ Correctly judging the cooking time, so avoiding depressurising and re-pressurising
10. ☐ Adding all ingredients at the beginning, so avoiding cooking with the lid off (frying/boiling)
11. ☐ Other/s. Please describe
    _____
    _____
    __

Thank the household for participating in the survey and the Chicken Curry Challenge.

The Prize will be presented to the winner after all exit survey interviews have been completed.

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