Analysis Framework – MECS Cooking Diaries

September 2021

Lead author: Nigel Scott

With contributions from: Anna Clements, Jon Leary, Richard Sieff, Tash Perros, Will Clements

This material has been funded by UKAid from the UK government; however the views expressed do not necessarily reflect the UK government's official policies.

1 Introduction

The Cooking Diaries approach developed for the MECS programme aimed to address a lack of data around how people cook, and how they might cook with electricity (eCook). It was originally designed to answer the following principal research questions:

- Are electric cooking devices compatible with local cooking practices
- How much energy is used for cooking in practice (using different fuels)

Several organisations within the MECS programme are running some kind of cooking diaries activity as part of the country programme, either already completed, currently ongoing, or planned for the future. These activities have been designed by each organisation to answer slightly different research questions, reflecting the local context, the particular interests of implementing partners, and the interests of the MECS workstream that oversees the cooking diaries activity. Therefore, it is not possible to create any kind of template that can be used by all partners to analyse all the data collected as each dataset will be different.

Having said that, this document summarises the findings the MECS programme would like to learn from Cooking Diaries activities. The research questions and the level of detail are based on an Example data collection form, presented at the end of the document. Irrespective of the level of detail in the design, a cooking diaries experiment should generate the following types of data:

- Breakdown of meals cooked and water heated (or 'heating events' to be more precise – see definitions below);
- Individual dishes (or foods) cooked as part of a meal;
- Fuels used
- Energy consumptions (by meal and by dish cooked)
- Cooking times (both time of day and duration)

The aim of this document is to standardise the results from all the cooking diary experiments, and to make them as compatible as possible in order to make cross-country comparisons.

2 Background and definitions

Further background on the cooking diaries experiments designed by the MECS programme can be found in the Cooking Diaries 3.0 Protocols document. The protocols document describes multiple activities that can form part of a comprehensive cooking diaries experiment, but this analysis framework addresses only the cooking diaries activity, not the registration / exit surveys. A series of webinars dealing with different aspects of the Cooking Diaries methodology can be found on the MECS website here.

MECS is primarily interested in a transition to cooking with electricity, so it has been assumed that the cooking diaries study has been designed with two phases:

- Phase 1 - baseline (e.g. 2 weeks) – free choice of baseline fuels and appliances (i.e. cooking as normal)
- Phase 2 – transition (e.g. 2 – 4 weeks): participants are asked to switch to using electric appliances for all of their cooking (or as much as possible).

N.B. Some longer cooking diaries studies may have more than two phases (including, for example, a longer term monitoring phase with lighter touch data collection), however the analysis needed is likely to be similar to the comparative approach described in this document .

The Protocol suggests that Phase 2 can be designed to investigate both inefficient electric appliances (e.g. hotplate), and efficient electric appliances (e.g. EPC). This illustrates how participants may be able to use different cooking devices that use the same fuel. Ideally, figures will be calculated for each different device (this is referred to later on).

Definitions

The structure of the analysis depends on the structure of the data. The following structure has been assumed:

- Each data record, or piece of paper in a physical diary, is referred to as a **heating event** – it relates to a single occasion on which cooking was done.
- A heating event can cover one or more heating **purpose**, such as a meal (breakfast, lunch, dinner), or heating water, preparing a snack.
- A single heating event purpose, such as preparing a dinner, could include several **dishes** and/or heating water as part of that meal.

3 Data Checking

Some of the common errors that can creep into cooking diaries datasets are summarised in the following table. Data should be checked for all of these errors, and corrected if necessary, before starting on the data analysis. It's important to note that many of these errors can be ironed out by conducting quality checks on the forms within 1-2 days of commencing data collection and coaching participants through any issues identified. If using CAPI (Computer Assisted Personal Interviewing) software for data collection, some of these issues could also be mitigated using logic in the data collection form. However, it is inevitable that some errors will still creep in. You can use Excel features to check for these errors and identify records that may need to be corrected. If Excel is used, some errors can be corrected automatically (using some kind of algorithm) but others require manual inspection, judgement, and correction. See following table.

Potential error	**CAPI**	**Excel features which can help check for these errors.**	**Manual or automatic data correction**
Times			
End time is after start time (meals, and dishes)	Can create check in logic (doesn't work on all android devices)	Find and reverse	Auto
12/24 hour clock (see note below table)	Can set format of timepicker (doesn't stop people entering rubbish)	Make correction estimate based on meal type	Auto
Dish 1 start after meal start	Can create check in logic (doesn't work on all android devices)	Flag	Manual
Local time convention issue, eg: Swahili time (see note below table)	Add note beside question stating desired time format	Make correction estimate based on meal type	Auto
Dates			

Incorrect date (esp at turn of the month)	Should be able to use logic to check input date cannot be after 'today' date	Flag records with the same date and meal type & unique HH ID (suggests 1 field is incorrect)	Manual
US / European format	Add note beside question stating desired time format	Make correction based upon known start and finish dates of study	Manual
Missing data			
Time/date missing	Make mandatory	-	-
HH label missing	Make mandatory	-	-
Dish label missing	Make mandatory	-	-
Start/end time missing	Make mandatory	-	-
Datalogger data not matching up with diary data	Make mandatory	-	-
Fuels			
Start/end reading right way round	Use logic to check	Find and reverse	Auto
Wrong units on measuring device (e.g. lb instead of kg)	Add note beside question stating desired time format	Find and reverse	Auto
Measurements missing for some fuels used	Can make mandatory, but need to ensure there is an option for enumerator to make a comment instead if no measurement was taken, else it risks forcing enumerator to input rubbish.	Flag records where number of measurements less than number of fuels	n/a If data is missing there is nothing you can do, but if a lot is missing, its important to make the reader aware, e.g. the daily average energy consumption will be lower if lots of energy measurements are missing
Other			
Cook names – can get wrong HH ID	n/a	Flag records with the same ID, date and meal type (suggests 1 field is incorrect) Set up master list of all cooks in each household and check if they are paired as expected.	Manual
Duplicate forms (important)	n/a	For each record, check for other record with same Kobo start time (logs to millisecond)	Manual

Outliers – unreasonably high values distort mean values (especially energy consumption values).	Set max values based upon physical limitations	Flag records above physical limits	Auto
Spelling mistakes for dishes	Dropdown list of dishes	Flag records with dish names that don't feature on pre-defined list	Manual
Specific enumerators or participants recording questionable data	n/a	Display all flagged records from previous checks by enumerator or participant to spot if one individual is introducing a high number of errors	Manual

Times

This applies to meal times and to individual dish times. Where both start and end times are recorded, calculate time elapsed. Rank the elapsed time entries in order so you can spot 1) any negative values (negative values are errors and suggest 12 hr clock has been used instead of 24 hr clock, or that start and end times are the wrong way round, or that local time conventions have caused an error) and 2) any absurdly short and high times which will need exploring - manually correct only obvious mistakes.

When mixed together, Swahili time and AM/PM confusion can be very difficult to identify. In this section we describe how we cleaned the data from an example survey. We found 96% of all breakfast entries were accounted for within 3 hours of the mean breakfast start time (rounded to the nearest hour – 9am). Considering Swahili time is 6 hours behind 'normal' time, and AM/PM confusion would shift the time by 12 hours, accepting all mealtime entries for ±3 hours of the mean would separate the day into convenient 6 hour chunks. These 6-hour windows around each mealtime were then used to determine whether an entry qualified as a legitimate entry or an anomaly. These windows are as follows:

- If the given mealtime is ±3 hours of the mean it is considered legitimate.
- Considering that 1am Swahili time is in fact 7am 'normal' time, if there was confusion with Swahili time, it can be assumed that this will be manifested as a 6-hour shift. Therefore, if the given mealtime is ±3 hours of -6 hours of the mean, it is recorded as a Swahili time error.
- If the time is ±3 hours of the mean mealtime ±12 hours, it is assumed that there was confusion over the am/pm system and is recorded as an error.
- The remaining 6-hour window does not have any obvious reason for being and the entries are ignored (perhaps it could be explained as putting lunch when the meant to put supper?).

The table below illustrates which category a breakfast entry would fall into if the mean average breakfast start time were 9am. At the bottom of the table is the alteration that is subsequently made to the recorded time to correct it.

									Mean time for breakfast													
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
SHAHILI TIME ERROR						ASSUME CORRECT						ERROR ORIGIN OF UNKNOWN						AM PM ERROR					
+6 hours						No change						Ignored						+12hours					

The graphs below show the result of running each time entry through such a 'correction' for breakfast, lunch, and supper times. Note that of 281 entries:

- 20 were recorded as being in Swahili time.
- 5 were recorded as being AM/PM confused.
- 8 were recorded as random errors.

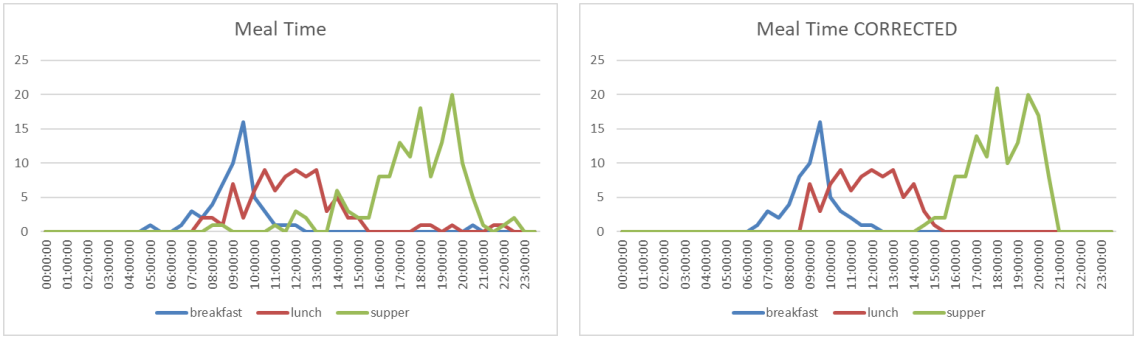

Figure 1 Meal time of day charts - raw and corrected data

Note: The ±3 hours are centred around the mean mealtimes which includes the anomalies. It may be worth considering using another average to find the average mealtime.

If using smart meters, times can be triangulated from the timestamps on automatically recorded cooking events.

Missing data

This applies to checks done during field work. Once the dataset is submitted for analysis, it's too late to do anything about missing data. However, if a lot is missing, it is important to make the reader of the final report aware, e.g. the daily average energy consumption will be lower if lots of energy measurements are missing.

Duplicate forms.

There appear to be two ways in which duplicates can arise:

- forms that have been entered into Kobo twice (exactly the same data) – this can happen if participants record data on a sheet of paper and enumerators the transcribe the data into Kobo
- households have been interviewed twice for the same heating event or purpose (e.g. dishes similar but different, fuel weights different. This can happen if an enumerator forgets they have interviewed for a certain event and does the interview again).

If duplicate records are identified, enumerators may be shed some light on which record is more valid, otherwise there is no way of knowing which is more accurate. Duplicates need to be deleted.

Outliers

Checking dish level plug in electricity meter readings:

- Calculate average power: calculate time taken (end time – start time) and energy consumption (end meter reading – start meter reading); divide energy by time (make sure you get the units right to calculate power in kW). Any average power above, say, 1.2 kW should be inspected (hotplates and EPCs are generally rated around 1 kW).
- Check that meter readings follow on from one another, e.g. dish 1 end reading should be the same as dish 2 start reading, and so on. This can help spot errors in meter readings.

- The average power may be high if the time records are inaccurate, so take a look, e.g. cooking rice in 4 minutes would be unreasonable. The meter readings and energy consumption may be reasonable, but the times may be incorrect, which would cause implausible average power figures.
- Using a 1 kW device for 15 minutes uses 0.25 kWh. You can use this benchmark to spot energy consumptions that appear unreasonably high, e.g. cooking rice should take approximately 0.3 kWh, so a reading of 1 kWh should be investigated.

Other fuels (weighed manually).

- Calculate the fuel used (weight and start of meal – weight at end of meal), then look for unreasonably high (and low) values; investigate. Weighing fuels can be tricky, especially weighing LPG cylinders. If a consumption value looks impossibly high – delete.

A golden rule for cleaning is you're looking for obvious mistakes made by participants when writing down, or enumerators when entering into Kobo. **Do not make up any numbers!**

4 Note on analysis

4.1 Wide and long datasets.

Data structure. Partners have used smartphones / tablets for digital data collection; this makes the data collection task easier in the field, and eliminates transcription errors that arise when copying data from paper to digital format.

Heating event level analysis ('wide' data format)

The cooking diaries data is normally collected on a 'heating event' basis, i.e. all the information for a single heating event (such as preparing a lunch) is collected on a single sheet of paper, or in a single data record. This includes multiple dishes as well as water heating events. This is fine for analysing the composition of meals, fuels used, time taken to prepare the whole meal etc. This is the 'wide' data format.

Dish level analysis ('long' data format')

Other parts of the analysis explore how the individual dishes that make up the meal are cooked. To do this, we need to separate out each different dish cooked as part of a meal and create a dataset in which each dish has a row to itself. Each record in this dataset will include all the information relating to how that dish was cooked (e.g. dish cooked, device used, utensil, lid, times). This is the 'long' data format. You also need to carry forward some of the data from the original dataset, such as Phase, household identifier, fuels used (and number of fuels used), purpose of heating event, number of people.

Data structures created by data collection platforms can differ, depending on how the XLSForms have been designed. Normally, all data will be collected in a single record (wide format), but it is possible for the dish level of information to be coded as a nested table, in which case the data will appear in a separate worksheet when downloaded (long format).

4.2 Types of calculations

The analysis is based on only two types of calculations:

1. Frequencies – count the number of times each option to a question is 'ticked'.

For each option, express the number (n) as a percentage of the total (of all valid responses). The percentage figures should sum to 100% - if the question is a single response question. If the questions is a multiple response question, where people can tick more than one option, then you want to express the number (n) as a percentage of all valid records, and the percentage figures will sum to more than 100%. In this case, don't include a 'Totals' row at the bottom of a table because it doesn't really mean anything.

2. Averages – any quantitative variables are best expressed as averages (e.g. time, amount of energy used, number of people). A small number of responses can often skew averages. For example, with time taken to cook a meal, there can be a long tail of a small number of occasions that take a long time to cook (e.g. a party). A small number of these big responses can have a large effect on the mean. Where this is the case, the median might be more informative, as it can be a more accurate representation of the majority of people. Therefore, it is useful to present both the mean and median (and standard deviation can also be useful).

Comparing Phase 1 (Ph1) and Phase 2 (Ph2) data. For most of the data analysis approaches listed in the "Structure of analysis" section, we are interested in comparing data from Phase 1 (Ph1 - the baseline phase) with data from Phase 2 (Ph2 – the transition phase). This is because we want to better understand whether the introduction of eCook affects cooking practices and energy consumption (see Cooking Diary principal research questions). Therefore, in the "Structure of analysis" section 5, where it says 'Compare ph1/2' – create 2 columns of data; compare both total frequencies for each phase (n) and percentages. Percentages are more useful when comparing Ph1/2 because the sub-sets of data will be different sizes.

3. Statistical tests. When comparing sub-sets of data (e.g. Ph1 / Ph2), if the dataset is large enough, you could consider using statistical tests to see if differences are statistically significant. The most commonly used tests are the chi square test and non-parametric tests such as the Mann-Whitney U-test.

4.3 Limitations

The structure in Section 5 goes through the kinds of analysis (and the research questions behind each) that can be performed using data collected from a survey like the one in the Example data collection form. If your survey design is different, or missing some questions, then there will be parts of the analysis that you will not be able to do – you can only work with the data you have collected. Similarly, if you have used additional questions, then you will have added them to gain a deeper understanding for some of the core cooking diaries research questions or to answer a new research question of interest to you, and you will need to analyse the data accordingly.

How much data is enough for meaningful calculations?

- If you are presenting tables with **frequency** data, then enter all data.
- However, if you are reporting **averages**, then as a rule of thumb, if there are less than 5 events in a group, then the average figure may be misleading, so do not report it (omit from any table). This also applies to any of the breakdown tables. For example, per capita energy for dishes cooked on different devices; if there are less than 5 occasions on which rice was cooked using an LPG stove, then omit the average from the table.

4.4 Software

If the Cooking Diaries data is digitised using interviewing software on a tablet or phone (we have used Kobo Toolbox, for example), then the data can be downloaded in a choice of formats: .csv, .xls,, and SPSS (with a bit of a work around).

We have used SPSS for the analysis, but it is expensive. SPSS data files can be exported for use in other packages such as Stata and R.

The calculations are quite straight forward so it should be possible to use Excel. Pivot tables are flexible, and you can specify the statistics you want e.g. means, median. BUT the Excel file may only contain options codes (e.g. 1,2,3) and you don't know what they represent (e.g. 'none', 'some', 'all'). You need to be careful. If you prefer to work with text, it is possible to download data as the text options rather than the code numbers. For example, when downloading Kobo data, in the 'Export Select Many questions as…' dropdown menu, select either 'Single column' or 'Single and separate columns'. It is the 'Single column' option that contains the text responses. BUT this can make statistical analysis difficult because you can't do some tests using text variables.

5 Structure of analysis

5.1 Overview of data

Before getting into the analysis it is important to give the reader a 'feel' for the amount of data in the dataset.

Variable	Analysis	What we want to learn
Number of records	Total number of heating event records in Phase 1 (Ph1) & Phase 2 (Ph2)	1. Are the number of records for Ph1 and Ph2 similar, enabling a more reliable comparison. 2. How large is the dataset?
Purpose of heating event	How many 'purposes' are included in each heating event i.e. what proportion of heating events cover only a single meal (or other purpose). Compare Phase 1 & 2	1. Do people do 'batch' cooking (for more than one purpose at one time)? 2. How many parallel cooking activities happen simultaneously? This will aid an understanding of the number of "clean" devices needed to avert stacking
Purpose of heating event (single)	For those events with a single purpose, breakdown by purpose, and compare Phase 1 & 2	1.does eCook change the kinds of meals being prepared? 2. What proportion of heating events are water versus food?
Number of people cooked for	Give the number of adults, children, and total. Then calculate the means. Compare Ph1 & 2	If household composition has changed, this might explain other differences in cooking practices in Ph2.
Number of people cooked for by type of heating event	Total number of adults, children[1] by meal and calculate the means. Compare Ph1/2	Which are the larger (more important) family meals?

[1] For simplicity, we advise weighting children the same as adults, but some people prefer to weight them as half. Whilst a 1 year old will not eat as much as an adult, a 16 yr old will likely eat twice as much, so it probably evens out in the end without collecting more specific data on the exact ages.

Heating events by participant - Phase 1 & 2	Show the number of days that each participant provided data, and the number of records	Helps understand if all households are similar; did they all continue into Ph2?

5.2 Energy consumptions by heating event

Variable	Analysis	What we want to learn
Fuels used	Number of fuels used in each event – compare Ph1/2	Do people do fuel stacking? When people get an electric device, do they use it instead of a traditional fuel or in addition?
Fuels used	% of events in which each fuel is used (compare Ph1/2)	How much is eCook used? Which traditional fuels does eCook substitute?
Fuels used	For each heating event, create a variable that gives stacking choices (e.g. charcoal & LPG). Give all fuel choices (both single fuels & stacking) – compare Ph1/2	Which fuels are commonly stacked? When eCook introduced, how often is it stacked? Which fuels does eCook substitute?
Per capita energy consumptions (heating events using a single fuel only)	Fuel consumption in a meal depends on the number of people cooked for. Calculate per capita consumptions by calculating the energy consumption (amount of fuel x calorific value), then divide by the number of people cooked for. Give mean per capita consumptions for each fuel. Giving means for each individual household helps show variation. Compare Ph1/2	Does eCook reduce traditional fuel use? Which fuels does eCook substitute? Energy consumption figures are useful because they can be used to estimate costs (but this is not part of the Cooking Diaries analysis).
Per capita energy consumptions (heating events using a single fuel only)	For each fuel, give average per capita energy consumption for each meal (compare Ph1/2)	Which are the most energy intensive meals? At which meals does eCook reduce traditional fuel use?
Daily energy consumption (use only days in which all heating events used only a single fuel)	Sum up the fuel used across all events in a day, convert to energy. Given average daily fuel used (in whatever units) and energy consumption (for comparison). Calculate separately for Ph1/2. N.B. modern fuels are often stacked, so there may not be enough events for a reliable average.	How much fuels does ecook save? (if you have enough data to compare Ph1/s). People like daily consumption figures because they can be used to estimate costs (but this is not part of the Cooking Diaries analysis).

5.3 Dishes cooked

Up to this point, the analysis has used the heating event ('wide format') dataset. However, when looking into the dishes cooked, we need to separate out each different dish cooked as part of a meal – this is the dish level analysis or 'long' format dataset.

Cooking food in advance and saving food for later are important aspects of cooking practice. When preparing a meal, this food may then only need reheating, rather than cooking from fresh. This can only be analysed if the Cooking Diary was designed to capture this information. If reheating information was asked of the meal, then use the original dataset; if reheating information was asked of each dish cooked, then use the long format dataset.

Variable	Analysis	What we want to learn
Dishes cooked	Count the number of times each dish was prepared, and express as % of all the dish records. Compare Ph1/2	What foods are most commonly cooked? How does eCook change cooking practices – which dishes are cooked more/less often when cooking with electricity?
Dishes cooked	For each meal (breakfast, lunch & dinner) count the number of times each dish was prepared (express as %). Possibly only top 10 dishes. Compare Ph1/2	Which meals are the most common dishes cooked for? How does eCook change cooking practices – which dishes are cooked more/less often when cooking with electricity?
Number of dishes cooked in a meal (meal purpose only) (this might be easier using the original wide dataset)	Calculate % heating events with 1 dish, 2 dishes, and so on. Compare Ph1/2 Breakdown by meal type.	Does eCook mean people have to cook simpler meals (with fewer dishes)?
Dishes cooked using different fuels (back to long format dataset)	For each cooking fuel, count the number of times each dish is cooked (all dishes). Compare Ph1/2. Breakdown by each meal (and %) (top 10 only?). Compare Ph1/2 if enough data exists (could compare top 3 most common dishes).	Which dishes do people prefer to cook using different fuels? Which foods do people like to cook using electricity? Which foods are difficult to cook using electricity?
Energy consumption per dish	Select records where only a single dish was cooked with a single fuel and compare both total and per capita energy consumption for each dish type	Which dishes are most energy intensive? Are there bigger energy savings on some dishes than others when switching to energy-efficient electric appliances?
Reheating food		

Fresh / reheated	For each meal, count the number of times the meal/dish was fresh or reheated (use all options included in question). Compare Ph1/2	Does eCook affect the ability to prepare food for later (e.g. pot not big enough)?
Reheating (use dish type long dataset)	For each food cooked, count the number of times the meal/dish was fresh or reheated (use all options included in question). Ideally, compare Ph1/2 but there will probably not be enough data (perhaps it might work for the top 3 most commonly cooked dishes).	Which foods are most commonly reheated?
Per capita energy consumptions (heating events using single fuel only) (use original wide format dtaset)	For each meal (breakfast, lunch, dinner) compare the per capita energy consumption of heating events cooking from fresh and those that reheated food. Repeat for each fuel, but there may be only enough data to do this for the most common fuel.	Does reheating food use less energy than cooking from fresh?
This approach can be repeated for a further set of questions on cooking in advance (e.g. cooking in advance; saved leftovers for later; precooking) if this included in the cooking diary.		

5.4 Cooking devices

It has been assumed that in the Cooking Diaries study, you asked for the following information for each separate dish cooked as part of a meal:

- Cooking device used i.e. what type of stove.
- Type of cooking pot / utensil.
- If a lid was used while cooking a dish.

Therefore, all of this analysis can only be done using the dish level, long format dataset.

Note that the breakdown of cooking device used should match the choice of fuels (e.g. LPG used in gas stove). It may be possible to get more nuanced information if a fuel is used in different types of stove (e.g. wood can be used in a 3 stone fire, or a stove, or improved cookstove).

Variable	**Analysis**	**What we want to learn**
Cooking devices used	Count the number of times each device was used. Compare Ph1/2	When eCook is introduced, which devices does it substitute for?

Utensils (pots) used	Count the number of times each type of utensil is used. Compare Ph1/2	What size of pots are used? How often are task specific utensils used (e.g. frying pan)?
Utensils (pots) used	Breakdown of use of pots by cooking device (type of stove)	Can people use the most common pots on MECS stoves?
Use of lid	Give breakdown of use of lid options by different cooking devices. You can combine Ph1 and 2 data.	Is food more likely to burn when using certain stoves? Assume that lid will not be used so food can be watched and stirred.
If a single fuel is used in multiple devices	If the most commonly used cooking devices are specific to unique fuels (e.g. gas stove, EPC, charcoal stove), then any analysis of stacking will only replicate the stacking in Section 5.2. However, if there are multiple devices using the same fuel, then it would be useful to explore differences between how these devices are used: • What dishes are cooked on each • Number of times (%) each is used in Ph1 and Ph2 (only records where a single cooking device is used to cook the meal) (original wide dataset): • Per capita energy consumption of each • Per capita energy consumption to cook single dishes on each	

5.5 Time

Cooking Diaries data should provide data to enable analysis of:

- Time to cook individual dishes – length of time the stove is actually being used; note that dishes can be cooked simultaneously.
- Meal preparation time – this is the time from when the cook starts preparing the meal to the time when the last preparation activity is completed.
- Time of day – what time of day cooking starts.

Variable	Analysis	What we want to learn
Time to cook dishes using different fuels	(long format dataset) For each fuel, give time to cook each different dish (mean, median) i.e. 1 table for each fuel	How much quicker can eCook devices cook the same dish? (compare dishes that have been cooked using different fuels)
Time to prepare meal using different fuels	(wide format dataset) For each fuel, give the duration of main heating events (breakfast, lunch & dinner) (mean, median).	Does quicker cooking mean that cooks send less time in the kitchen preparing meals? Are meals prepared using eCook quicker to prepare than using other fuels?
Time of day	(wide format dataset) For each fuel, give the time of day when meal preparation started (mean, median)	Does electric cooking demand coincide with solar electric availability or grid peak loading ?

Electrical cooking load profiles can be of value:

- How much do cooking loads coincide with energy availability? For example, are daytime loads on mini-grids are a good fit with solar PV generation?
- Can cooking loads make use of spare capacity on national grid? Grids tend to have spare capacity during the day, so there is an opportunity to meet additional cooking loads.

If smart meters are used, then data can be aggregated across multiple households to give accurate cooking load profiles. Alternatively, aggregating the meal start times as in Figure 1 can give an indication of the time of day when loads will be drawn.

5.6 Water heating

We know that heating water is an important part of kitchen energy consumption, but it is tricky to capture using the cooking diaries methodology. In the Definitions section, we said that if water is heated on its own, then the purpose of the heating event will be 'water heating'. However, water is usually heated for tea as part of a meal, so the purpose may be 'breakfast' or 'dinner'. In either case, the data should be recorded in the same fields.

In the example data collection form, there are 4 options for use of heated water: purifying, hot drinks, bathing, and other. This is in addition to the 'purpose' of the heating event, which could be breakfast, lunch, dinner, or heating water (on its own).

In the Example data collection form, it asks how much of the water heated is stored for use later; options are none, some, or all. The aim of this question is to capture whether people put a pot on the stove after the food is cooked in order to make use of the energy available in the embers of a fire, for example.

Variable	Analysis	What we want to learn
Use of heated water	Count the number of times water is heated for each type of use. Compare Ph1/2	How does ecook affect water heating behaviour?

Use of heated water	For each purpose, give the breakdown of uses of heated water (n, %)	How often do people need hot water at different temperatures (e.g. assume hot drinks needs boiling water; bathing only needs to be 40°C)
Devices (stoves) used to heat water	Count the number of times water is heated using each device (or fuel)	Which devices are best suited to heating water?
Devices (stoves) used to heat water	Breakdown number of times water is heated using each device by use of hot water (matrix table).	Which devices are best suited to heating water for different uses (temperature, volume)?
Per capita energy to heat water	For each hot water use (if there is enough data), calculate the per capita energy used by different fuels.	How much energy can be saved using eCook. (this can be used to compare costs – but not part of this analysis).
Utensils used to heat water	For each use of hot water, count the number of times each utensil is used.	How much water is needed to different uses of hot water (roughly)?
Storing hot water	Count the number of times how water is saved for later.	Are people able to store hot water?
Storing hot water	For heating events where water is stored, give the heating devices used.	Do people put a pot of water on the embers (biomass stoves)?
Time taken to heat water	For each use of hot water, calculate the average time taken to heat (mean, median).	Which are time critical uses where eCook could help?
Time taken to heat water	For each device, calculate the average time taken to heat water (mean, median). If there is one main use of hot water (e.g. tea), it would be interesting to take just the 'tea' heating events, and calculate the time taken to heat on each different device. This would be a more useful comparison because you're comparing like with like.	Can eCook heat water quicker?

Example data collection form

DIARY FORM: Please fill in one form every time you cook or heat water. **vKE230518**

Household Identifier: _____ | Date: _____

Before cooking			**After cooking**		
Time: ____:____	LPG: ____kg	Kerosene: ____ltrs	Time: ____:____	LPG: ____kg	Kerosene: ____ltrs
Electricity □	Charcoal: ____kg	Firewood: ____kg		Charcoal: ____kg	Firewood: ____kg
How long to light charcoal/ wood fire? ____mins			Did you save any charcoal/ wood for later? Yes □ No □		

Who cooked?	Name: _____		Gender:	Male □	Female □	
What did you cook/ heat water for?	Breakfast □	Lunch □	Supper □	Snack □	Food for baby □	Water heating □	Other: _____
How many people did you cater for?	Adults: _____		Children: _____			
Did you serve any food that did not require cooking?	Yes □	No □				If yes, specify: _____

	WHICH DISHES DID YOU PREPARE?			DEVICES?		UTENSILS?	PROCESS?		LID?	FRESH?	LEFTOVER?	DURATION?
Dish 1	Rice □	Chicken □	Leafy veg □	Rice cooker □	Pressure cooker □	Sufuria big □	Boil □	Steam □	Yes □	Fresh □	None □	Time spent cooking:
	Chips □	Matoke □	Sausages □	Microwave □	Electric hotplate □	Sufuria med □	Grill □	Dry fry □	No □	Reheated □	Leftovers □	____:____
	Meat □	Mandazi □	Pasta/noodles □	Gas stove □	Kerosene stove □	Sufuria small □	Bake □	Wet fry □	Sometimes □	Partially	Precooking □	
	Fish □	Matumbo □	Githeri/mokimo □	Charcoal stove □	Firewood stove □	Frying pan □		Deep fry □		precooked □	Preparing meal	If electric,
	Eggs □	Porridge □	Pancakes/Chapati □			Kettle □		Pressure cook □			in advance □	Meter reading before:
	Pilau □		Beans/peas/kamande/ndengu □									_____
	Ugali □		Potatoes/pumpkin/nduma/muhogo □									Meter reading after:
	Other: _____			Other: _____		Other: _____	Other: _____					_____
Dish 2	Rice □	Chicken □	Leafy veg □	Rice cooker □	Pressure cooker □	Sufuria big □	Boil □	Steam □	Yes □	Fresh □	None □	Time spent cooking:
	Chips □	Matoke □	Sausages □	Microwave □	Electric hotplate □	Sufuria med □	Grill □	Dry fry □	No □	Reheated □	Leftovers □	____:____
	Meat □	Mandazi □	Pasta/noodles □	Gas stove □	Kerosene stove □	Sufuria small □	Bake □	Wet fry □	Sometimes □	Partially	Precooking □	
	Fish □	Matumbo □	Githeri/mokimo □	Charcoal stove □	Firewood stove □	Frying pan □		Deep fry □		precooked □	Preparing meal	If electric,
	Eggs □	Porridge □	Pancakes/Chapati □			Kettle □		Pressure cook □			in advance □	Meter reading before:
	Pilau □		Beans/peas/kamande/ndengu □									_____
	Ugali □		Potatoes/pumpkin/nduma/muhogo □									Meter reading after:
	Other: _____			Other: _____		Other: _____	Other: _____					_____
Dish 3	Rice □	Chicken □	Leafy veg □	Rice cooker □	Pressure cooker □	Sufuria big □	Boil □	Steam □	Yes □	Fresh □	None □	Time spent cooking:
	Chips □	Matoke □	Sausages □	Microwave □	Electric hotplate □	Sufuria med □	Grill □	Dry fry □	No □	Reheated □	Leftovers □	____:____
	Meat □	Mandazi □	Pasta/noodles □	Gas stove □	Kerosene stove □	Sufuria small □	Bake □	Wet fry □	Sometimes □	Partially	Precooking □	
	Fish □	Matumbo □	Githeri/mokimo □	Charcoal stove □	Firewood stove □	Frying pan □		Deep fry □		precooked □	Preparing meal	If electric,
	Eggs □	Porridge □	Pancakes/Chapati □			Kettle □		Pressure cook □			in advance □	Meter reading before:
	Pilau □		Beans/peas/kamande/ndengu □									_____
	Ugali □		Potatoes/pumpkin/nduma/muhogo □									Meter reading after:
	Other: _____			Other: _____		Other: _____	Other: _____					_____

	WHY WAS THE WATER HEATED?	DEVICE?		UTENSILS?	LID?	HEATED FROM?	SAVING FOR LATER?	DURATION?
Water 1	Dinking/ purifying □	Rice cooker □	Pressure cooker □	Sufuria big □	Yes □	Fresh □	None □	Time spent heating:
	Tea/ coffee/ cocoa □	Microwave □	Electric hotplate □	Sufuria med □	No □	Still warm □	Some □	____:____
	Bathing □	Gas stove □	Kerosene stove □	Sufuria small □	Some of the time □		All □	Meter reading before:
		Charcoal stove □	Firewood stove □	Frying pan □				_____
		Electric kettle □		Kettle □				Meter reading after:
	Other: _____	Other: _____		Other: _____				_____
Water 2	Dinking/ purifying □	Rice cooker □	Pressure cooker □	Sufuria big □	Yes □	Fresh □	None □	Time spent heating:
	Tea/ coffee/ cocoa □	Microwave □	Electric hotplate □	Sufuria med □	No □	Still warm □	Some □	____:____
	Bathing □	Gas stove □	Kerosene stove □	Sufuria small □	Some of the time □		All □	Meter reading before:
		Charcoal stove □	Firewood stove □	Frying pan □				_____
		Electric kettle □		Kettle □				Meter reading after:
	Other: _____	Other: _____		Other: _____				_____

ANY OTHER OBSERVATIONS? e.g. Did you burn food? Did power go off/gas run out during cooking? If so, please explain?