eCook Uganda Cooking Diaries

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1 Executive Summary

The cooking energy mix in Uganda is dominated by biomass. Only less than six percent of the population has access to clean and modern cooking technologies while the majority of households rely on biomass to cook[1]. Thus, making the expansion of access and adoption of clean and modern cooking energy a critical challenge and an important task. *Uganda: Cooking Diaries Study* report is an outcome of a two months study that aimed to understand everyday cooking practices in Ugandan households to support efforts to advance context relevant modern energy cooking services. The study, which was carried out in Kampala, and engaged 11 households aimed to understand households cooking habits and preferences in order to evaluate the key components necessary for a modern energy cooking services transition in Uganda. The study specifically focused on cooking with electricity and the appropriateness of energy efficient appliances like the electric pressure cooker (EPC) to the Ugandan households needs.

Cooking Diaries is a research methodology that combines qualitative and quantitative research techniques. It is used to understand what people cook, how they cook, when (frequency of certain dishes), and how compatible these practices are with innovative modern energy cooking products and services. It involves recording qualitatively 'how' people cook with quantitative measurements of energy consumption.

The study was structured into two Phases with 11 households. At the beginning households were instructed to cook as normal with their current appliances and keep diaries of their menu and process through enumerators who interviewed them daily. Measurements of their existing fuel usage (biomass, LPG, electricity) were recorded. In the second Phase, the same households were encouraged to cook with an electric pressure cooker (EPC) provided by the programme. Smart energy meters (A2EI) were set up in the second Phase to understand energy consumption when using electricity for cooking. This report draws from data gathered using these methods and at different stages of the project, including registration and exit surveys, semi-structured interviews, and cooking diary forms. Participants were asked to keep paper records of their daily meals, time it took to prepare the meal and fuels used. Paper records were copied into Kobo Toolbox by enumerators, and uploaded into an Excel worksheet.

1.1 Cooking appliances and fuels:

Fuel stacking is a widely common practice. Households own multiple appliances, more than one charcoal stove (improved and traditional), LPG gas, electric stove along with other electrical appliances (kettle). Households say they use appliances depending on what is available and what is being cooked. Meals that take a long time to prepare (beans and matooke) are often prepared using charcoal, while quick meals such as eggs and potato chips are prepared using LPG or electricity. Cost is the main reason offered.

> **Appliances owned**: Households owned and cooked with a variety of cooking appliances that used different fuels: basic biomass cookstoves that can burn charcoal or wood; LPG stoves with various tank sizes and number of burners; electric rice cookers; and/or electric kettles. Cooking appliances that use LPG (8), electrical stove (3), basic biomass cookstoves (5), improved cookstoves (7), 3-stone firewood (1), kettle (7).

[1] IEA (2018) SDG: Data and Projections: Access to clean cooking https://www.iea.org/reports/sdg7-data-and-projections/access-to-clean-cooking

Fuels mainly used: Four cooking fuels were used by respondents: firewood, charcoal, LPG, and electricity. Charcoal was the most popular (100%), followed by LPG (82%). *All the households/ participants used multiple fuels*

Cost of fuels: Households paid a high premium for LPG compared to charcoal and firewood. Households that used LPG reported paying an average of approximately 9,167 UGX/kg for LPG and tended to purchase 12KG and refilled every (1.5 to 6 months). Most buy charcoal on monthly basis and cost remains consistent (within the range of UGX 60,000 to UGX 120,000 depending on size). Households cooking with electricity reported an overall monthly electricity budget ranging from 30,000 UGX to 100,000 UGX.

Appliance used: Various cooking appliances were used to cook food during this study. The most commonly used cooking appliances in Phase 1 was charcoal stoves (48%), followed LPG stove (25%) and then electric appliances (7%). In Phase 2, with households encouraged to cook with the EPC, the most commonly used fuel was electricity (44%) followed by charcoal (18) and then LPG (10%).

Fuel stacking: in Phase one participants rarely used multiple fuels in heating events, however, the use of multiple fuels (stacking) increased in Phase 2, reflecting a reluctance or inability to cook all dishes in a meal using electric devices only. Where households use multiple fuels in Phase 1, the most common combination was electricity and LPG (13%) followed charcoal and electricity (2%). In Phase 2, electricity was commonly stacked with other fuels more – with charcoal (14%) and with LPG (13%).

1.2 Cooking practices and food preferences:

Most Ugandan dishes rely on steaming and boiling. Separating out foods cooked for breakfast, lunch, or dinner only, shows a degree of consistency in the mix of foods cooked in both Phases and cooking with electricity did not seem to cause participants to substantially change what they cooked. During the first Phase, Lunch and breakfast were mostly cooked (31% each), followed by supper (29%), water heating (8%) and food for baby (1%). During the second Phase, the frequency of food preparation changed a bit. Lunch was mostly cooked (49%), followed by supper (34%), breakfast (14%) and then water heating (3%). In Phase 2, participants mostly cooked bean stew, rice, and porridge; and to boil (but not fry) a variety of tubers. Porridge is the most popular breakfast dish whereas for lunch and dinner it is rice, beans, and matooke. When EPCs were introduced in Phase 2, porridge was cooked more often for breakfasts, and eggs less often, which may reflect a reluctance to use the EPC for frying. For lunches and dinners, EPCs meant that rice, beans and matooke were all cooked more often.

1.3 Heating energies and cooking time

During Phase 2 electrical heat energy use increased from 7% to 50% because a higher proportion of dishes were prepared using electricity. Correspondingly, the energy intensity of meals cooked using LPG in particular fell in Phase 2 from 25% to 10%. This implies that LPG was only used for meals requiring less energy; further investigation is required to confirm if this represents simple meals that needed to be prepared quickly. Patterns of charcoal energy consumption between Phase 1 and 2 are less clear.

When looking at the time spent cooking dishes using electricity, mostly EPCs, it is clear that electric pressure cookers have the potential to shorten cooking times compared with cooking using LPG or charcoal. Time savings are greatest for dishes that take a long time to cook, notably beans and chicken stew, and porridge.

1.4 Heating water and other kitchen equipment:

Kettle is widely identified and used by households as a kitchen appliance. Kettle is used preparing bath water (30%) as well as drinking water (53%), both in the morning (prepare tea) (15%) and evening (bathing and drinking) (2%). If no kettle, or power is out, gas stoves are used for heating water (7.5%). Charcoal is used for water heating (47.5%) if there is any hot charcoal left after preparing meals (leftover charcoal). For some however, especially those concerned about the cost of electricity, kettle is used as a last resort (22.5%). As a need to boil water for multiple purposes at a time e.g purifying and bathing, households decide to use more than one fuel i.e. electricity and gas stove (17.5%) and LPG and charcoal (5.0%). During the second Phase of the study, there was a change in the pattern of water heating whereby electricity was mostly used (49%), charcoal (26%), LPG (4%), Electricity and LPG (15%) and charcoal combined with LPG (6%).

2 Introduction

2.1 Aims and objectives

The core purpose of a cooking diaries study is to understand how and what people cook and how compatible the cultural cooking practices are with modern energy cooking products/services and generating quantitative measurements of energy consumption and time. The study in Uganda is driven by the need to understand if and how energy efficient electric cooking devices can fit existing cooking practices. Thus, the study relies on real-life test approach, i.e. explore and allow people to experiment and explore the appliances in their everyday cooking routines.

2.2 Methodology

For this purpose, the study was carried out over an eight weeks period, in two Phases. The first Phase is when the study participating households are asked to cook as normally but information is gathered on their day to day cooking activities, energies used, devices used, cooking time of day, and type of foods cooked. After two weeks of that, follows a one week long transition Phase. During this stage households are introduced to an electric cooking device, in Uganda, an electric pressure cooker. By giving the appliances to households, the study aims to remove or reduce some of the barriers to switching to eCooking. Besides, covering the upfront cost, the research team also provided additional awareness raising, demonstrations, and training. Once households are comfortable with the appliance the second Phase starts. Phase two is when households are asked and encouraged to cook as much of the meals they cook using the EPC as they can.

Phases	**Description of tasks for households**	**Description of research team interaction**
Pre- testing Phase	Building rapport with the enumerators and establishing communication	Internally test the KoBo surveys, assign households, interview each other to find questions with gap, test the registration and survey tools,
Phase 1: two weeks	Households cook as they normally do using existing appliances and fuels in the house. Cooks are also asked to keep a note of the meals they cook and the fuels they used on daily basis for two weeks. They are also asked to measure the fuel before and after the cooking activity is done and make note.	Visit households daily to interview and collect data on the meals cooked, the fuel used and how much of it was used to prepare meals for the day.
Transition period: one week	At the beginning of the week participants were introduced to the new appliance (EPC) and trained on how to use it	Available to demonstrate, answer questions and advice on how the appliance may be used.
Phase 2: four weeks	Households were advised to use the EPC in their daily cooking as much as it is possible. Similar to Phase 1, households were also asked to keep a record of the meals they cooked, the fuels and appliances they used, and measurement of fuel before and after the cooking event.	Visit households daily or interview households remotely to collect data on foods prepared, cooking and energy consumption.

Fuel measurement - Equipment used	
Charcoal/ firewood 	Used a 50kg with accuracy of 10g calibrated digital scale to measure the weight of firewood or charcoal used to cook dishes or boil water. It has a hook that allows easy measurement of the bundled up fuel. It has an easy-to- read backlit LCD screen with a push- button control that allows taring/ zeroing and switch off and on. It has a power supply of a 3V CR2032 battery
LPG 	Used 30kg calibrated digital scales to measure the weight of the LPG in grams or kilograms. This was a water resistant scale made out of stainless steel encapsulated for a higher protection and had a LED display which eased measurement recording. The stainless steel edges are rounded and the surface is flat.
Electricity 	Used A2EI smart meters with accuracy of 0.001kW, unit of measure - kWh These are used on AC, with single Phase power and have internal back-up memory
	**Provided Electric Appliance** The appliance given to the participants was the Electric Pressure Cooker given its efficiency

3 Results

In this section we discuss the qualitative and quantitative data collected throughout the study during registration, household engagement and study exit.

3.1 General characteristics of Households [demographics, cooking appliances and fuels]

In order to investigate cooking habits, 11 participants were asked to keep cooking diaries for each cooked meal.

All the respondents were female with the mean number of household members as 7 (min = 4, max = 12); and the mean age of respondents was 36 years old. All respondents had completed primary school and 91% of them had qualifications higher than secondary school. About two-thirds (64%) of respondents lived in urban areas, and the other third (36%) lived in peri-urban areas. Majority (64%) of the households lived in separate houses, 27% lived in compound houses, and only 9% lived in a flat or apartment. On type of construction materials, for the roof, majority (73%) had a corrugated iron roof while 9% had a cement roof, another 9% had a tiled roof and 9% had other type of roof. 91% of the respondents had tiled floors while 9% had cement floors. Cooking space, 55% were cooking indoors, while 27% had an indoor cooking space with outdoor area and 18% were cooking outdoors.

A registration survey done at the start of the study showed the following: all households were using more than one fuel to cook with majority (73%) using a combination of charcoal, LPG and electricity; 18% reported using charcoal and electricity; and 9% (1 household) reported using firewood, charcoal, LPG and electricity. All households were using charcoal and electricity for cooking. The household that

was using firewood were the same household with most household members (12) and they reported that they collect the wood from the village every after two months. Households reported that they usually used the electricity for fast foods such as breakfast, eggs, fish, rice, warming food, boiling water, when LPG runs out, baking, deep frying chips. Majority of the households that were using charcoal for all meals and in particular long cooking meals and were buying it mostly in bulk i.e. a sack in about three to four weeks' time, spending averagely UGX 22,644 per week. LPG is used for quick meals, warming and baking.

The experiment was split into two Phases. In Phase 1, participants were not asked to change their cooking habits, only to fill in the cooking diaries. In Phase 2, households were given an electric pressure cooker and asked to cook as much of their food as possible using it. The number of records obtained from each Phase is shown in Table 1.

Paper records were kept by participants, copied into Kobo Toolbox by enumerators, and uploaded into an Excel worksheet. Every row in the worksheet contains the information for one record. Each record could cover multiple purposes e.g. an early morning record could include breakfast, preparing food for a baby, and heating water (3 events).

Table 1 shows the total number of records and daily average records per day that were collected in Phase 1 and Phase 2. Majority, 65% of the records were collected in Phase 2 which was done over a longer time period, however the average number of records per day shows that there was a reduction in daily records per day by 3% in Phase 2.

Table 1 Number of records in Phases 1 and 2

	Total Number of records		**Records per day**	
	Number	**Percent**	**Duration in days**	**Average Number of records / day**
Phase 1	520	34.8	14	37
Phase 2	975	65.2	28	35
Total	1495	100.0		

Table 2**Error! Reference source not found.** shows the heating event purposes for records that only recorded one event. Events are split equally between breakfast, lunch and dinner. Water was heated (on its own rather than as part of a meal) more often in Phase 2, and breakfasts were prepared slightly less often in Phase 2.

Table 2 Number of heating events (single heating event records only)

	Phase 1	Phase 2	Total
Breakfast	161	275	436
	34.4%	29.7%	31.3%
Lunch	142	305	447
	30.3%	32.9%	32.0%
Dinner	142	257	399
	30.3%	27.7%	28.6%
Snack	1	4	5
	0.2%	0.4%	0.4%
Food for baby	2	12	14
	0.4%	1.3%	1.0%
Heating water	13	65	78
	2.8%	7.0%	5.6%
Other	7	9	16
	1.5%	1.0%	1.1%
Total	468	927	1395
	100.0%	100.0%	100.0%

Table 3 shows that the composition of families remained similar across Phase 1 and Phase 2. Note that although the difference in the number of children cooked for is small, it is significant (Mann-Whitney p value = .001). The detail presented in Table 4 shows that lunches in Phase 2 were prepared for larger numbers of people, especially adults.

Table 3 Average number of adults and children cooked for

	Phase 1			Phase 2		
	N	Mean	Median	N	Mean	Median
Adults:	511	3.8	4	955	4.0	4
Children:	489	2.0	2	934	2.1	2
TOTAL people	519	5.6	6	974	6.0	6

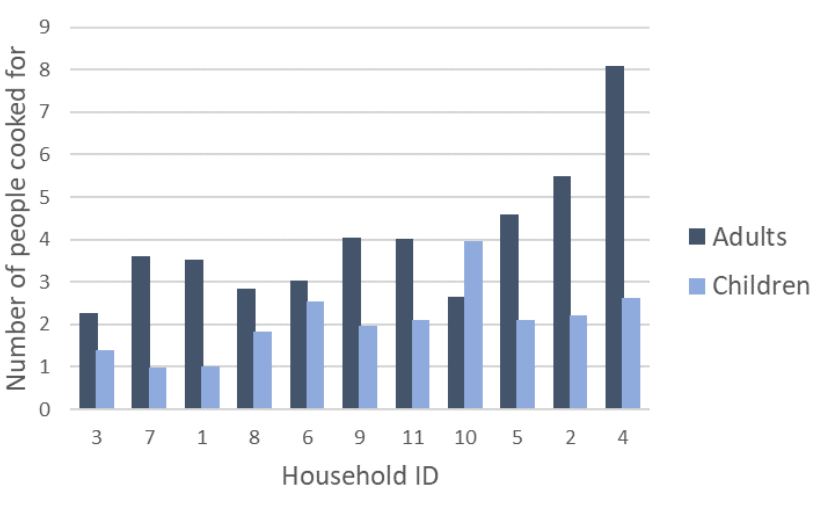

Figure 1 Number for people cooked for across households

Table 4 Average number of adults and children cooked for by meal

		Phase 1			Phase 2		
		N	**Mean**	**Median**	**N**	**Mean**	**Median**
Breakfast	Adults	161	3.7	4	274	3.7	3
	Children	151	2.0	2	266	2.1	2
	Total	161	5.6	5	274	5.7	6
Lunch	Adults	142	3.5	4	305	4.2	4
	Children	135	2.0	2	296	2.2	2
	Total	142	5.4	5	305	6.3	6
Dinner	Adults	142	4.1	4	257	4.2	4
	Children	134	2.1	2	253	2.2	2
	Total	142	6.0	6	257	6.4	6

Table 5 shows that meals prepared in Phase 2 tended to be simpler, comprising fewer dishes (Mann-Whitney p value < .001). This trend can be seen across all of the main meals, but especially at dinners.

Table 5 Average number of dishes cooked (single heating event records and main meals only)

	Phase 1		**Phase 2**	
	N	**Mean**	**N**	**Mean**
Breakfast	145	2.0	239	1.8
Lunch	142	2.3	305	2.1
Dinner	140	2.3	253	1.9
Total	427	2.2	797	1.9

Table 6shows the number of heating events per day recorded by each participant, and the allocation of those days to Phase 1 and Phase 2. Note that for any given participant, the number of heating events recorded in a day varies. This reflects variations in heating behaviour e.g. water may not be heated every day, lunches may only be prepared at weekends, and certain meals may not be prepared if the household eats out.

Table 6 Number of heating events per day by household

HH ID	Phase 1																	
					24/05/2021							31/05/2021						
	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
2	2	2		1	2	2	2	2	3	2	2	3	2	2	2	1	1	
3		3	3	3	3	3	3	3	5	4	3	3	3	3	2	4	2	
4	3	3	1		2	3	3	3	3	3	2	3	2	2	2	2	2	
5	3	4	2	1	3	3	3	3	3	2	3	1	3	3	3	2	3	
6	3	3	3	1	4	3	4	4	3	3	3	3	3	3	3	3	3	
7	3	3	3	4	4	3	3	5	5		2	4	7	4	4	4	5	
8	3	3	3	3	2	3	3	4	3	3	3	2	2	3	3	3	3	
9	2	3	3	2	3	3	3	3	3		6	2	3	3	3	4	2	
10	3	3	3	3	2	3	3	3	3	3	3	3	2	3	2	3	2	
11			2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	

HH ID	Phase 2													
	21/06/2021							28/06/2021						
	M	T	W	T	F	S	S	M	T	W	T	F	S	S
1		3	3	3	3	3	3	3	3	3	3	3		3
2		2	2	3	2	4	4	4	2	2	2	2	4	2
3		3	3		3	3	3	3	3	3	3	3	3	3
4	1	1	2	3	3	3	3	3	3	3	3	3	2	3
5		3	2	3	3	3	3	3			2	1	3	3
6		3	5	4	3	3	4	4	4	3	3	3	3	5
7		2	3	3	3	6	3	4	6	3	5	3	3	5
8	1	3	3	3	3	3	2	3	3	3	3	3	3	3
9	2	1	3	4	3	3	3	2	3	4	2	2	3	3
10	3	3	3	3	3	3	3	3	3	3	3	3	3	3
11	1	1	3	3	2	3	3	3	3	3		6	3	2

HH ID	Phase 2 (continued)																	
	05/07/2021							12/07/2021							19/07/2021			
	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T
1	2	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	
2	3	4	1	2	2	2	2	2	3	3	4	3	3	3	3	2		
3	2	3	3	3	2	3	3	3	3	3	3	2	3	2	3	3		
4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		
5	3	3	2	3	3	3	3	3	3	3	3	2	3	2	3	3		
6	5	5	6	5	3	6	3	3	3	5	3	3	4	4	4	4		
7	7	3	5	4	3	4	3	4	3	3	3	5	3	4	4	5		1
8	3	2	2	3	4	2	3	4	3	2	5	3	3	3	4	3	3	
9	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	2		
10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		
11	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2		

3.2 Dishes cooked and Reasons for cooking

3.2.1 Food types cooked

Separating out foods cooked for breakfast, lunch, or dinner only, Table 7 shows a degree of consistency in the mix of foods cooked in both Phases i.e., cooking with electricity did not cause participants to substantially change what they cooked. There are a couple of exceptions e.g., in Phase 2, participants were more likely to cook bean stew, rice, and porridge; among the less commonly prepared dishes, they were more likely to boil (but not fry) a variety of tubers (sweet potato etc.). Foods cooked less often in Phase 2 include leafy vegetables and eggs; they were also less likely to cook a range of stews (meat, chicken, fish in groundnut paste).

N.B. the 'Other' dish most commonly prepared in both Phases 1 and 2 were mostly preparing tea and milk.

Table 8 shows which meals the 10 most common dishes are cooked for. Porridge is the most popular breakfast dish whereas for lunch and dinner it is rice, beans, and matooke. When EPCs were introduced in Phase 2, porridge was cooked more often for breakfasts, and eggs less often, which may reflect a reluctance to use the EPC for frying. For lunches and dinners, EPCs meant that rice, beans and matooke were all cooked more often. This could be construed as reducing dietary diversity.

Table 7 Number of meals containing food types (Breakfast, lunch, and dinner heating events only – ranked by Phase 1)

Dish cooked	**Phase 1**		**Phase 2**	
	N	**percent**	**N**	**percent**
Other	162	18.5%	270	18.6%
Rice	113	12.9%	221	15.3%
Beans/Peas Stew	77	8.8%	159	11.0%
Porridge	65	7.4%	122	8.4%
Matooke (boiled)	63	7.2%	94	6.5%
Matooke (steamed)	53	6.1%	105	7.3%
Leafy Vegetables (cabbage, nakati, dodo, malakwang, gobe etc)	43	4.9%	35	2.4%
Eggs	42	4.8%	34	2.3%
Katogo	37	4.2%	58	4.0%
Ground nut paste	34	3.9%	54	3.7%
Goat/Meat Stew	33	3.8%	32	2.2%
Sweet potatoes/ irish / cassava/ yams/ pumpkin (boil or steam)	33	3.8%	85	5.9%
Chicken stew	24	2.7%	26	1.8%
Ugali (posho)	18	2.1%	43	3.0%
Sweet potatoes/ irish / cassava/ yams/ pumpkin (boil and fry)	17	1.9%	10	0.7%
Spaghetti (pasta)	16	1.8%	24	1.7%
Sweet potatoes/ irish / cassava/ yams/ pumpkin (fried or deep fried)	14	1.6%	18	1.2%
Fish in groundnut stew	11	1.3%	2	0.1%
Fish Stew	10	1.1%	28	1.9%
Millet cassava mix bread (Karo)	8	0.9%	9	0.6%
Soup (goat, beef, fish)	3	0.3%	18	1.2%
Roasted Meat (Muchomo)	1	0.1%	1	0.1%

Table 8 Top 10 dishes by meal and Phase

		Phase 1		Phase 2	
		N	**percent[2]**	**N**	**percent**
Breakfast	Rice	1	0.4%	9	2.4%
	Beans/Peas Stew	6	2.4%	10	2.6%
	Porridge	53	21.0%	110	28.9%
	Matooke (boiled)	5	2.0%	7	1.8%
	Matooke (steamed)	0	0.0%	0	0.0%
	Leafy Vegetables (cabbage, nakati, dodo, malakwang, gobe etc)	0	0.0%	1	0.3%
	Eggs	35	13.9%	26	6.8%
	Katogo	24	9.5%	18	4.7%
	Ground nut paste	2	0.8%	2	0.5%
	Sweet potatoes/ irish / cassava/ yams/ pumpkin (boil or steam)	3	1.2%	27	7.1%
Lunch	Rice	59	18.6%	121	19.8%
	Beans/Peas Stew	43	13.6%	104	17.0%
	Porridge	9	2.8%	6	1.0%
	Matooke (boiled)	29	9.1%	47	7.7%
	Matooke (steamed)	29	9.1%	69	11.3%
	Leafy Vegetables (cabbage, nakati, dodo, malakwang, gobe etc)	22	6.9%	18	2.9%
	Eggs	1	0.3%	4	0.7%
	Katogo	12	3.8%	34	5.6%
	Ground nut paste	16	5.0%	33	5.4%
	Sweet potatoes/ irish / cassava/ yams/ pumpkin (boil or steam)	10	3.2%	27	4.4%
Dinner	Rice	53	17.3%	91	20.0%
	Beans/Peas Stew	28	9.1%	45	9.9%
	Porridge	3	1.0%	6	1.3%
	Matooke (boiled)	29	9.4%	40	8.8%
	Matooke (steamed)	24	7.8%	36	7.9%
	Leafy Vegetables (cabbage, nakati, dodo, malakwang, gobe etc)	21	6.8%	16	3.5%
	Eggs	6	2.0%	4	0.9%
	Katogo	1	0.3%	6	1.3%
	Ground nut paste	16	5.2%	19	4.2%
	Sweet potatoes/ irish / cassava/ yams/ pumpkin (boil or steam)	20	6.5%	31	6.8%

Figure 2 below shows dishes that were most commonly cooked i.e. at least 100 times in the entire study across both phases and their average cooking time using different cooking appliances *(refer to section 3.5.1 for a more detailed analysis).* It is evident that steaming matooke is an activity that on

[2] Expressed as a proportion of the total number of dishes prepared for each meal (i.e. based on all dishes, not just the top 10.

average requires a lot of time regardless of the device used in preparation. Dishes listed as 'other' in figure below, but had their specific names written in the column 'Please specify:'. This meant that these dishes often could be matched with the standard dish types. This significantly increased the amount of 'Tea/coffee/cocoa/milk', but it did not give any extra events for rice. In other words, many of the specified dishes had names like 'Heating water for tea' or 'Heating milk'. Also to note was that the changes of what kind of dish types that were cooked in Phase 1 compared to Phase 2 were modest.

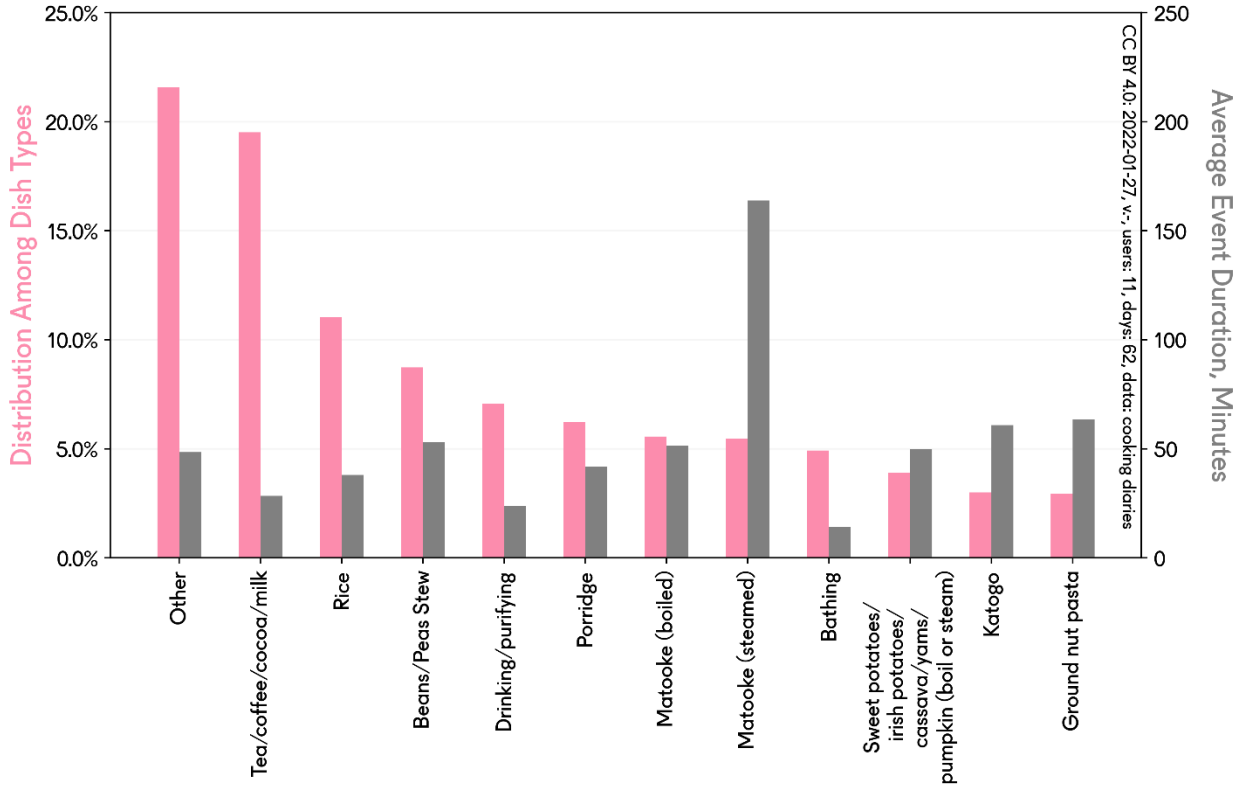

Figure 2 Relative Frequency of Dishes That Have Been Cooked at Least 100 Times and the Dishes Average Cooking Time in Cooking Diaries - Phase 1 and 2

Table 9shows in Phase 2, participants were significantly less likely to prepare complex meals comprising of multiple dishes (Person chi square p value <0.001). If we assume this is because of the introduction of an EPC, this could be explained by how easily 'one pot' meals can be prepared and cooked in a pressure cooker. This is consistent with a reduction in the preparation of stews, which can involve multiple tasks and ingredients.

Table 9 Number of dishes included in a heating event (Breakfast, lunch, and dinner heating events only)

	Phase 1		Phase 2	
	N	percent	N	percent
1	137	28.5%	368	42.8%
2	206	42.8%	321	37.3%
3	95	19.8%	144	16.7%
4	35	7.3%	25	2.9%
5	8	1.7%	2	0.2%
Total	481	100.0%	860	100.0%

3.2.2 Appliances used

Figure 3 is showing the cooking appliances and most common dishes in Phase 1 and Figure 4 is showing the same for Phase 2. It is interesting to note that some households had stated that they used a pressure cooker instead of an electric pressure cooker, especially when heating tea or milk (77 events), which suggests that these appliances were used more like electric kettles. However, the only pressure cookers in the study were SESCOM (9 pcs.) and two non-SESCOM (2 pcs.). The current was approximately four (4) amperes, which further suggests that the pressure cookers were the same as the electric pressure cookers even if the peculiar phenomenon of almost exclusively appearing in the data when heating water could suggest otherwise.

Note: To put the 10 most cooked dish categories into perspective to the rest of the dish categories, the less cooked dishes were lumped together in the category called 'other'.

In Phase 1, the most common appliance used was the charcoal stove, followed by the gas stove and then the electric kettle that is commonly used for water heating for different purposes.

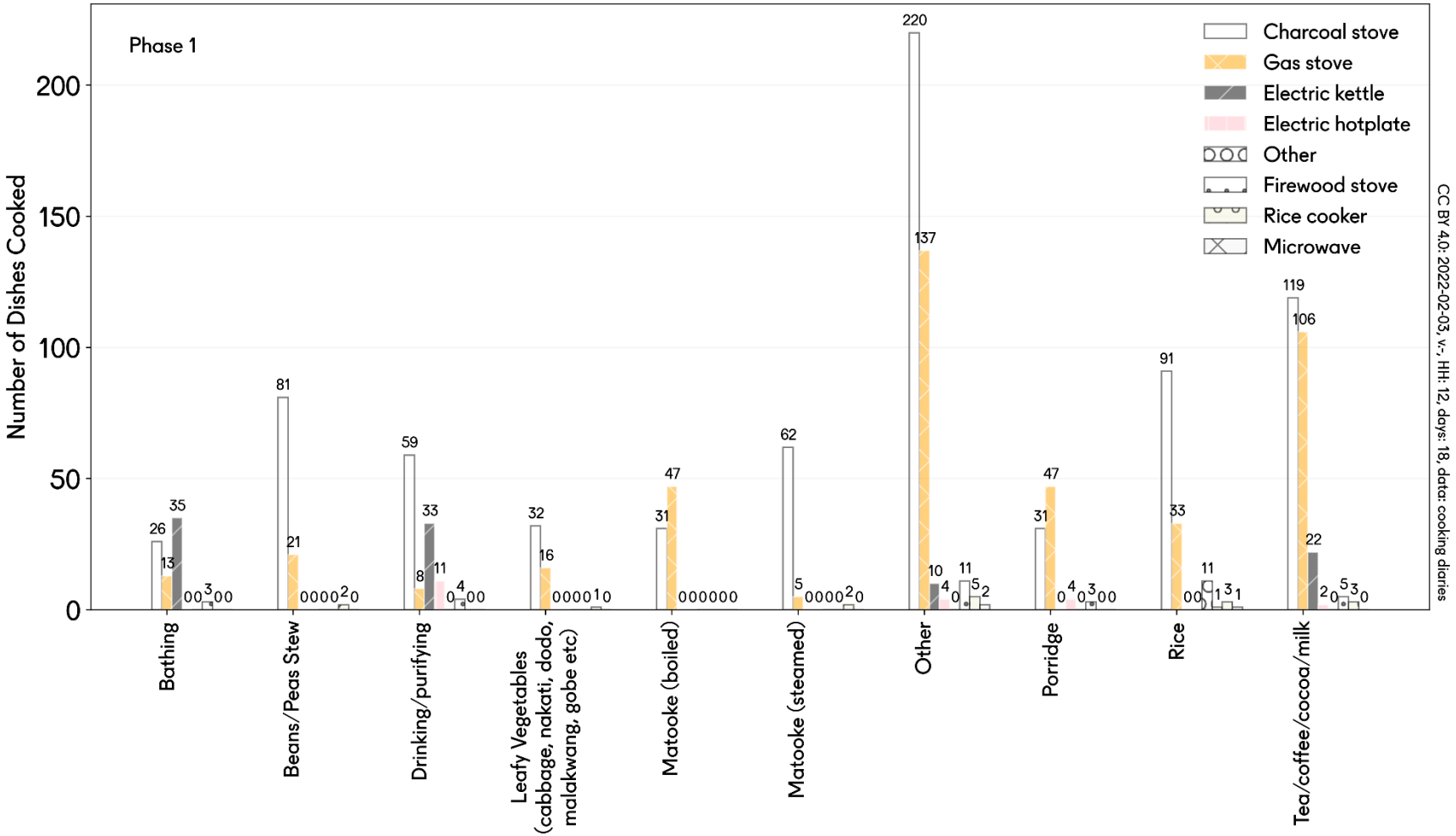

Figure 3 Appliances used for the 10 most popular dishes in the cooking diaries – Phase 1

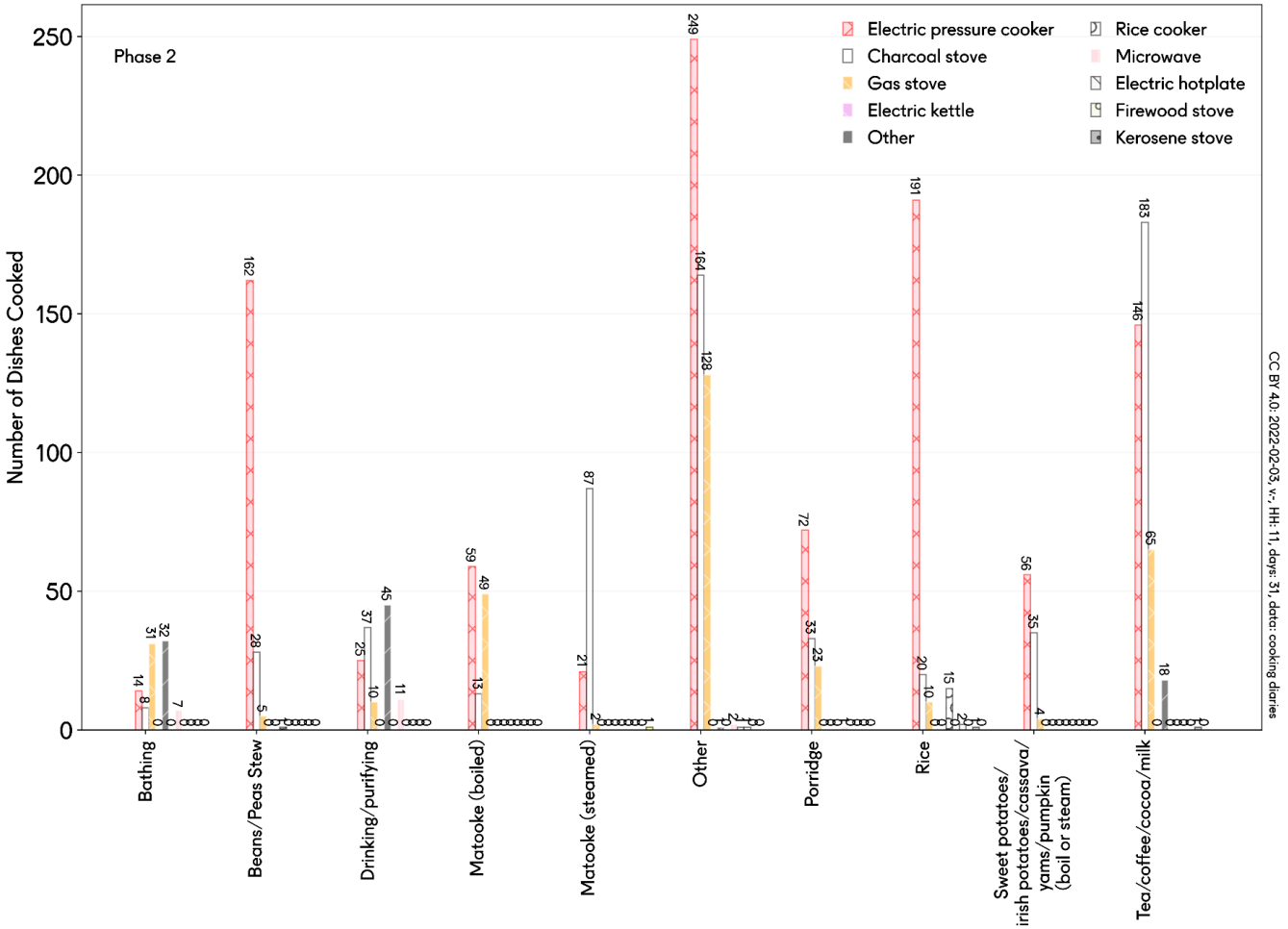

Figure 4 Appliances used for the 10 most popular dishes in the cooking diaries – Phase 2

In Phase 2, the electric pressure cooker was the most used appliance as participants were encouraged to use it for most of their cooking.

An interesting data point is that the EPC was used for steaming matooke though still the charcoal stove was the most used for this activity. This shows that there is a real possibility for cooks to consider continued use of the EPC for steaming of matooke despite the status quo.

3.3 Heat energy use [per person, per heat event, per day, meal, appliance]

3.3.1 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 10.

Table 10 Calorific values and conversion efficiencies[3]

Fuel	Calorific value
Wood	16.2 MJ/kg
Charcoal	29.6 MJ/kg
LPG	49.3 MJ/kg
Electricity	3.6 MJ/kWh

[3] https://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html

3.3.2 Mix of fuels

Figure 5 shows how often fuels were used in each Phase. In Phase 1, charcoal and LPG were the dominant fuels, but electricity was still used in 23% of heating events. As expected, electricity was used in most heating events in Phase 2 (72%). Charcoal and LPG were used as backup fuels and again charcoal was more commonly used than LPG.

The total energy consumption of each fuel is presented in Figure 6. This presents the total energy consumed over the duration of each Phase; note that Phase 2 is nearly twice as long as Phase 1. Although electricity is the most commonly used fuel in Phase 2, it accounts for a small proportion of all the energy consumed in Phase 2. This shows the relative efficiency of electric cooking devices compared to traditional stoves.

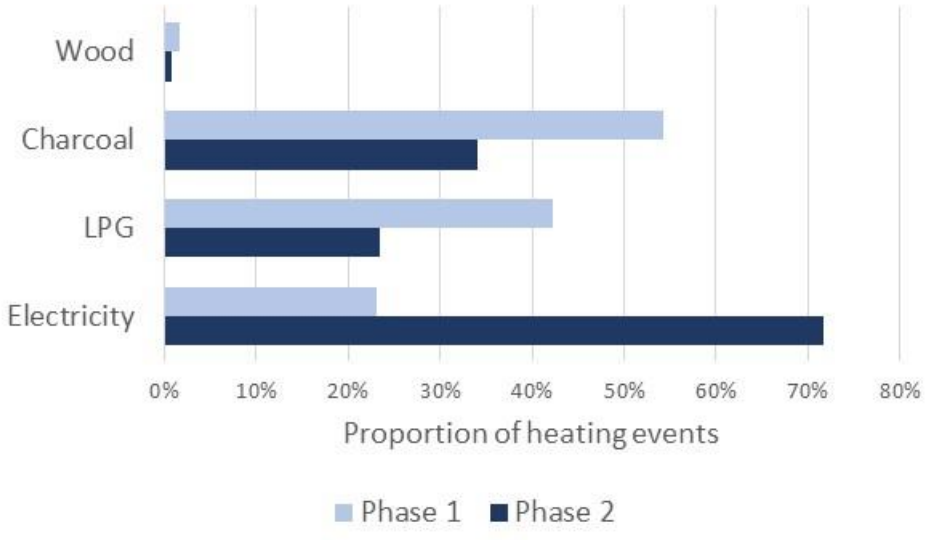

Figure 5 Fuel choices

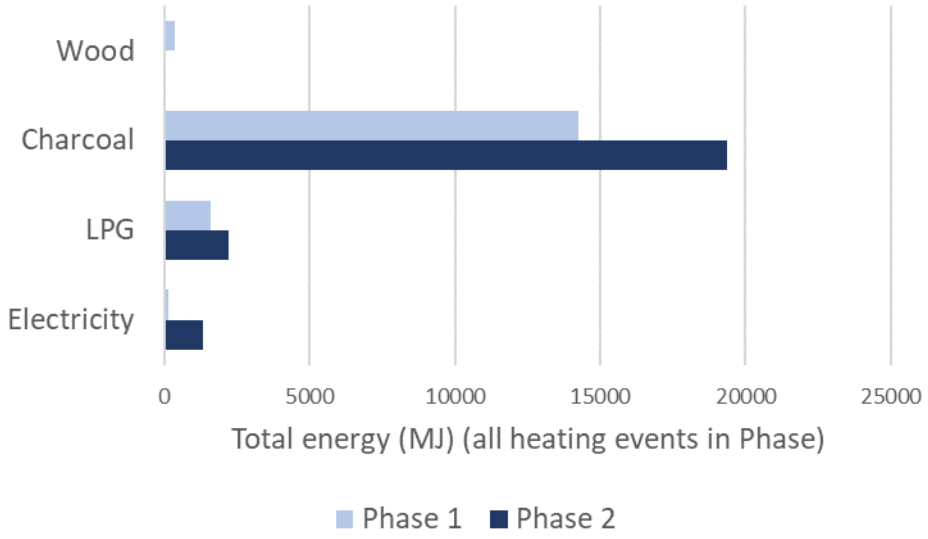

Figure 6 Energy content of fuels used

Table 11 shows that participants rarely used multiple fuels in heating events for either Phase 1 or Phase 2. However, the use of multiple fuels (stacking) increased in Phase 2, reflecting a reluctance or inability to cook all dishes in a meal using electric devices only. Table 12shows that although electricity is usually used on its own in Phase 2, it is commonly stacked with other fuels (split equally between LPG and charcoal). Note that in Phase 1, electricity was rarely used to cook an entire meal, and was usually stacked with LPG. This suggests that, although it appears possible to cook using electricity only, people prefer to stack it with other fuels.

Table 11 Number of fuels used in single heating event

Number of Fuels per heating event	Phase 1		Phase 2	
	N	percent	N	percent
0	15	2.9%	8	0.8%
1	398	77.6%	691	71.2%
2	95	18.5%	262	27.0%
3	5	1.0%	9	0.9%
Total	513	100.0%	970	100.0%

Table 12 Fuel choices

	Phase 1		Phase 2	
	N	percent	N	percent
Electricity	33	6.6%	425	44.2%
LPG	123	24.7%	88	9.1%
Electricity/LPG	64	12.9%	121	12.6%
Charcoal	238	47.8%	178	18.5%
Electricity/Charcoal	11	2.2%	134	13.9%
LPG/Charcoal	16	3.2%	7	0.7%
Electricity/LPG/Charcoal	5	1.0%	9	0.9%
Wood	4	0.8%	0	0.0%
Electricity/Wood	2	0.4%	0	0.0%
LPG/Wood	2	0.4%	0	0.0%
Total	498	100.0%	962	100.0%

To put the data from the smart electricity meters into a broader perspective, figure 7 provides insight into all the energy sources included in the cooking diaries. By comparing Phase 2 to Phase 1 of the cooking diaries it can be seen that electricity replaced a large portion of the cooking with charcoal and LPG. At the beginning of Phase 2, the use of charcoal was especially decreased. Then again, later in the study the use of LPG decreased significantly in favour of an increase in the use of charcoal.

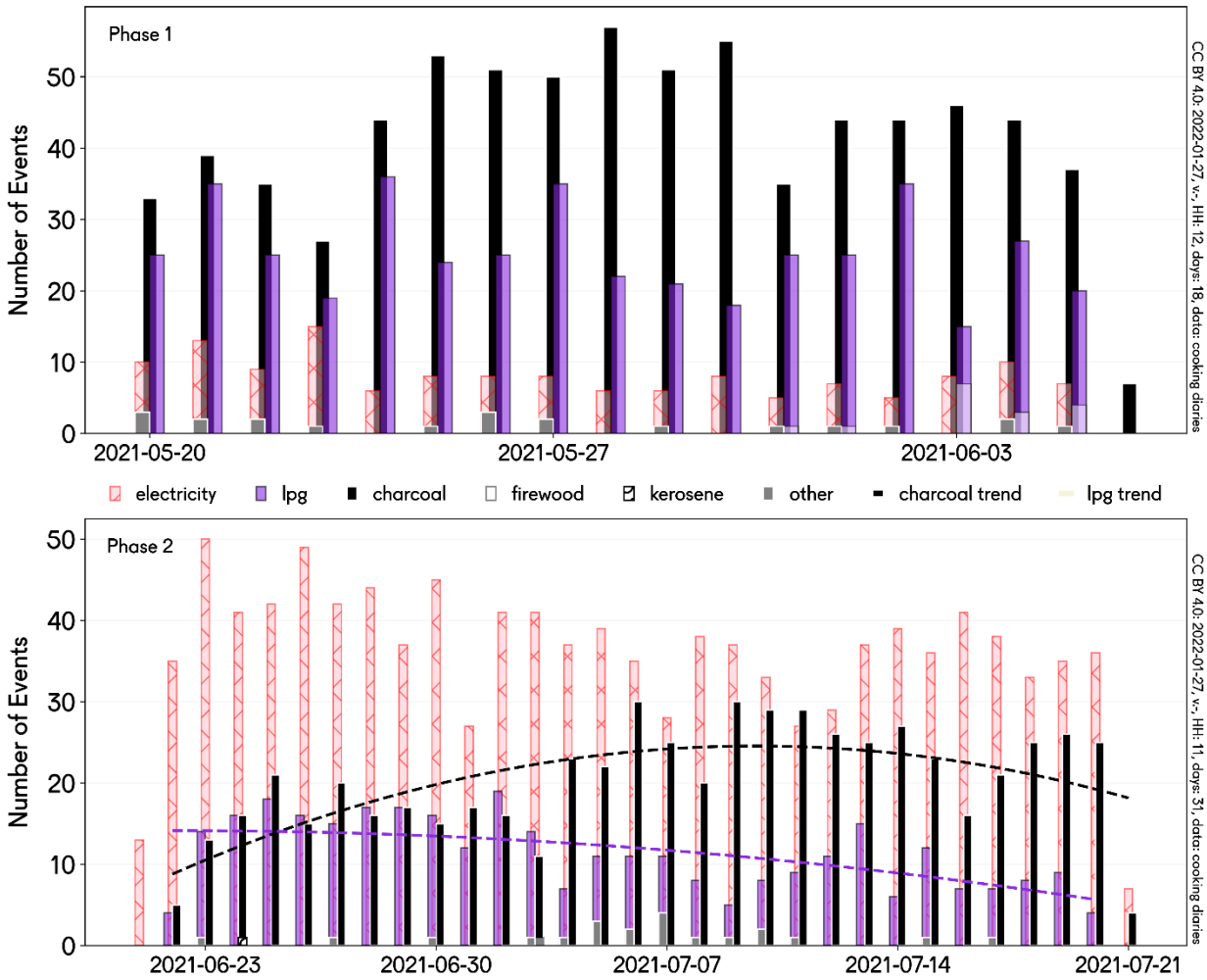

Figure 7 Number of events per day divided between energy sources used

3.3.3 Per capita consumptions

Energy consumption depends on the number of people being cooked for. Therefore, per capita energy consumptions have been calculated simply by dividing the energy consumption for a given 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.

In order to investigate the per capita energy consumption of each fuel, records that used multiple fuels had to be excluded because they only partially account for a heating event's energy consumption.

From Table 13, the mean per capita energy consumption figures indicate that in Phase 1, cooking with charcoal used around 20 times as much energy as cooking with electricity. Note that the mean charcoal energy consumption dropped in Phase 2 as compared to Phase 1, indicating that the use of electric cooking devices did displace some use of charcoal; this is could be as a result of increase in use of electricity to prepare majority of the dishes inclusive of the more energy intensive dishes.. This is evidenced in the total number of meals in table 13 below whereby meals prepared using electricity increased by 396 from Phase 1 to Phase 2, while the number of meals prepared using charcoal reduced by 66. However, an interesting data point is that the overall mean per capita electricity consumption remained constant across Phase 1 and Phase 2 despite the fact that electricity was used for majority of the cooking in Phase 2 while it was mostly used for water heating in Phase 1. This could be due to the fact that whilst in Phase 1 electricity was almost exclusively used for water heating thus fewer meals, the appliances used were less efficient when compared to the EPC while in Phase 2, an efficient EPC was used to cook majority of the dishes including long cooking meals and water heating.

Table 13 Per capita energy consumptions (MJ/ person/event) and number of people cooked for– single fuels only

	Phase 1												Phase 2								
	Electricity			LPG			Charcoal			Wood			Electricity			LPG			Charcoal		
Household ID	Median consumption	Median number of people	Number of meals cooked	Median consumption	Median number of people	Number of meals cooked	Median consumption	Median number of people	Number of meals cooked	Median consumption	Median number of people	Number of meals cooked	Median consumption	Median number of people	Number of meals cooked	Median consumption	Median number of people	Number of meals cooked	Median consumption	Median number of people	Number of meals cooked
1							4.8	5	43				0.5	4	9				3.4	4	44
2	0.0						8.5	7	29				0.2	8	41				3.7	8	22
3	0.3	3	13	1.1	3	14	3.7	4	19				0.3	4	79	0.8	4	1			
4				1.5	9	14	15.0	7	19				0.3	12	14	0.9	12	1	15.8	12	39
5							8.0	7	31				0.3	6	12	0.0	6	20	8.7	6	28
6	0.1	4	4	1.0	4	10	6.1	7	33				0.2	5	60				2.4	7	17
7	0.6	4	12	1.9	4	13							0.3	4	56	0.9	3	16			
8	0.5	5	4	0.8	5	19	4.4	5	18	6.1	5	4	0.6	5	91						
9							11.5	6	46				0.4	6	15	1.8	6	10	4.5	6	33
10	0.1	6	1	1.0	6	29							0.4	7	23	1.0	7	22	1.2	7	1
11	0.1	7	3	0.6	7	27	4.4	6	2				0.1	6	34	0.5	6	15			
Mean	0.3			1.1			6.3			6.1			0.3			0.8			4.7		
Median		6			6			6			5			5			6			6	
Total			38			126			240			4			434			85			174

3.3.4 Energy consumption by heating event

The median per capita energy consumption for each type of heating event illustrates differences in the overall conversion efficiencies associated with different fuels. Figures in table 14 phase 1 show that the median usage of electricity consumption at dinner is higher than lunch and breakfast combined this implies that during breakfast and lunch households preferred other methods of cooking compared to electricity whereas in phase 2 energy intensity was relatively similar throughout all the meals but the median figures also indicate the highest variability (between phase 1 and phase 2) in the lunch hour hence in phase 2 a higher proportion of dishes were prepared using electricity. Correspondingly, the energy intensity of meals cooked using LPG in particular fell in Phase 2. This implies that LPG was only used for meals requiring less energy; further investigation is required to confirm if this represents simple meals that needed to be prepared quickly. Basing on the median values, figures in table 14 to Table 16 show that Electricity usage is inversely proportional to traditional fuel use with an exception of breakfast. This means that as electricity usage increased in Phase 2, the usage of charcoal and LPG reduced especially for lunch and dinner. While at breakfast, patterns of charcoal energy consumption indicated an increased usage intensity during breakfast, this could be explained by participants feedback indicating that EPCs were not very ideal for breakfast and as such some came up with tips on how to prepare breakfast with EPCs for example, “Not covering the EPC when boiling milk or cooking small foods; though this reduces its efficiency thus more power consumption”.

Table 14 Per capita energy consumption (MJ/person/event) by single fuel heating events – Electricity

		N	Mean	Median	Std. Deviation	25% Quartile	75% Quartile
Breakfast	Phase 1	15	0.228	0.171	0.178	0.082	0.288
	Phase 2	126	0.435	0.270	0.444	0.158	0.540
Lunch	Phase 1	4	0.252	0.174	0.224	0.094	0.488
	Phase 2	124	0.401	0.350	0.215	0.258	0.486
Dinner	Phase 1	3	0.277	0.367	0.215	0.031	.
	Phase 2	105	0.403	0.333	0.334	0.204	0.540

Table 15 Per capita energy consumption (MJ/ person/event) by single fuel heating events – LPG

		N	Mean	Median	Std. Deviation	25% Quartile	75% Quartile
Breakfast	Phase 1	56	1.380	1.045	1.309	0.535	1.598
	Phase 2	126	0.435	0.270	0.444	0.254	1.387
Lunch	Phase 1	32	1.614	1.339	1.304	0.933	2.018
	Phase 2	124	0.401	0.350	0.215	0.119	0.887
Dinner	Phase 1	27	1.499	0.879	2.221	0.493	1.602
	Phase 2	105	0.403	0.333	0.334	0.288	3.831

Table 16 Per capita energy consumption (MJ/ person/event) by single fuel heating events – Charcoal

		N	Mean	Median	Std. Deviation	25% Quartile	75% Quartile
Breakfast	Phase 1	56	6.894	5.920	5.365	2.250	10.184
	Phase 2	62	8.925	6.993	7.069	2.821	14.862
Lunch	Phase 1	32	8.633	7.795	5.958	4.085	11.722
	Phase 2	36	6.010	4.237	4.969	3.400	7.292
Dinner	Phase 1	27	7.971	5.201	7.686	3.086	11.269
	Phase 2	46	4.772	4.237	4.101	1.758	6.376

3.3.5 Energy consumption per day

In order to explore daily energy consumptions, heating event records have been aggregated by date, summing up all energy used in a day using each fuel. The distribution of these daily records is given in Table 17. The following analysis in this section is based on these daily consumption records.

Table 17 Number of records in Phases 1 and 2

	Number of daily records	Percent
Phase 1	164	34.5%
Phase 2	312	65.5%
Total	476	100.0%

The energy required to cook all meals in a day using different fuels are presented in Table 18. Figures in this table are based on days when only a single fuel is used, so the number of days is relatively low. The purpose of this table is to illustrate the total energy needed for households to cook all their meals using a single fuel. It shows that charcoal requires around 20 times the energy needed when cooking with electricity, and LPG uses approximately 5 times the energy (comparing Phase 1 traditional fuels with Phase 2 electricity). Note that we would not necessarily expect a reduction in traditional fuel used in Phase 2, but a substantial reduction is evident in the table (albeit with small numbers of valid records). Further investigation is required to understand why this is. *It is also important to note that in some households that used charcoal to cook, once the charcoal stove was lit in the morning, meals were cooked throughout the day until dinner time and as such charcoal measurements done were for fuel used throughout the day and not per meal or dish.*

Table 18 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
		n	Mean	Median	Breakfast	Lunch	Dinner	Heating water	(mean of means)
Electricity	Ph 1								
	Ph2	72	5.7	4.2	88%	97%	82%	22%	4.4
LPG	Ph 1	11	25.8	18.2	100%	91%	91%	0%	6.0
	Ph2	3	2.5	1.6	100%	67%	67%	0%	5.8
Charcoal	Ph 1	59	123.8	87.6	75%	90%	88%	15%	6.1
	Ph2	11	74.5	53.0	82%	82%	64%	18%	5.3

Table 19 presents figures for all energy used in a day for each fuel. The purpose of this table is to highlight savings in traditional fuels due to the adoption of electric cooking. There is no evidence that LPG consumption dropped in Phase 2, the mean daily energy consumption is higher than median due to a few outliers in the households, this makes the median a more representative statistic since it is not influenced by the outlier. The median figures suggest that charcoal consumption dropped dramatically (44%) in Phase 2.

Table 19 Total daily energy consumption (MJ/household/day) – all fuels used in a day (Phase 1 and Phase 2)

		Daily energy consumption (MJ/household/day)			Proportion of days with heating event				Household members
		n	Mean	Median	Breakfast	Lunch	Dinner	Heating water	(mean of means)
Electricity	Ph 1	65	2.0	1.5	98%	97%	95%	37%	5.1
	Ph2	297	4.4	3.5	89%	99%	89%	33%	6.1
LPG	Ph 1	100	15.8	11.0	99%	94%	93%	27%	5.5
	Ph2	108	20.6	11.0	94%	96%	86%	44%	5.8
Charcoal	Ph 1	130	109.6	78.4	88%	97%	96%	18%	6.1
	Ph2	168	115.2	43.8	87%	98%	93%	29%	7.1
Wood	Ph 1	5	69.3	49.2	100%	100%	80%	0%	4.9
	Ph2	0							

The figures below provide a closer insight into the energy consumption data from the smart meters.

During Phase 1, the number of cooking events with electricity range between 10 and 25 and in the transition phase there is a noticeable increased trend in the adoption of electrical appliances. In phase 2 the trend is relatively stable ranging between 30 and 50 cooking events which is significantly higher than phase 1.

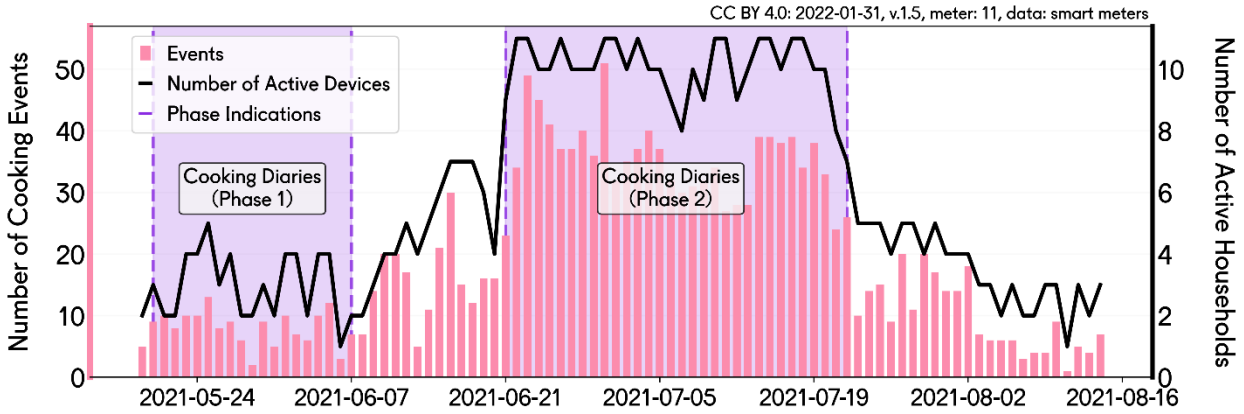

Figure 8 Overview of smart electricity meter activity during study period

Figure 9, shows an interquartile range of about 9.8 kWh to 12 kWh with a median around 11.2 kWh, this suggests that the grouped households had a daily energy consumption totalling to a median of about 11.2kWh

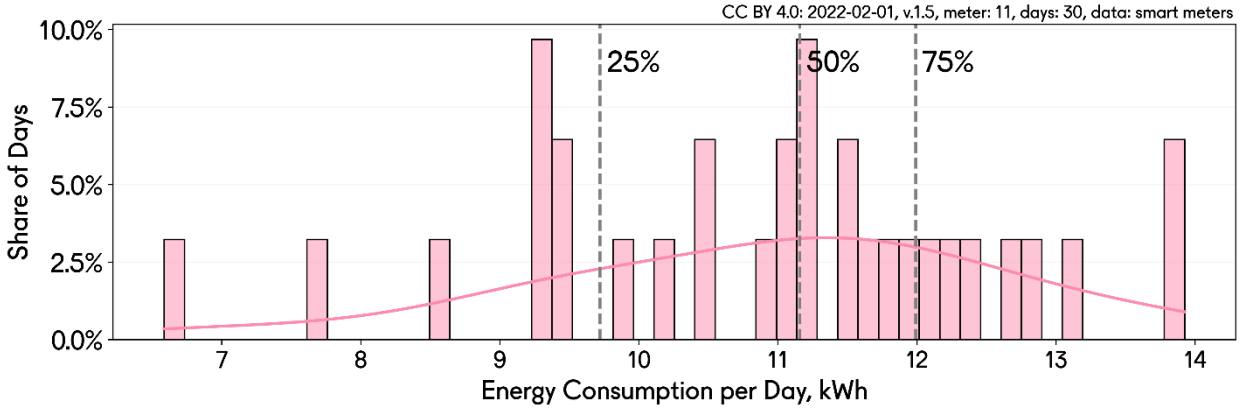

Figure 9 Distribution of aggregated daily energy consumption of Phase 2 (21 Jun to 22 Jul)

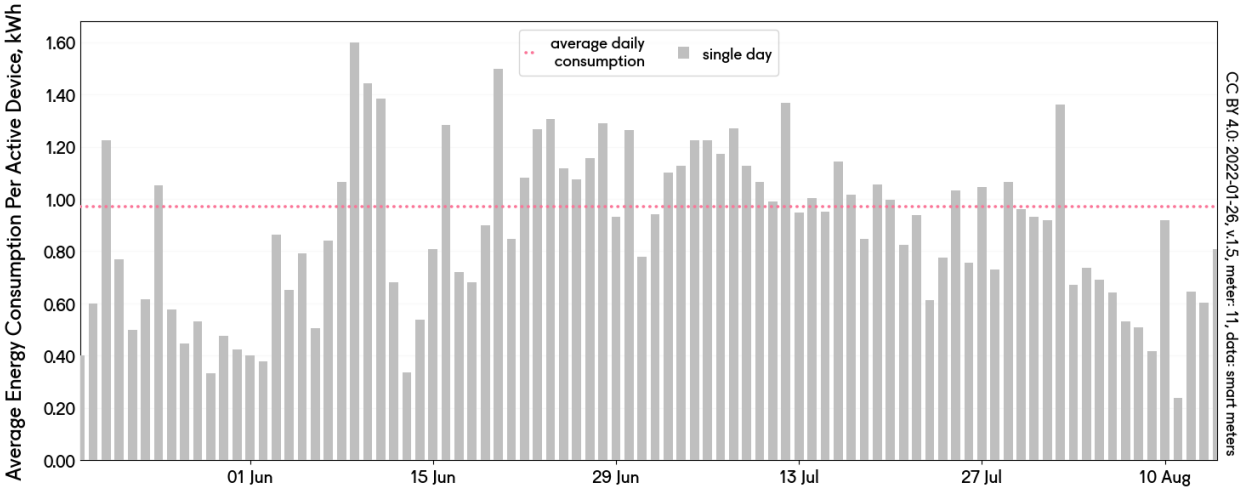

Figure 10 Energy consumption of the active meters on a particular day from the households in the study

Figure 10 above shows a daily average energy consumption from the smart meter data of about 1.00 kWh. This is less than the 2 kWh of daily energy required for cooking food in other comparative studies in East African countries and south-east Asia4. However, the champions of electric cooking in the current study had an average energy consumption of over 2 kWh per day in Phase 2 of the cooking diaries (see annex). An average energy consumption over 1 kWh could suggest that households are likely to be using additional appliances than the electric pressure cooker.

3.4 Foods cooked / Reheated / saved for later

3.4.1 Reheating food

For each food item prepared, participants were asked if the dish was fresh, reheated, or partially cooked. Results for all those records that contained only a single heating event are presented in Table 20.

Table 20 Number of meals fresh or reheated (single heating event records only)

			DISH IS FRESH OR REHEATED			
Phase			Totally Fresh	Reheated	Partially cooked	Total
Phase 1	Heating event (single event only)	Breakfast	124	17	1	142
		Lunch	110	29	2	141
		Dinner	90	50	0	140
		Snack	1	0	0	1
		Food for baby	2	0	0	2
		Other	3	3	0	6
	Total		330	99	3	432
Phase 2	Heating event (single event only)	Breakfast	221	16	0	237
		Lunch	231	71	1	303
		Dinner	187	65	1	253
		Snack	4	0	0	4
		Food for baby	11	0	0	11
		Heating water	1	0	0	1
		Other	7	0	0	7
	Total		662	152	2	816
Total	Heating event (single event only)	Breakfast	345	33	1	379
		Lunch	341	100	3	444
		Dinner	277	115	1	393
		Snack	5	0	0	5
		Food for baby	13	0	0	13
		Heating water	1	0	0	1
		Other	10	3	0	13
	Total		992	251	5	1248

[4] https://documents1.worldbank.org/curated/en/920661600750772102/pdf/Cooking-with-Electricity-A-Cost-Perspective.pdf

While most meals are cooked fresh and meals are rarely partially cooked and saved for later, Table 20 also shows that for the reheated foods, dinners were the most reheated meal of the day at followed by lunches.

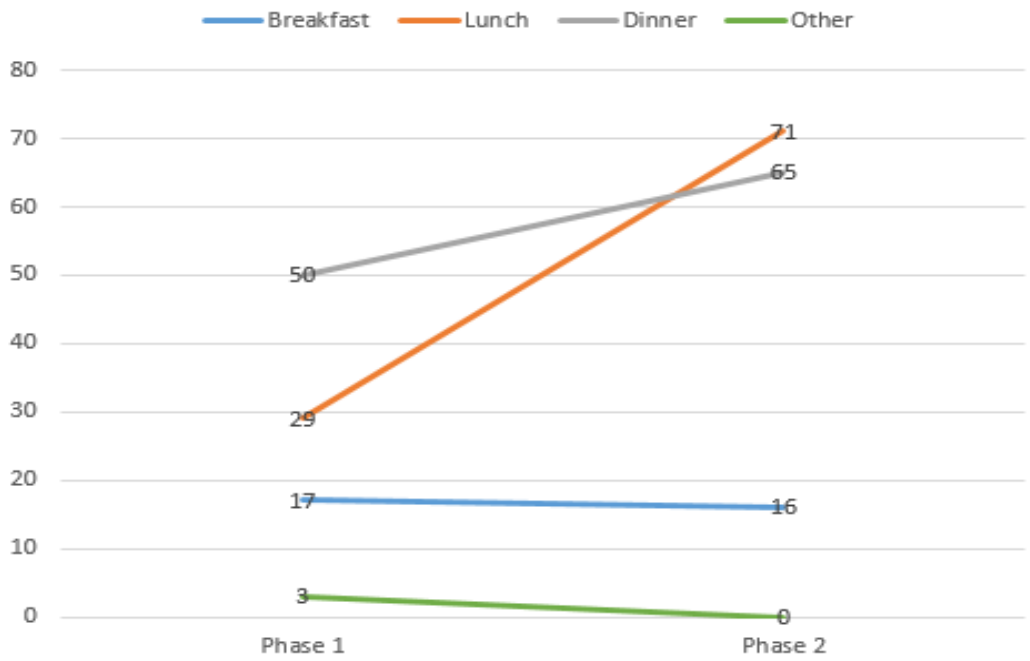

Figure 11 Number of meals reheated in Phase 1 vs Phase 2 (single heating event records only)

Figure 11 above compares the number of reheated foods in both Phases; it indicates that there was a 145% increase in the number of lunches reheated followed by 30% increase in dinners reheated while breakfast had had a decrease of 6% in reheating. This could suggest that an introduction of EPCs enables cooking of enough food and reheating it later especially for major meals.

3.5 Cooking time

3.5.1 Time taken to cook food types

The times taken to cook individual dishes using only electricity, LPG, and charcoal are presented in Table 21, Table 22, and Table 23 respectively. Tables are based on both freshly cooked food and reheated food. When looking at the time spent cooking dishes using electricity, mostly EPCs, (Table 21), it is clear that electric pressure cookers have the potential to shorten cooking times compared with cooking using LPG or charcoal. Time savings are greatest for dishes that take a long time to cook, notably beans and chicken stew, and porridge (see Table 24). The shorter times to cook beans/peas stew on LPG are attributed to the fact that LPG was mostly used for reheating.

Table 21 Time taken to cook dishes using Electricity only (hh:mm) (Phase 1 and Phase 2)

	N	Mean	Median	Std. Deviation	25% Quartile	75% Quartile
Beans/Peas Stew	79	00:50	00:38	00:38	00:25	01:00
Chicken stew	7	00:34	00:33	00:18	00:24	00:54
Eggs	11	00:19	00:12	00:19	00:08	00:26
Ground nut paste	8	00:54	00:49	00:27	00:38	00:58
Katogo	23	00:40	00:27	00:37	00:18	00:41
Matooke (boiled)	28	00:34	00:29	00:31	00:16	00:38
Matooke (steamed)	9	01:49	02:04	00:58	00:48	02:28
Porridge	71	00:33	00:29	00:22	00:15	00:47
Rice	114	00:32	00:28	00:15	00:22	00:39
Ugali (posho)	15	00:26	00:26	00:10	00:22	00:35

* where N>= 5

Table 22 Time taken to cook dishes using LPG only (hh:mm) (Phase 1 and Phase 2)

	N	Mean	Median	Std. Deviation	25% Quartile	75% Quartile
Beans/Peas Stew	9	01:33	00:19	02:16	00:10	02:25
Chicken stew	10	00:44	00:42	00:34	00:08	01:15
Eggs	24	00:19	00:17	00:15	00:08	00:21
Ground nut paste	6	00:31	00:31	00:14	00:20	00:43
Katogo	18	00:48	00:44	00:21	00:37	00:59
Matooke (boiled)	23	00:41	00:32	00:24	00:27	00:46
Porridge	52	00:35	00:30	00:32	00:18	00:37
Rice	21	00:33	00:27	00:20	00:19	00:44

* where N>= 5

Table 23 Time taken to cook food types using charcoal only (hh:mm) (Phase 1 and Phase 2)

	N	Mean	Median	Std. Deviation	25% Quartile	75% Quartile
Beans/Peas Stew	85	01:22	01:05	01:21	00:15	02:02
Chicken stew	15	01:25	01:00	01:15	00:23	02:18
Eggs	23	00:17	00:15	00:11	00:10	00:25
Ground nut paste	47	01:31	01:04	01:29	00:48	01:44
Katogo	39	00:55	00:45	00:29	00:39	01:01
Matooke (boiled)	32	01:04	00:48	00:41	00:36	01:19
Matooke steamed)	71	02:37	02:20	01:39	01:34	03:03
Porridge	52	00:59	01:04	00:31	00:30	01:26
Rice	85	00:58	00:40	00:45	00:27	01:12
Ugali (posho)	19	01:12	00:40	01:13	00:21	02:30

* where N>= 5

Table 24 below shows the median time it took to cook different dishes using different fuels for both Phases

Table 24 Comparing median times to cook dishes using different fuels (hh:mm) (Phase 1 and Phase 2)

	Electricity	LPG	Charcoal	Time savings Electricity over Charcoal	Time savings LPG over Charcoal
Beans/Peas stew	00:38	00:19	01:05	42%	
Chicken stew	00:33	00:42	01:00	45%	30%
Eggs	00:12	00:17	00:15	20%	-13%
Ground nut paste	00:49	00:31	01:04	23%	52%
Katogo	00:27	00:44	00:45	40%	2%
Matooke (boiled)	00:29	00:32	00:48	40%	33%
Matooke (steamed)	02:04		02:20	11%	
Porridge	00:29	00:30	01:04	55%	53%
Rice	00:28	00:27	00:40	30%	33%
Ugali (posho)	00:26		00:40	35%	
Mean	00:39	00:30	00:58	34%	27%
Median	00:29	00:30	00:54	37%	33%

From Table 24 above, it took less time on average to prepare a meal with electricity and LPG compared to using charcoal. Electricity had an average of 34% time savings cooking the different dishes as compared to charcoal while LPG had an average of 27% time savings when cooking the different dishes as compared to charcoal. Note that LPG was mostly used for short cooking dishes and also the data point for beans/peas stew is not considered as the dish was mostly reheated when cooked with LPG.

3.5.2 Time taken to prepare meal

The time that devices take to cook food do not necessarily represent the total time dedicated to preparing a meal. The survey asked participants to note the time that cooking activities started and the time at which all of the activities were finished. The time elapsed has been calculated as the meal preparation time. Meal preparation times for all heating events using only electricity, LPG and charcoal (irrespective of Phase) are presented in Table 25, Table 26, and Table 27 respectively. These tables show that the shortened cooking times seen when using electric devices has a greatest effect on breakfast preparation times. Using LPG reduces meal preparation times considerably compared to using charcoal; using electric devices provides only modest further time savings.

Table 25 Duration of heating events using electricity only (hh:mm) both Phases

	N	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Breakfast	140	01:06	00:26	01:47	00:13	01:15
Lunch	128	02:19	01:32	02:21	00:43	03:09
Dinner	108	01:24	01:03	01:09	00:40	01:52

Table 26 Duration of heating events using LPG only (hh:mm) both Phases

	N	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Breakfast	103	01:19	00:50	01:15	00:30	01:43
Lunch	44	01:40	01:16	01:56	00:50	01:48
Dinner	43	01:43	01:18	02:09	00:29	01:54

Table 27 Duration of heating events using charcoal only (hh:mm) both Phases

	N	Mean	Median	Std.dev.	25% Quartile	75% Quartile
Breakfast	110	02:04	01:41	01:21	01:00	03:02
Lunch	111	03:17	02:53	02:09	02:01	03:56
Dinner	124	02:44	01:54	02:43	01:04	02:52

Table 28 Comparing median duration of heating events using different fuels (hh:mm) (Phase 1 and Phase 2)

	Electricity	LPG	Charcoal	Time savings Electricity over Charcoal	Time savings LPG over charcoal
	Mean	**Mean**	**Mean**		
Breakfast	01:06	01:19	02:04	47%	36%
Lunch	02:19	01:40	03:17	29%	49%
Dinner	01:24	01:43	02:44	49%	37%
			Mean	42%	41%
	Median	**Median**	**Median**		
Breakfast	00:26	00:50	01:41	74%	50%
Lunch	01:32	01:16	02:53	47%	56%
Dinner	01:03	01:18	01:54	45%	32%
			Median	47%	50%

From Table 28 above Time savings for the duration of the heating event or meal preparation indicate that an average time saving of 42% when using electricity as compared to charcoal and 41% when using LPG as compared to charcoal; while the median time saving is 47% for electricity as compared to charcoal and 50% when using LPG as compared to charcoal. This clearly indicates significant time savings as the need for charcoal stove preparation (which duration can greatly vary depending on the quality of fuel used) is eliminated when using electricity and LPG.

3.5.3 Cooking Time Patterns

The change of cooking behaviour from Phase 1 to Phase 2 is shown in the 24-hour plot.

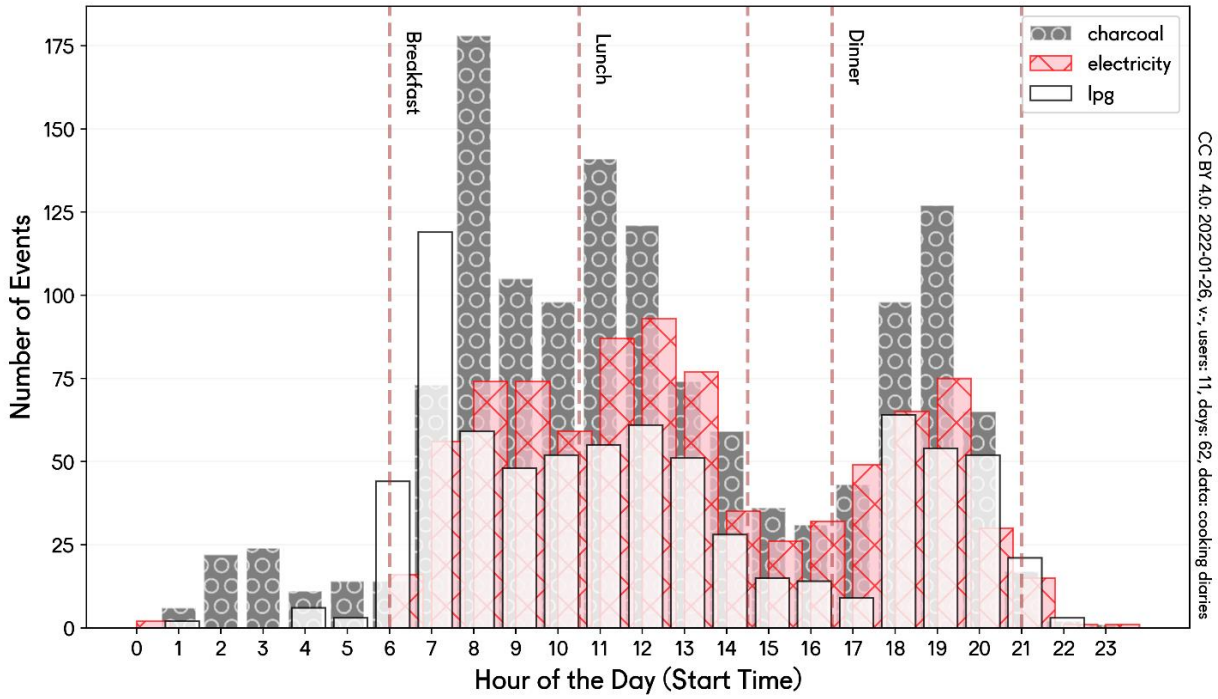

Figure 12 The start time of the cooking events distributed over the 24 hours of the day per energy source in Phase 1

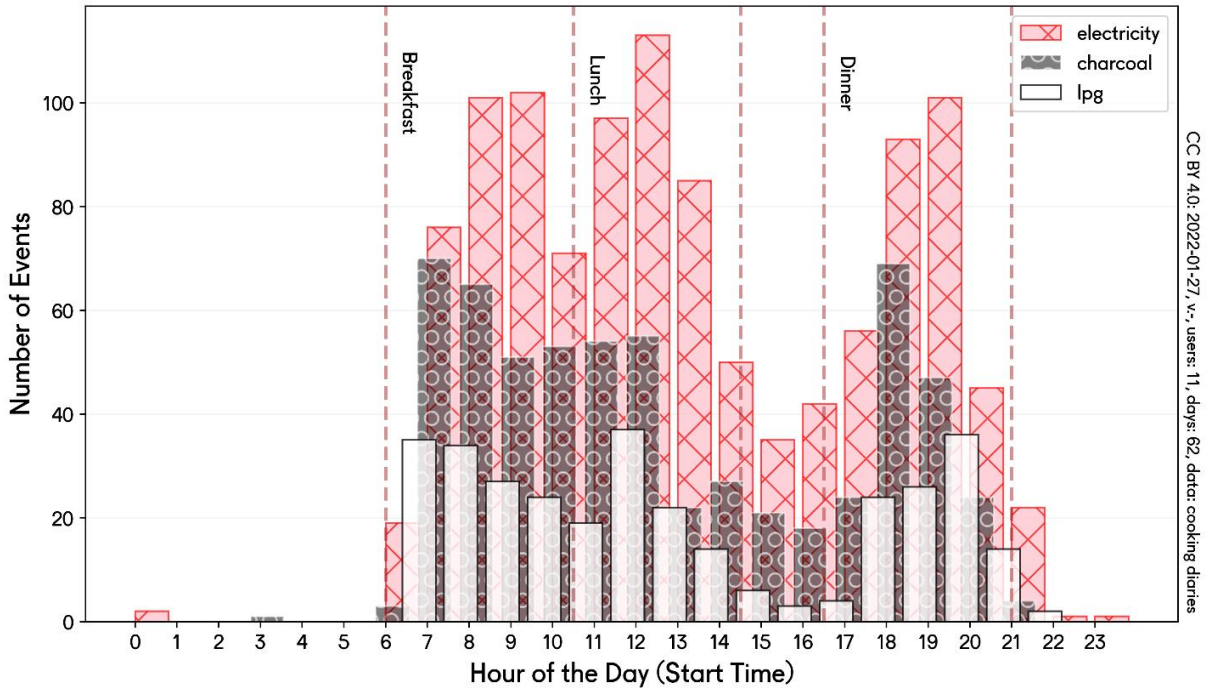

Figure 13 The start time of the cooking events distributed over the 24 hours of the day per energy source in Phase 2

There were 3 peaks, one during each meal time i.e. breakfast, lunch and dinner. From figure 13, in Phase 2, there is a reduction in general cooking time which includes preparation time as compared to Phase 1 as evidenced with close to minimal activity in between the hours of 0 and 6 in figure 13. Figure 12 shows a high number of cooking events with charcoal while figure 13 shows a reduction in cooking events with charcoal due to the use of electricity (EPCs). To verify the event distribution, the load profile of an average day follows a trimodal distribution (contains three peeks) this can be observed from figure 13. It shows that cooking starts at around 6AM, the first peek is observed around the hours of 7AM to 10AM which suggests preparation of breakfast, the second peek is observed around the hour of 11AM to 12PM which suggest preparation of lunch and the last peek observed around 6PM to 8PM that suggests preparation of dinner. Also concurring to the cooking diaries is the end of cooking, which happens about 10 PM.

3.6 Findings from the exit survey;

Participants reported that the following tasted better than usual when cooked with the EPC; rice, irish potatoes, fresh maize, beans, cow peas, meat, chicken, sweet potatoes, yams and balugu, katogo. One respondent reported that cake tasted better than usual, and fried egg. All users reported that rice tasted much better than usual.

Participants reported that the following did not taste better than usual when cooked with the EPC; katogo for cassava, pumpkin, ground nut sauce, matooke (if overcooked when directly boiled in water or when steaming stand is not used – note that for steaming matooke in banana leaves, a longer cooking time is preferred), boiling water (has some smell), and cake; though the respondent reported that this happens when you have not flipped it but when flipped it is very nice. One user reported that rice didn't increase in size or quantity compared to using other fuels like charcoal; this could have been as a result of the amount of water used.

Responses from Users on what they LIKE about the EPC

Participants liked the Electric Pressure Cooker for its ability to consume little power; this was reported by all households. Other reasons given were; it cooks faster, it's clean - no smoke, easy to use or operate, easy to master especially for children who can cook, it's safe especially when you have young children in the house, it looks nice in the kitchen, does not produce heat in the kitchen so one might not notice you are actually cooking, it has a good non-stick pan. And lastly, it is versatile, can be used on a solar system with an inverter for AC appliances and its flexibility allows you to do other activities alongside cooking.

Responses from Users on what they DO NOT like about the EPC

The size of the EPC was a key issue; 64% of the respondents reported that the EPC was not sufficient for their cooking needs and thus needed to use their previous appliances to meet my cooking needs while 36% said that they could use the EPC for most of their cooking needs.

Households reported that the 6 litre size was small for their big families and as such some had to cook the same dish multiple times or opt for alternate fuels to cook larger meals or alternate meals to supplement the food cooked in the EPC.

Another concern related to the size was the size of pot which was small for big families and also the fact that only one pot could be used thus the need to remove food and wash every time you needed to cook another dish. Thus, having multiple pots would be great. One respondent expressed her desire as such: *"If I can get the one with multiple cooking pots to cook different dishes at a time! say I should be able to cook matooke and rice at the same time."*

There is no regulator for control the heat. The heating capacity does not favour cooking of ground nuts sauce since one needs to regulate the heat or cook on low heat to avoid burning.

Having extra components such as the rubber ring would be helpful. For some of the brands, the rubber ring for the cover wears out quite fast.

Power cut off or unreliability of power makes cooking difficult and inconvenient since the EPC can only be powered by grid electricity.

One respondent had this to say: *"There is nothing that I don't like about the pressure cooker because it cooks very fast and it's efficient in power usage and consumption."*

Willingness to buy

All participants were willing to buy the appliance and would recommend others to buy it for the following reasons;

- It saves fuel compared to charcoal
- It is cost saving
- It is easy to use
- Takes a short time to cook *"It cooks very fast especially when preparing food and breakfast for children going to school early morning*"
- It eases life
- It keeps the kitchen clean
- It is a good and versatile appliance
- It looks nice

When asked what they thought the cost of the EPC was, participants had the following perceptions: majority, 55% perceived the EPC to cost between UGX 200,000 to 350,000, 36% estimated the cost at UGX 500,000 and above while 9% estimated the cost at UGX 50,000.

Participants were then informed that the EPC may cost between UGX 270,000 to 400,000 depending on brand and quality and asked once again if they were still willing to buy; all said they would still buy the EPC for the same reasons as already mentioned however some additional reasons were given by some respondents.

- It has become a necessity in my kitchen and is more reliable than other cooking devices
- It does not produce fumes and some foods taste better when cooked with the EPC as compared to other cooking fuels or appliances
- Two respondents stated that it was affordable while one respondent said that they were willing to borrow money to buy the appliance

Continued use of the EPC

When asked if they would continue using the EPC even after the end of the study, all participants said that they would continue using the appliance. One respondent said they were planning to buy another EPC and another if a bigger sized EPC were available, she would be the first to buy to be able to cater for her entire family's cooking needs; she noted that family members that did not like cooking are now happy to be in the kitchen. Participants were really grateful for having been invited to participate in the study.

New tips or techniques learned

Participants shared the following new tips or techniques that they had learned while cooking with the EPC;

- When boiling milk or cooking small foods, you do not cover the EPC; however not covering takes a lot of power.
- The EPC can be used for cooking everything
- How to open the pressure valves is key
- It is important to learn how to time the different dishes for a perfect meal
- If the EPC is not covered well, the green light will not come on and the appliance will not cook, so you must cover the EPC well and correctly
- You can cook with the EPC without covering, say for frying, however when you cook without covering it consumes more power.
- It cook cake using the EPC and yet to try out many other things with it
- When baking a cake using the EPC, you have to flip over the cake so that it gets ready on the top side. One participant recommended that opening the pressure valves when baking cake results in a good outcome.
- You can cook luwombo stew in banana leaves using the EPC
- Cooking luwombo, matooke and pumpkin at the same time in the same EPC
- Warming the soup without closing the EPC

Participants reported that they had learned the tips mentioned above through trial and error, discovery, exploring, asking other EPC users and the research team.

Learnings about household cooking practices

Participants reported learning the following about their household cooking practices:

- I learnt to save power and plan to do away with charcoal with time
- Conceptualising how much is spent on cooking fuels per day, week, and month, which had never crossed her mind. Thus a take-home was the importance of record keeping.
- The cost of cooking fuel
- To note down my fuel consumption, what I have put, getting a book and write down what I have bought electricity units and what we used it for. With that you can gauge and conclude electricity is cheap to use than gas and charcoal
- The ability to multitask while cooking and doing other activities.
- The ability to plan well the cooking time including preparations within a defined time; no need to spend a whole morning on a cooking task e.g. if lunch is to be serve at 1pm, one can plan preparations and cooking time of less than 2 hours; though this can also lead to laziness.
- I can use my solar home system to cook since the EPC does not consume that much electricity, it can be sustained on solar which has not increased on the bill of electricity at all.
- The cost of cooking with electricity compared to other fuels is lower than I used to think
- It has given me an insight on how much time is required to prepare food
- I got to know about the existence of pressure cooker for cooking and amount of power that makes food ready when cooking using electricity depending on the nature of food being cooked.
- I learnt how to operate the pressure cooker

4 Conclusion

Among the 11 households taking part in the survey, charcoal was the dominant fuel of choice, followed by LPG (prior to the introduction of EPCs).

In Phase 1, electricity was rarely used to cook an entire meal, and was usually stacked with LPG. When EPCs were introduced, charcoal and LPG continued to be used as supplementary fuels. Although it appears possible to cook exclusively with electricity, further investigation is required to understand why people chose to use supplementary fuels.

Electric cooking uses a fraction of the energy (at the household) involved in cooking with charcoal. Cooking with charcoal used around 20 times as much energy as cooking with electricity, and LPG used approximately 5 times the energy as cooking with electricity.

The following effects can be seen when introducing EPCs to household kitchens:

- People tend to prepare simpler meals comprising fewer dishes - 'one pot' meals are easy to prepare in a pressure cooker.
- There were only modest changes to the dishes cooked:
    - More cooking of beans, rice, and porridge.
    - Less of boiled matooke, leafy vegetables and eggs

  This could suggest that the electric pressure cooker meets a significant part of the households' cooking needs. The cuisine in Uganda comprises many traditional dishes that are suitable for electric pressure cookers.
- Median figures suggest that charcoal consumption dropped dramatically (44%). There is no evidence that LPG consumption dropped.
- At least three households or 27%, switched almost entirely to e-cooking during Phase 2. Each of these top users consumed more than 2 kWh with the electric pressure cooker on an average day.
- Cooking times are reduced, especially for dishes that take a longer time to cook, notably beans, chicken stew, and porridge.
- Total meal preparation times are greatly reduced (compared to charcoal), especially for breakfasts. Time savings compared to LPG are more modest.
- Time savings might be highly appreciated by the part of the younger generation of city dwellers in Kampala who prioritize time to study and work.

From the pointers above, a proposed hypothesis that electric cooking is desirable in many urban environments connected to the national grid when electricity is offered at a market price. The time savings are significant and particularly focused on women, as they are often responsible for cooking most of the food in the households. In addition, electric cooking improves the conditions for maintaining good health by limiting exposure to combustion vapours.

4.1 Outlook

Although we found significant user benefits in the use of electric pressure cookers in this study, the basis in our conclusions would be significantly stronger if the study lasted for a longer period of time with a diverse sample size for different cultures thus an understanding of how these variations would affect electric cooking, the seasonal variations in foods cooked, whether electric cooking is realistically sustainable in the longer term, what combinations of electric cooking appliances make sense for sustainability and national grid stability with increase in electric cooking. Therefore, conducting an additional study would be recommended in order to confirm and reveal more behavioural trends by adding several more months of data collection to complement the existing data.

To further reveal which factors determine whether and to what extent households switch from traditional cooking to electric cooking alternatives, further multi-faceted research, including customer surveys, is needed. A2EI wants to continue exploring the popularity of electric cooking around the

world. With this knowledge base, we hope to be able to provide guidelines for designing mini-grids and explore how tariffs and other factors affect the uptake of electric cooking.

5. APPENDIX

Data on the Use of Electric Appliances from Smart Electricity Meters

The distribution of cooking minutes between the electric cooking appliances shows that most cooking times are shorter than 45 minutes. In total, the smart electricity meters registered 1713 cooking events by the households that took part in the cooking diaries and 4163 by the households that did not. Energy consumption is less than 0.1 kWh for the shortest events such as re-heating food and boiling water. The most common events have an energy consumption of about 0.2 kWh, which includes cooking rice, beans, fish, and meat. Most cooking events consume less than 0.5 kWh.

It is possible to distinguish differences in cooking between the households in Group 1 and Group 2. As an example, there were more short events [read: less than 20 minutes] and a very high concentration of a specific size of the energy consumption (approx. 0.25 kWh) in Group 1. This could be due to a higher frequency of heating tea or milk. This could indicate that the dishes cooked in Group 2 became more varied over time when more and more households started to adopt the electric pressure cooker. When they became more popular, households wanted to try out more and different dishes with the electric pressure cooker, which could be a matter of taste or that the households discovered that it was both cheaper and faster to cook with the electric pressure cookers.

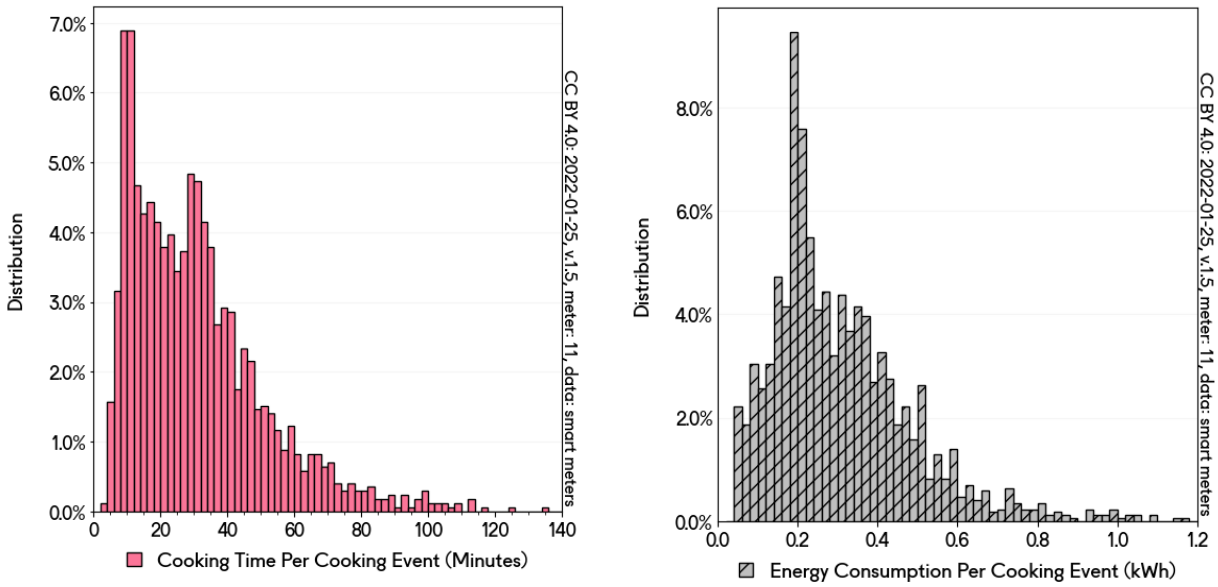

Figure 14 Distribution of Minutes and Energy Consumption per Cooking Event from Smart Electricity Meter Data

By looking at the trajectories of how the energy counter value increased during the study, it is possible to get an overview of the main user trends for each meter. For example, all electric pressure cookers were to some extent used. Smart meter number 86000147 was the study's top user with 1078 events and more than 0.5 MWh in electricity consumption.

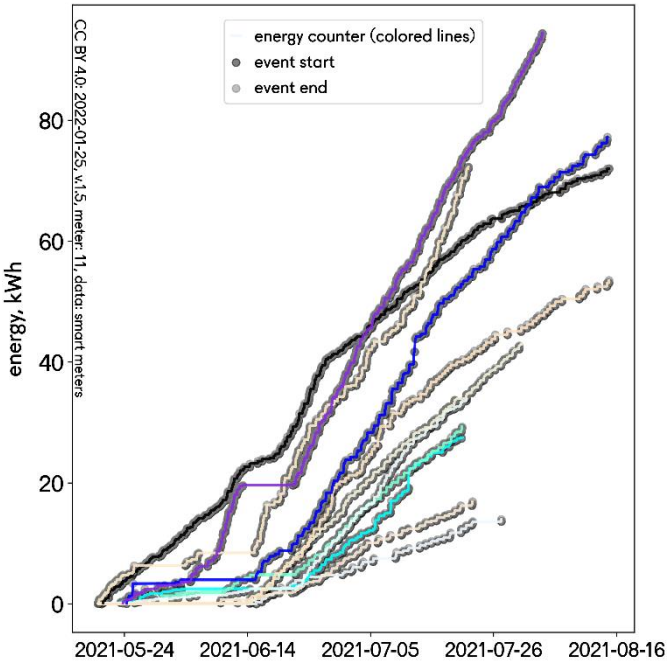

Figure 15 Energy Counter Lines and Dots for Event Start and End. List with the Date for the First and Last Event from Smart Electricity Meter Data – Group 1

Meter number	First event	Last event	Energy, kWh	Color
202086000895	2021-05-23	2021-08-03	94.39	blue violet
202086000492	2021-05-24	2021-08-14	77.24	blue
202086001057	2021-05-19	2021-07-21	72.29	blanched almond
202086000778	2021-05-20	2021-08-14	72.04	black
202086000616	2021-06-14	2021-08-14	53.53	bisque
202086001122	2021-06-12	2021-07-30	42.72	beige
202086000615	2021-05-20	2021-07-21	33.85	azure
86000175	2021-06-10	2021-07-20	29.31	aquamarine
202086001058	2021-05-23	2021-07-20	27.53	aqua
202086000896	2021-05-19	2021-07-22	16.95	antique white
202086001121	2021-06-15	2021-07-27	13.98	alice blue

In the relatively short time period that the meters reported the cooking activities, an electric hotplate user with meter number 202086000895 became one of the study's champions of electric cooking, consistently using the electric appliance several times a day. It can be seen that the EPC was not used much at all until the start of Phase 2 [read: 2021-06-21] of the cooking diaries.

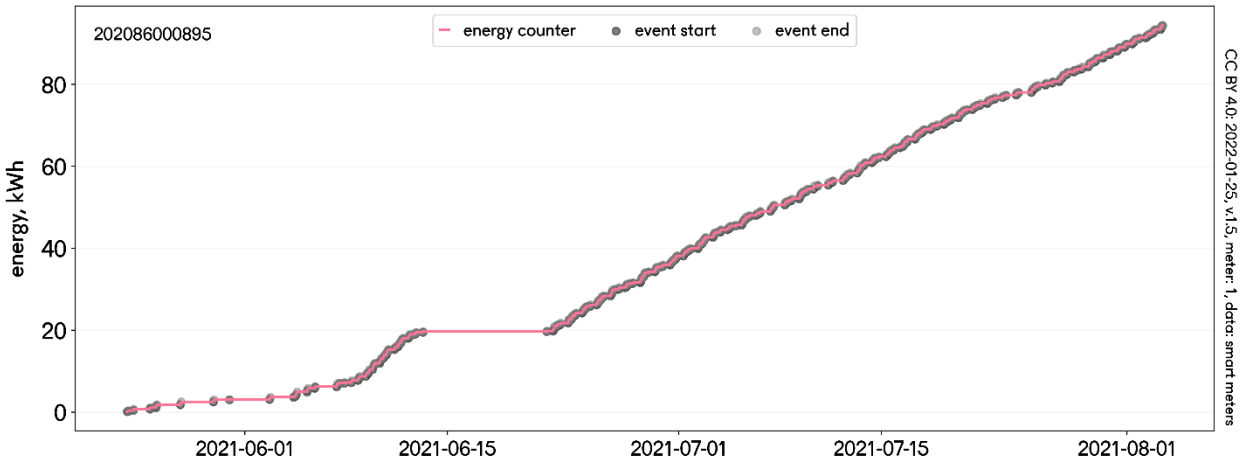

Figure 16 The Cooking Events Recorded by Smart Electricity Meter #202086000895

By zooming in on a couple of days' data, it is possible to study how well the household recorded the start and end time of when the electric pressure cooker was used. This household was recording about 200 dishes by the electric pressure cooker in Phase 2 of the cooking diaries.

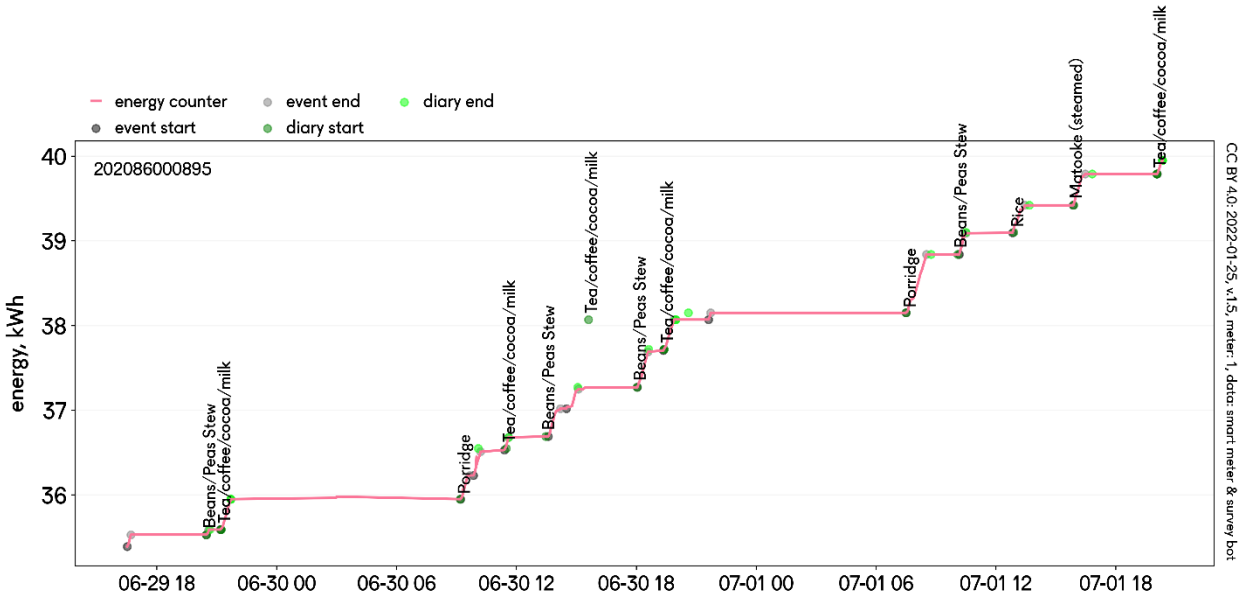

Figure 17 Closer look at cooking events from #202086000895 from June 29 to July 2

Table 29 A table of all the events made in an electric appliance in the cooking diary of Phase 2 for #202086000895

			Event Duration, minutes				
	Name of dish	Number of dishes				Quantiles	
			Mean	Median	Std	25%	75%
Electric pressure cooker	Beans/Peas Stew	37	47.24	31.0	45.51	15.0	59.0
	Drinking/purifying	3	16.67	12.0	12.66	9.5	21.5
	Eggs	1	12.0	12.0		12.0	12.0
	Fish Stew	2	16.0	16.0	2.83	15.0	17.0
	Fish in groundnut stew	1	42.0	42.0		42.0	42.0
	Goat/Meat Stew	3	282.67	68.0	381.38	62.5	395.5
	Ground nut pasta	3	51.67	52.0	8.5	47.5	56.0
	Katogo	3	23.0	30.0	14.8	18.0	31.5
	Leafy Vegetables (cabbage, nakati, dodo, malakwang, gobe etc)	1	21.0	21.0		21.0	21.0
	Matooke (boiled)	4	46.25	34.0	27.43	30.0	50.25
	Matooke (steamed)	2	48.0	48.0	11.31	44.0	52.0
	Other	1	37.0	37.0		37.0	37.0
	Porridge	28	52.39	51.5	18.18	40.5	58.0
	Rice	24	31.67	29.0	11.55	24.0	40.5
	Soup (goat, beef, fish)	1	6.0	6.0		6.0	6.0
	Sweet potatoes/ irish potatoes/ cassava/ yams/ pumpkin (boil or steam)	14	44.57	38.0	16.41	34.0	56.25
	Sweet potatoes/ irish potatoes/ cassava/ yams/ pumpkin (fried or deep fried)	1	44.0	44.0		44.0	44.0
	Tea/coffee/cocoa/milk	45	34.62	29.0	42.95	17.0	37.0
	Ugali (posho)	11	30.82	32.0	6.05	26.0	35.0

The second champion among the households was also not really using the electric pressure cooker until the start of Phase 2. If this household would cook with the same intensity as from the start of Phase 2, this household would use about 800 kWh per year or 2.2 kWh per day only from cooking with an electric pressure cooker. If an electricity price of $0.10/kWh is used as an example, this would mean that the household will spend $80/year in electricity consumption for cooking. #202086000492 is a household of 7, which means $11.4/(year*person).

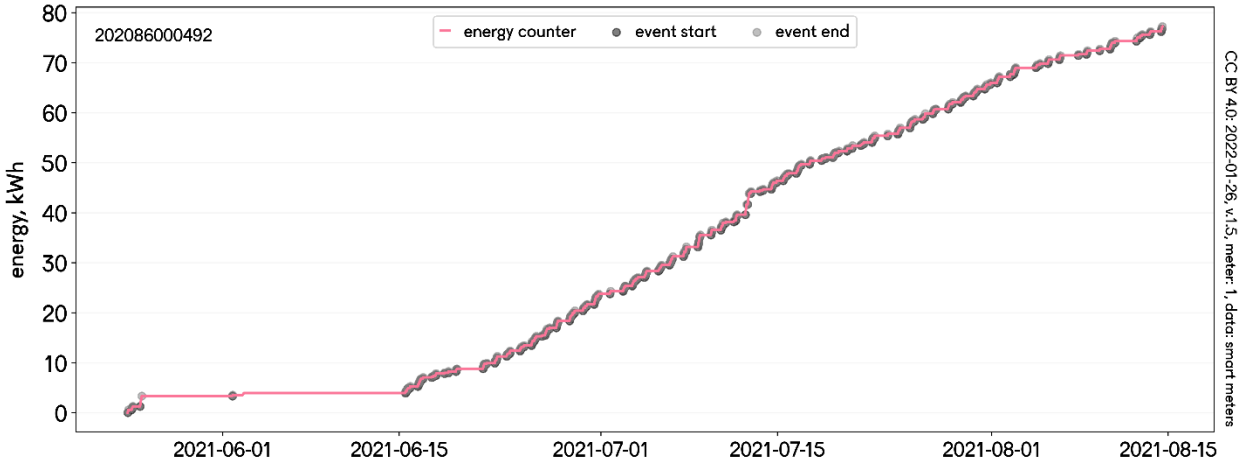

Figure 18 The Cooking Events Recorded by Smart Electricity Meter #202086000492

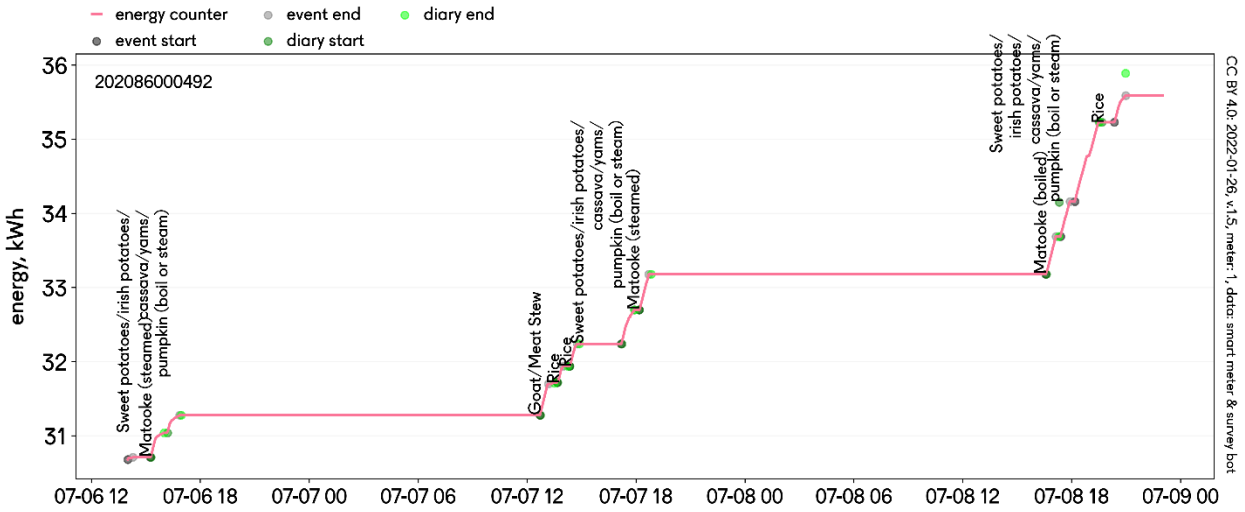

Figure 19 Closer Look at Cooking Events from #202086000492 from July 6 to July 9

Table 30 A table of all the events made in an electric appliance in the Cooking Diary of Phase 2 for #202086000492

			Event Duration, minutes				
Electric pressure cooker	Name of dish	Number of dishes				Quantiles	
			Mean	Median	Std	25%	75%
	Beans/Peas Stew	16	76.06	55.5	44.59	47.5	99.25
	Chicken stew	6	43.83	42.5	18.19	27.75	57.25
	Eggs	3	36.67	29.0	15.95	27.5	42.0
	Goat/Meat Stew	7	43.0	46.0	14.61	43.0	50.0
	Katogo	3	101.67	111.0	77.42	65.5	142.5
	Matooke (boiled)	13	41.31	43.0	8.95	39.0	45.0
	Matooke (steamed)	4	45.0	44.0	5.1	42.25	46.75
	Other	3	66.0	71.0	19.97	57.5	77.0
	Rice	39	50.03	31.0	116.41	24.0	37.5
	Sweet potatoes/ irish potatoes/ cassava/ yams/ pumpkin (boil and fry)	1	16.0	16.0		16.0	16.0
	Sweet potatoes/ irish potatoes/ cassava/ yams/ pumpkin (boil or steam)	16	49.19	42.5	29.61	31.75	61.75

The third champion had the same behaviour as the two others; The household did not use the electric pressure cooker until the start of Phase 2 of the cooking diaries.

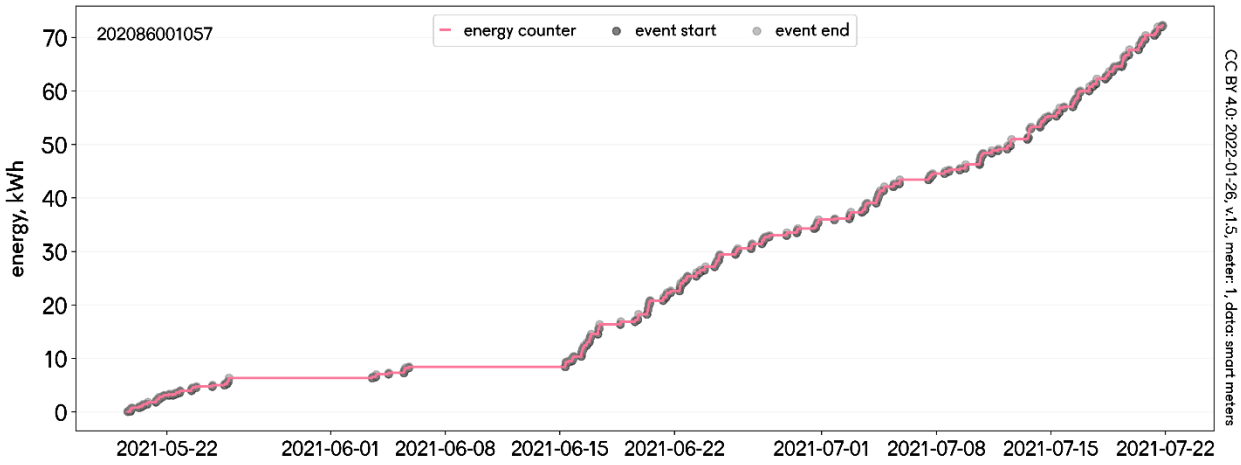

Figure 20 The Cooking Events Recorded by Smart Electricity Meter #202086001057

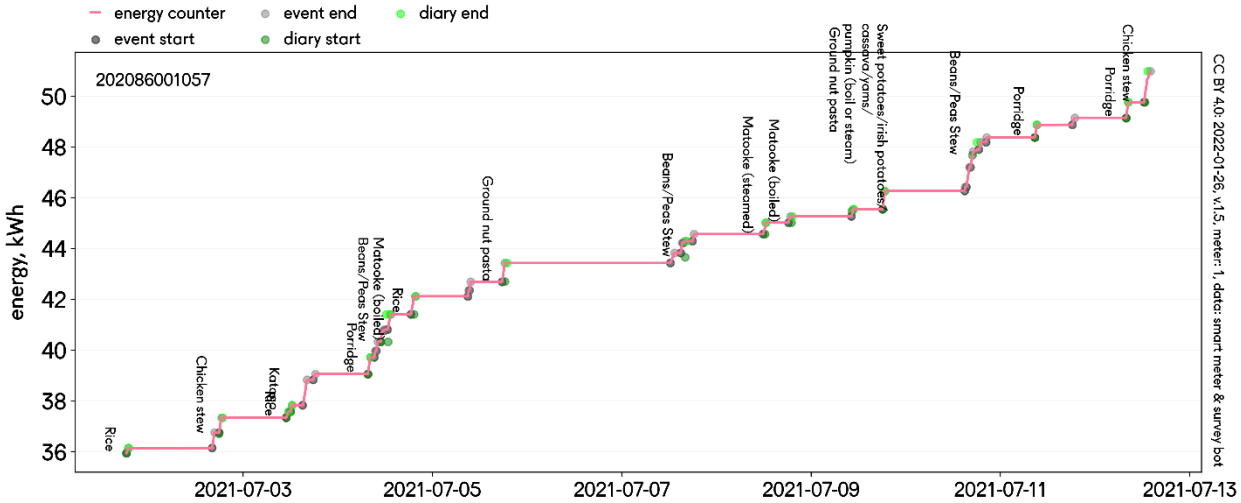

Figure 21 Closer Look at Cooking Events from #202086001057 from July 1 to July 13

Table 31 A table of all the events made in an electric appliance in the Cooking Diary of Phase 2 for #202086001057

			Event Duration, minutes				
	Name of dish	Number of dishes	Mean	Median	Std	Quantiles 25%	75%
Electric Pressure Cooker	Beans/Peas Stew	12	71.67	70.0	22.55	59.5	82.25
	Chicken stew	2	51.5	51.5	13.44	46.75	56.25
	Goat/Meat Stew	3	60.67	53.0	36.12	41.0	76.5
	Ground nut pasta	5	31.6	30.0	5.32	28.0	35.0
	Katogo	4	30.0	26.0	10.13	24.5	31.5
	Leafy Vegetables (cabbage, nakati, dodo, malakwang, gobe etc)	2	16.5	16.5	2.12	15.75	17.25
	Matooke (boiled)	5	22.2	16.0	10.5	15.0	28.0
	Matooke (steamed)	1	14.0	14.0		14.0	14.0
	Other	1	113.0	113.0		113.0	113.0
	Porridge	10	34.9	34.5	8.1	30.25	39.0
	Rice	6	42.17	33.0	40.09	26.0	42.25
	Spaghetti (pasta)	2	17.0	17.0	4.24	15.5	18.5
	Sweet potatoes/ irish potatoes/ cassava/ yams/ pumpkin (boil or steam)	3	58.33	40.0	50.08	30.0	77.5
	Sweet potatoes/ irish potatoes/ cassava/ yams/ pumpkin (fried or deep fried)	3	29.67	27.0	9.29	24.5	33.5
	Tea/coffee/cocoa/milk	1	11.0	11.0		11.0	11.0

Estimate on the Power Profile:

Based on the small sample size of 11 households and the quite modest rate of electrical cooking among the whole household sample, the effect of the electrical cooking on the national grid stability in the capital of Uganda could be considered as insignificant; however this requires further investigation with a larger sample size. The chart below has multiplied the figures up to represent the load presented by 1000 households.

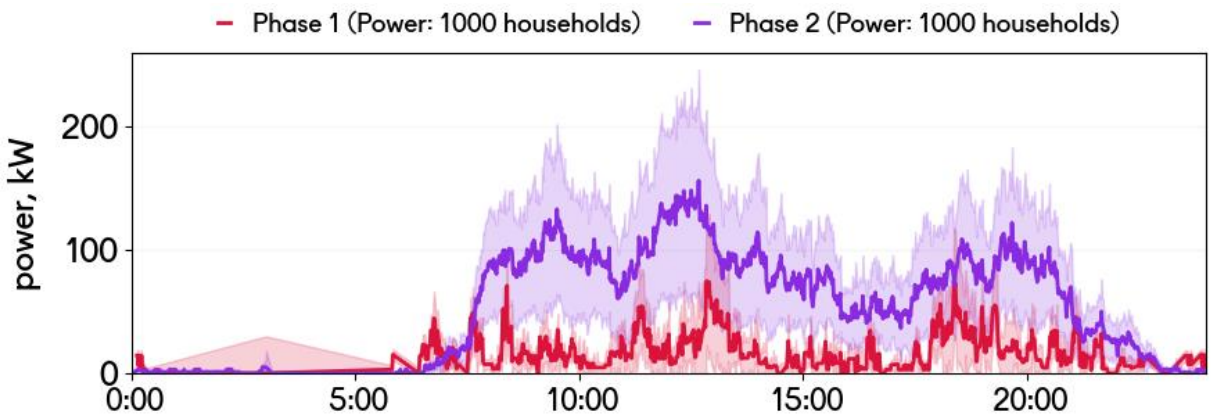

Figure 22 Power Profile Based on Smart Electricity Meter Data Incl. Standard Deviation – Scaled up to 1000 Households – Time Period is Phase 1 and 2 of Cooking Diaries