Sustainable Energy Services Company (SESCOM)

Piloting Innovative Business Models for Accelerating Uptake of Efficient Electric Cooking Appliances in Morogoro, Tanzania

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Contents

Glossary of Abbreviations

CSOs	Civil Society Organizations
EPC	Electric Pressure Cooker
EWURA	Energy and Water Utility Regulatory Authority
LPG	Liquefied Petroleum Gas
Global LEAP	Global Lighting and Energy Access Partnership
MECS-ECO	Modern Energy Cooking services – Electric Cooking Outreach
SACCOS	Savings and Credit Cooperative Society
SESCOM	Sustainable Energy Services Company
SUGECO	Sokoine University Graduate Entrepreneurs Cooperative
TAFORI	Tanzania Forestry Research Institute
TBS	Tanzania Bureau of Standards
TANESCO	Tanzania National Electricity Supply Company
VICOBA	Village Community Bank
UWATAFO	Umoja wa Wanawake TAFORI

Executive Summary

This report present findings from the electric pilot cooking diary study, performance of a new electric pressure cooker (EPC) monitoring device, and the innovative business model for EPC distribution to inform the acceleration of efficient electric cooking appliances uptake. The aim of the study was to gain a deeper understanding of how households in Morogoro Municipality cook, their responses to EPC and how compatible is the EPC with electricity supply. Further intends to test a financing models for EPC distribution. Mixed methods and approaches were used to gather data from various sources including cooking diary forms, energy measurements, TrekAMP, Stove trace trek, registration survey, exit survey, trainings and meetings. The study forms part of the Modern Energy Cooking Services (MESC) programme and Electric Cooking Outreach (ECO) challenge fund.

Fifty households were selected from urban and peri-urban of the Morogoro Municipality and asked to keep detailed cooking diaries, recording exactly what they cooked, when and how for six month split into four phases (baseline, transition, monitor and endline). In phase 1 (three weeks), participants were not asked to change their cooking habits, intensive type of cooking diary was used in data collection, in phase 2 (four weeks), households were given an electric pressure cooker (EPC), trained on how to use it and were encouraged to use it whenever possible and intensive type of cooking diary was employed, phase 3 (three months), light cooking diary type of data collection was used, only cooking events on electric cooking appliances were recorded, and phase 4 (three weeks), intensive, cooking diary type used, cooking events on all cooking fuel were recorded.

Cooking records were uploaded into the kobo Toolbox and downloaded into an excel worksheet for analysis. A database of foods cooked; cooking time and duration; and energy used was pulled together. The type of meals cooked, energy required to cook each meal type were produced, and disaggregated as far as possible to explore the influence of a variety of parameters, including fuel, appliance and meal type.

The key findings are that use of efficient electric pressure cookers fit the cultural processes of cooking in the Morogoro region in Tanzania. Introduction of EPCs did not cause households to change meal from what they were used to instead increase or reduced frequencies of cooking some foods, this implies that EPC was compatible with households' menus.

Furthermore, the diaries also show a general increase in fresh meal preparation as opposed to partially pre-cooked or re-heated over the phases. Introduction of EPC increases fresh meal preparation as household perceived cooking using EPC was faster and affordable and there was no need for precooking food for later use, the need for boiling heavy food such as beans and saving in the refrigerator for later use decreased. This may lead to improved diet and health and

possibly lower energy consumption from refrigeration (although the refrigeration point needs to be verified in terms of behaviour dynamics (switching on/off or constantly on) and energy consumption).

Time for preparing meals, especially dinner changed, they start a bit late from normal experience as they found EPC cooking faster. Also, following introduction of EPCs, the diaries show fewer multiple-dish meals at breakfast and supper and more at lunch, suggesting shifts in the times of day during which households did additional cooking.

Regarding fuel choice, once EPCs were introduced, there were a very large increase in cooking with electricity accompanied by a correspondingly large drop off in charcoal use for cooking. This usage of EPCs were consistent across the 6 month pilot.

Results also indicated that fuel stacking increased since EPCs were introduced. There was evidence of some stacking behaviour before EPCs were introduced. The transition to phase 2, though, saw increased adoption of electric cooking (28% of cooking events) and electric-included stacks; charcoal-electric made up 6.44% of events in phase 2, and LPG/Electric made up an additional 3.8% and trends were largely consistent into phase 4. The apparent displacement effect of electricity on charcoal use after the introduction of EPCs is very encouraging for the potential of EPCs to reduce reliance on charcoal and bring numerous health and climate benefits. Local and national energy planning should consider EPCs as part of strategies to reduce charcoal use and wider scale projects should be monitored to verify if charcoal displacements trends hold true on a larger scale and over a longer period of time.

Findings also indicated that previous experience with electricity is not a large factor in EPC adoption. The Stovetrace data showed that EPC usage was similar throughout the pilot among households who already had an electric cooking appliance versus those who did not. While the sample size is small, the experience of these 50 households is therefore encouraging for efforts to scale EPCs into the population more broadly, and that households not already using modern energy and electricity may be able to adapt equally well to use of an electric appliance.

Findings related to effects of EPC use on electrical supply and the grid, results indicated that EPC usage was consistent as there was a clear evening peak, the highest likelihood of affecting the grid comes around 17:00-18:00 when households begin cooking dinner. This raises an important question of what would be the impact of expanded eCook usage on the national grid.

According to findings from the exit survey, few outages were reported to persist for few minutes or hours, however households did not stop cooking with electricity despite those few outages.

Findings from this pilot project also indicated that opportunities exist to accelerate distribution of EPC through an electric cooking appliance financing model. The tested models enabled members of the cooperative/microfinancing entity to access electric cooking who could not pay for the appliance upfront. Rate of uptake was not very high from the organisations worked with in this pilot project. The main barrier was because the cooperatives/VICOBA did not pay SESCOM for the appliances upfront but only when they begin to receive cash payments from their members. When there were insufficient cash payments, then SESCOM could not release a second round of appliances for others in the VICOBA to access. An alternative might be to use the M-Kopa model where the device is switched off if payments are not made. However, there are uncertainties over whether that would increase the speed of payments (likely depends on how much customers value electric cooking). Experience indicated that the electric cooking appliance financing model fits well with economic groups which have regular flow of income. Therefore, while targeting other segments of the community especially the rural poor another type of financing model should be considered.

Furthermore, employee financing facility could also provide an opportunity to reach a large number of formally employed workers because they have stable income and they are more willing to adopt once became knowledgeable of the EPC benefits.

1.0 Introduction

1.1 Background

According to energy access and use situation survey II of 2021 in Tanzania Mainland, 37.7% of all households are connected to electricity. Whereas more than 85 % of the population still depend on solid biomass fuels for cooking, 63.5% of households using firewood, followed by charcoal users 26.2%, only 5.1% use LPG and 3% use electricity. Charcoal is the main fuel in urban areas and firewood in rural areas. Most of the biomass fuels is burned in inefficient stoves, which in turn affects the health and wellbeing of the population. Lack of reliable, affordable and sustainable supply of energy for cooking continues to be a critical constraint to transition to clean cooking solutions. Batchelor *et al* 2019 noted that cooking with an electric pressure cooker (EPC) in Tanzania was competitive with other energy sources.

Agriculture, forestry, fisheries, beekeeping, wildlife, mining and industries are the main productive sectors in Morogoro region, Tanzania. Agriculture is the major economic activity in the region engaging about 80- 90 percent of the region's labour force. According to the survey conducted in August 2020 the result indicated that more than 60% of the households in Morogoro municipal had attained the secondary school education. Regarding the housing, more than 95% of buildings were made up of either concrete or burnt brick wall, 60% with tile floor and corrugated iron sheet or cement roof. More than 95% of kitchens were indoor and households had a range of fuels and stoves used for cooking. About 95% of the households were relying on biomass as primary energy source for cooking, 60% were using improved charcoal cook stove, 32% traditional charcoal metal stove and 20% three stone fire place. More than 70% of the household own LPG stove, 11% microwave, 10% rice cooker, 5% kettle, 2% electric hotplate and 3% kerosene stove. Stacking of different fuels and cooking solutions is therefore already common among many participants. Based on national energy access and use situation survey II report of 2021, 28.4% of all households in Morogoro region are connected to electricity.

1.2 Project Aims and Objectives

Sustainable Energy Services (SESCOM), Tanzania Forestry Research Institute (TAFORI) and Nexleaf Analytics teamed up to implement the community-scale pilot study under the Modern Energy Cooking Services - Electric Cooking Outreach (MECS-ECO) programme. The pilot study aimed to test the business model for EPC distribution and responses of the community to the EPC. The specific objectives of the project were:-

- To test the business model for distribution of Electric Pressure cookers (EPCs) in grid connected communities in the urban area of Morogoro Region, Tanzania.
- To pilot the use of a new monitoring device, TrekAMP, to monitor the use of EPCs in the study community, with the longer-term goal of informing the development of Result Based and Carbon Finance Mechanisms.

- To monitor and document the end users' impressions, acceptability and responses to the Electric Pressure Cooker (EPC).

2.0 Methodology

To achieve the objectives, project employed the following methodologies:-

Cooking Diaries

The cooking diaries study was designed to address the two ECO research questions:

- Does the use of efficient electric pressure cookers fit the cultural processes of cooking in the Morogoro Municipal in Tanzania?
- Can the efficient electric pressure cooker fit with the electricity delivery in Morogoro Municipal in Tanzania?

Fifty (50) households were selected from the Morogoro Municipality based on their willingness to participate in the study. The study was conducted for six months split into four phases (baseline, transition, monitor and endline); in phase 1 (three weeks), participants were not asked to change their cooking habits, intensive type of cooking diary was used in data collection (under intensive type of cooking diary data collected included all fuels and quantities used for cooking each dish, appliances used (EPC, charcoal, firewood stoves, LPG, kerosine), menu items cooked, cooking processes, cooking time, number of people the meal/ dish cooked for, reason for cooking, user perceptions, barriers and challenges, in phase 2 (four weeks), households were given an electric pressure cooker (EPC), trained on how to use it and were encouraged to use it whenever possible and intensive type of cooking diary was employed, phase 3 (three months), light cooking diary type of data collection was used, only cooking events on electric cooking appliances were recorded, and phase 4 (three weeks), intensive cooking diary type used, cooking events on all cooking fuel were recorded. This report treats monitor and endline phase as an extension of phase two with the intention to discover how cooking practices evolve over time. Phase 3 data included fewer (and less specific) questions regarding cooking practices than did phases 1, 2, and 4. Where phase 3 is not included in a figure, it is due to differences in the ways that cooking diaries were deployed during that phase. Cooking records were kept by participants, copied into offline Kobo forms by enumerators, and uploaded into the kobo Toolbox. Data was downloaded into an excel worksheet for analysis.

Exit Survey

Additional to the main cooking diaries, exit survey was conducted with the aim to capture qualitative data that was not easy to obtain. The exit survey focuses to understand the user experiences of electric cooking and barriers to uptake of EPCs. The collected information was analyzed using NVivo, the qualitative Data Analysis Software.

Use of TrekAMP and Stove Trace Treks

A manual energy meter was used on the EPCs, with energy use recorded in accordance with the cooking diaries methodology. In addition, all other household stoves (charcoal, LPG, three stone fire place, etc.) were outfitted with Nexleaf Stovetrace sensors to measure and monitor all

household stove use throughout the pilot. Stovetrace Trek sensors measure temperature to indicate cooking, and this additional monitoring was intended to provide another source of stove stacking and stove use in addition to the diaries information. The project also piloted the use of a new Stovetrace electric data logger - TrekAMP - to monitor electric appliance use. TrekAMP monitors amperage, thus providing an indication of electric appliance use. Unlike manual energy meters, TrekAMP logs on-time automatically, without the need for households to remember to log start and stop time. However, TrekAMP does not directly give kWh data, and rather gives on-off time from amperage. Data logger devices such as TrekAMP were used to capture and monitor the use of electric cooking appliances and Stove Trace Treks were used to monitor biomass, gas and other stoves.

Training of the Community to Support the Use of the EPC

Training on the use of EPCs was provided to the community in the project area through groups and individuals. Training involved theory and practical. A total of 256 people were trained on how to use EPC, cleaning and maintenance of EPC. EPC was displayed to the participants to show different parts including safety parts. During training participants were given the opportunity to list typical food they would like to cook using EPC. They were then divided into groups of five people and provided with EPC and food stuff based on their preference. Under supervision of the trainer, participants prepared varieties of food using EPC and then tested the food and provided feedback regarding the use of EPC and the food test. Among other challenges faced during training, it was not possible to demonstrate the use of EPC in some places due to limited time allocated by the targeted community and in some places there was no electricity supply in the venue planned for the meeting.

Assessment of appliance and Development of Mechanism for Maintenance

Assessment of Appliance

The brand promoted in the project area was SESCOM electric pressure cooker. SESCOM EPC was among the EPCs which participated in the 2020 Global LEAP Electric Pressure Cooker Competition award and emerged as a winner under medium AC Power category https://storage.googleapis.com/e4a-website-assets/2020-Global-LEAP-EPC-Buyers-Guide.pdf.

EPCs Maintenance

All people who acquired EPCs were informed on mistakes to avoid when using EPC. They were also trained on how to clean EPC, how to troubleshoot and sort out simple challenges when using it. Also through the project two technicians were trained on how to repair and maintain the EPC. The trained technicians are located within the project area and were already involved in repair and maintenance of various home appliances; EPC was just an additional item to their business. Within the project time, two EPCs got challenges with fuse. One was because of careless use and the other one was because of power fluctuation. The trained technicians were informed and the problem was fixed and the EPCs continued to work. Furthermore, knowing that with time some of the parts of EPCs will require replacement, accessories such as rubber seals, pressure release valves, floating valves, etc. SESCOM made them available in the country, including in the project area.

Stakeholder Interactions

Households were the key stakeholder in the project. Their willingness to cooperate was the determinant factor whether the project would succeed or fail. All experiments were happening in the household and they had the responsibility to record and keep the information in the notebook. Another key stakeholder was the enumerators, whenever we had committed enumerators even the quantity and quality of the data which were coming from the households were good and timely submitted.

Resistance/Opposition from Stakeholders to the Project

Five households dropped out of the study, four at baseline phase and one at transition phase. Most of the households dropped out; their main concern was on longevity of the study and tedious methods of data collection. Others provided excuses related to medical issues (expectant women) and social issues hampering their availability. Households which dropped during the baseline phase were replaced. The dropped households do not mean they disliked the technology (EPC), but as a matter of time schedules for data collection did not suit as there were several factors as mentioned before.

Testing EPC Financing Model

Various micro financing institutions (MFIs) operating at ward level to national level were approached and introduced to EPCs through demonstration. Demonstrations were followed with discussions on possibility to collaborate on EPC business. Whenever agreement reached, contract was signed between SESCOM and the financing institution. Thereafter the agreement was executed.

3.0 Main Research Findings and Lessons Learned

3.1 Overview of Data

The number of records obtained from each phase of cooking diary is shown in Table 1.

Table 1: Number of Records

Phase	Freq.	Percent
1	1,669	18.77
2	3,488	39.24
3	2,347	26.40
4	1,386	15.59
Total	8,890	100.00

The differences in number of events captured in each phase are largely attributable to differences in the duration of each phase. Diary logs in phases 1 and 4 covered periods of 41 and 52 days, respectively, while phases 2 and 3 captured 84 and 92 days of records, respectively. Consequently, raw counts of cooking events by phase are less easily interpretable than

percentages within phase. Wherever possible, we report those percentages for ease of comparison.

Table 2 shows the number and percent of reasons given for cooking (e.g. breakfast, lunch, supper, snack, etc.) across four phases of cooking diary.

Table 2: Number and Percentage of Reasons given for Cooking

		Phase				
	Reasons Given	1	2	3	4	Total
Frequency	1	1,002	2,094	2,317	912	6,325
	2	492	1,006	0	206	1,704
	3	135	347	0	34	516
	4	7	14	0	23	44
	5	1	0	0	0	1
	Total	1,637	3,461	2,317	1,175	8,590
Percent	1	61.2	60.5	100.0	77.6	73.6
	2	30.1	29.1	0.0	17.5	19.8
	3	8.3	10.0	0.0	2.9	6.0
	4	0.4	0.4	0.0	2.0	0.5
	5	0.1	0.0	0.0	0.0	0.0

It is most common for people to prepare one meal at a time, but participants frequently prepare food or heat water for a second purpose as well. This is most common practice especially when charcoal or firewood is used. There was no recorded multiple heating event in phase three where only EPC heating events were recorded. We observe fewer multiple heating events in phase four, relative to phases 1 and 2, this might be associated with EPC intervention.

Table 3: Counts and Proportions of Reasons Given for Cooking, All Phases Recording Multiple Reasons

		Phase			
	Reason Given	1	2	4	Total
Frequency	Breakfast	345	951	113	1409
	Lunch	140	196	106	442
	Supper	168	293	104	565
	Snack	72	161	28	261
	Food for Baby	109	247	77	433
	Heating Water	588	1255	178	2021
	Other	0	6	0	6
	Total	1422	3109	606	5137
Percent	Breakfast	24.3	30.6	18.6	27.4
	Lunch	9.8	6.3	17.5	8.6
	Supper	11.8	9.4	17.2	11.0
	Snack	5.1	5.2	4.6	5.1
	Food for Baby	7.7	7.9	12.7	8.4
	Heating Water	41.4	40.4	29.4	39.3
	Other	0.0	0.2	0.0	0.1

Table 3, breakfast and heating water are the most commonly reported reasons given for cooking. While trends are largely consistent from phase 1 to phase 2, phase 4 sees a decline in the relative frequency of events dedicated to both breakfast and heating water, with an increase in preparation of food for babies from 7.9% of reasons given in phase 2 to 12.7% in phase 4. Similarly, we observe an increase in logging of supper preparation from 9.4% of stated reasons in phase 2 to 17.2% in phase 4. According to exit survey, the increment might be contributed by EPC due to convenience of use in cooking.

Table 4: Number of Events (when only one reason was given)

Reason	Phase 1	2	3	4	Total
Breakfast	43	103	213	115	474
	4.29	4.92	9.19	12.61	7.49
Lunch	454	925	723	317	2,419
	45.31	44.17	31.20	34.76	38.25
Supper	401	979	975	363	2,718
	40.02	46.75	42.08	39.80	42.97
Snack	3	5	46	2	56
	0.30	0.24	1.99	0.22	0.89
Baby	1	10	11	1	23
	0.10	0.48	0.47	0.11	0.36
Water	98	72	349	112	631
	9.78	3.44	15.06	12.28	9.98
Other	2	0	0	2	4
	0.20	0.00	0.00	0.22	0.06
Total	1,002	2,094	2,317	912	6,325
	100.00	100.00	100.00	100.00	100.00

Table 4, when limiting analyses to events with only one stated reason given for cooking, supper becomes the most commonly occurring reason for heating event followed by lunch, water heating and then breakfast. This suggests that cooking breakfast is commonly paired with other daily cooking tasks (like heating water or preparing food for a baby). In Tanzania this is quite common practice to heat water for tea preparation as part of the breakfast.

Table 5: Number of People Cooked for

	Phase 1	2	3	4	Total
Number of non-missing values					
All People Served	1,567	3,440	2,317	1,158	8,482
Adults Served	1,637	3,458	0	1,180	6,275
Children Served	1,567	3,440	0	1,161	6,168
Mean					
All People Served	5.1	5.1	4.5	5.8	5.0
Adults Served	3.3	3.0	.	3.3	3.1
Children Served	1.9	2.1	.	2.5	2.1
Median					
All People Served	5	5	5	5	5
Adults Served	3	3		3	3
Children Served	2	2		2	2
Standard deviation					
All People Served	3.2	2.8	3.2	4.5	3.3
Adults Served	1.5	1.4	.	1.9	1.5
Children Served	2.7	2.4	.	4.1	2.9

Table 5 shows that more adults were cooked for than children however the number of adults, children, and total people served is consistent from phase 1 to phase 2. On average, households prepare meals for 5 people (3 adults and 2 children). Registration survey also indicated there were an average of five people per households.

Table 6: Number of People Cooked for by Type of Heating Event (Phases 1, 2, 3, and 4)

	Meals			
	Breakfast	Lunch	Supper	Total
Number of non-missing values				
All People Served	1,777	2,642	3,246	7,665
Adults Served	1,583	1,964	2,307	5,854
Children Served	1,564	1,919	2,272	5,755
Mean				
All People Served	5.2	5.5	5.0	5.2
Adults Served	3.0	3.2	3.1	3.1
Children Served	2.3	2.3	1.9	2.2
Median				
All People Served	5	5	5	5
Adults Served	3	3	3	3
Children Served	2	2	2	2
Standard deviation				
All People Served	4.1	4.1	1.8	3.3
Adults Served	1.5	1.5	1.4	1.5
Children Served	3.7	3.6	1.2	2.9

Table 6, these averages remain consistent when examining records by meal type as well. The average meal serves 3 adults and 2 children, regardless of time of day. Of potential note, though, is the difference in standard deviation in children served between breakfast/lunch (3.2/2.9) and supper (1.3). This suggests that while the average number of children served at these meals is still two, the number of children being served breakfast and lunch varies a lot more than it does for supper. This suggests that the number of people being fed at supper is more consistent than the number of people being fed breakfast or lunch. This is understandable as most of people during day time go to work and children go to school and coming back home in the evening.

Table 7: Number of People Cooked for by Type of Heating Event (Phases 1, 2, and 4 only)

	Meals			
	Breakfast	Lunch	Supper	Total
Number of non-missing values				
All People Served	1,564	1,919	2,271	5,754
Adults Served	1,583	1,964	2,307	5,854
Children Served	1,564	1,919	2,272	5,755
Mean				
All People Served	5.3	5.5	5.1	5.3
Adults Served	3.0	3.2	3.1	3.1
Children Served	2.3	2.3	1.9	2.2
Median				
All People Served	5	5	5	5
Adults Served	3	3	3	3
Children Served	2	2	2	2
Standard deviation				
All People Served	4.1	3.9	1.8	3.3
Adults Served	1.5	1.5	1.4	1.5
Children Served	3.7	3.6	1.2	2.9

Table 7 duplicates Table 6 above, but excludes phase 3, which did not distinguish between adults and children when recording the number of people served at a meal. The results are largely unchanged.

Table 8: Number of heating events per day by household (phase 1)

	Week 42					43							44							45							46							47							48	
	Day of Week					Day of Week							Day of Week							Day of Week							Day of Week							Day of Week							Day of Week	
HHID	S	M	T	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S	S	M	T	W	R	F	S	W	R
1	1																																	3	2							
2						3	2	3		4	1	3																														
4	1								1	1				2	2							1	2	1																		
6		2	2			3	3	3	2	2	3	3	2	3	3	3	1	3	2				3	3	3	2																
7	1	2	2			3	1	1	2	3	2	3	2	3	3	3	2	2	3				2																			
8	1	2	3			3	1	1	1	3	1	2	2	3	1	2	3	2	2	1			2	2	1	1																
9	2	3	2	1		3	3	3	3	3	3	3	3	3	3	2	3	3	3	2			3	3	3	3																
11																									1																	
12	1	1								2	1			1	1					1			1	1	1																	
13	1										1									2	2				2	3																
14			1					1	1	2	2			1	1								1	1	1				1					1	1	1	1	1	1	1	1	1
15		2	1											1	1					1	1	2	1	3	2																	
16	2	3	3			3	3	3	3	3	2	3	2	3	2	3	1	3	3	2			2	3	2	2																
17	1	1	2			3	2	2	2	2	3	1	3	2	3	2	2	2	1	2			2	3	2	3																
18	1	2	2			2	2	2	2	2	4	2	2	2		1	3	2	3	3			2		1	3																
19		1				1	3	2	3	2	2	4	3	3	3	3	3	3	3	3			3	3	3	3																
20		1	2			2	3	3	3	3	2	3	2	3	3	3	2	3	4	4			3	3	3	3	1	3	3		1	3	3				3					
21			1			2	1		3	3	2	4	2	3	1		2	3	2	1			2	2	1	1																
22						2	1	1	3	3	2	2			2								1	2	1	1																
23		1				1	2	3	2	1	6	2	2		3	1	2		2					1	3	2																
24	1	3	2		1		2	1	3	3	3	1	1	2	2			2	1	1			2		2																	
25		1	3			1	1	1	3	4	2	1	2	2	1	2	2	3	1	2			3	3	2	3																
26																				3	3	3		1	1		3			2	3	3	4									
27																				3	2	3	2	2	2		1			3	3	3										
28			2																	3	2	3		2	3	3	2			2	3	2	2									
29										1										3	3	3				3				6	3	3	1									
30										1										2	1	1																				
31	3	3	3			3	3	3	3	3	3	3	3	3	3	3	3	3	3				3	3	2																	
32	1	4	3			2	3	3	3	3	3	2	3	1	2	2	3	3	3				3	2	1	1																
33		3	3			3	3	2	3	3	2	3	3	3	3	3	1	2	3				3	2	1	2																
34	1	4	3			2	1	3	2	3	2	3	3	3	3	3	3	3	3				2	2	1	2																
35			2			3	3	3	3	3	3	3	2	3	3	1	2	2	2				2	2	1	1																
36	1	2	3			2	2	2	2	2	2	2	1	2	2	2	1	2	2	3	3	3	3	3	3	3	1			3	3	2	3									
37							1	2	2	2	2	1	2	2	3	2	2	1					2	3	3	2																
38		2	1			1	1	2	2	1	1	1	1	2	2	1	1	2	2		1	2	2	2	3	2																
39	2		1			2	2	3	1	2	3	3	3	3	3	2	3	3	3				2	3	3	2																
40	2	4	3			2	1	4	3	2	3	3	2	3	1	2	3	3	3																							
41						3	3	3	2	3	3	3	3	3	3	3	3	3	3				3	4	2																	
42		1	2			1	1	1			1	2		1	2	3	1	1	2		3	3	2	2						3	3	3										
43		1	1				2	2	1	1			2	3	2	1	3	2	3				3	3	2																	
44	1					2			3	1		1	2	2	1			1					3	3	2																	
45	1	3	3			3	3	2	3	3	2	4	3	2	3	2	5	3	3				3	2	3																	
46	2	1			1	3	3	3	1	2	1	2				3	3	2																								
47						1				1	1	1	1	1	1			1	1				1	1																1		
48	2	2	1			1		1	4	3	1	1	1	1	2	2		1	1	1			2	2	2	3																
49	2	1	1			6	3	4	4	2	2	1	3	2		2	1	3	2	1			1	2	1	2																

Table 8 depicts the number of heating events logged per household by date in phase 1. As is evident from the response pattern, data is more complete for some households than for others reflecting variation in heating behavior. The gaps in most cases happened when the main cook travelled away or was unable to cook due to health related issues, social issues, etc. In total, though, phase 1 contains fairly consistent data for the first four weeks of phase 1, with few households logging data into the 5th, 6th, and 7th weeks of data collection during that phase.

3.2 Energy Consumptions

Registration survey revealed that households had a wide range of pre-existing fuel and stove use, with some households using only biomass options before the introduction of the EPC, while other households already had multiple modern energy options, including multi-burner LPG and other electric appliances (electric kettles, hot plates, and microwaves).

Over the course of the pilot, the choice of fuels changed dramatically across the entire group of households, with cooking on electric stoves increasingly dramatically alongside a reduction in the use of charcoal. As demonstrated in Figure 1, there is a substantial increase in use of electricity for cooking between phase 1 (pre-EPC) to phase 2 (post EPC introduction) from 3% of fuel choice

to 39%. Concurrently, there is a reduction in choice of charcoal, from 76% to 46%. These trends persisted into phase 4. Interestingly, use of LPG increased slightly in phase 2 and persisting into phase 4 as well.

Figure 1: Fuel choice by phase

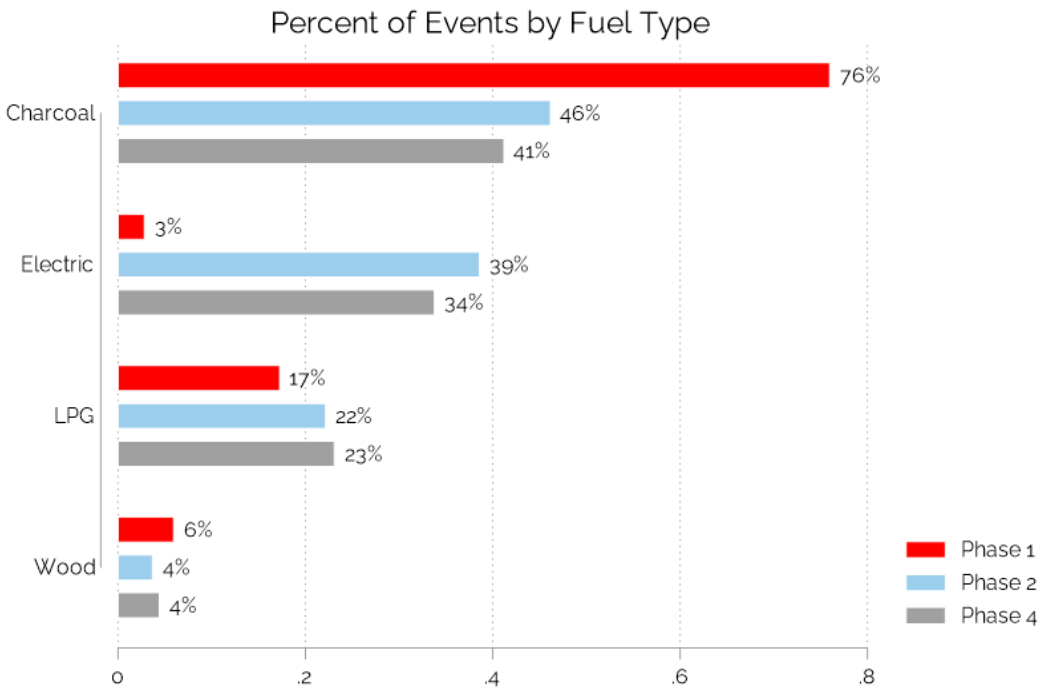


Table 9 shows the number of times different fuels were used to cook a meal by phase, including cases where multiple fuels were used for one meal. Single fuel use is the most common cooking behavior, with charcoal dominating use in phase 1 (with 73% of events using charcoal only) and LPG constituting an additional 14%. Electricity made of roughly a quarter of single-fuel events in both phases 2 and 4, up from only 2.4% of events before the introduction of EPCs. Single-fuel meals remained the most common throughout all phases, although fuel stacking (using more than one fuel type within a single meal) with electricity became more common with the introduction of the EPCs. Charcoal-electric stacks made up 6.44% of events in phase 2 and LPG/Electric made up an additional 3.8%. Trends were largely consistent into phase 4 , with even more increases in electric/LPG stacks, which doubles from phase 2 to phase 4.Overall, while fuel stacking within a given meal remains much less common than single-fuel meals, the EPCs do appear to bring about more stacking with electricity, including combinations with other modern energy (LPG).

Stacking patterns may differ when analyzed by day rather than by meal, and further analysis defining stacking by day rather than by meal would be worthwhile to assess whether overall diversity of fuel is consistent day to day (e.g. a "stack" of charcoal, electricity, and LPG throughout the day) or if fuel choice changes day to day, perhaps in line with fuel availability, price, or other factors.

Table 9: Fuel Stacks, Frequency and percentage

	Phase			
Stacking Behaviors	1	2	4	Total
Charcoal	1,207 73.73	1,367 39.50	502 40.10	3,076 48.44
LPG	231 14.11	624 18.03	220 17.57	1,075 16.93
Wood	94 5.74	107 3.09	48 3.83	249 3.92
Electric	40 2.44	971 28.06	314 25.08	1,325 20.87
Charcoal/Electric	4 0.24	223 6.44	55 4.39	282 4.44
Charcoal/LPG	53 3.24	14 0.40	5 0.40	72 1.13
Electric/LPG	3 0.18	132 3.81	95 7.59	230 3.62
Electric/Wood	0 0.00	16 0.46	4 0.32	20 0.31
Charcoal/Wood	4 0.24	2 0.06	9 0.72	15 0.24
Charcoal/Electric/Woo	0 0.00	2 0.06	0 0.00	2 0.03
Charcoal/Electric/LPG	0 0.00	2 0.06	0 0.00	2 0.03
LPG/Wood	1 0.06	1 0.03	0 0.00	2 0.03
Total	1,637 100.00	3,461 100.00	1,252 100.00	6,350 100.00

These findings on fuel choice and stacking behavior are aggregated across the entire group of participants. Further analysis could be valuable in showing the range of electric cooking adoption across the group. It is possible, for instance, that increases in electric cooking and electric stacks are happening disproportionately in some households more than others, or that some households represent "super adopters" while others have little to no use on their EPCs. Some such segmentation of households was investigated using the Stovetrace data, including whether

there were differences in stove stacking according to different fuel/stove type profiles. We theorized that households who already had access to electrical appliances and modern fuels might use their EPCs more or less than households who began the pilot with only charcoal and three stone fire place (3SF). The Stovetrace data showed that EPC usage was similar throughout the pilot among households who already had an electric appliance vs. those who did not, suggesting that previous experience with electricity may not be a large factor in EPC adoption. Households who already had electric appliances were different in their cooking habits in terms of LPG and charcoal, however households with electric appliances cooked more on LPG stoves and less on charcoal, suggesting some overall propensity for modern fuels among those with multiple modern options available. Figure 2, 3 and 4 below show daily cooking times on EPCs, LPG, and Charcoal divided by user type (households with biomass and LPG, households with biomass only, and households with other electric appliances).

Figure 2: Daily Minutes of Cooking using EPC

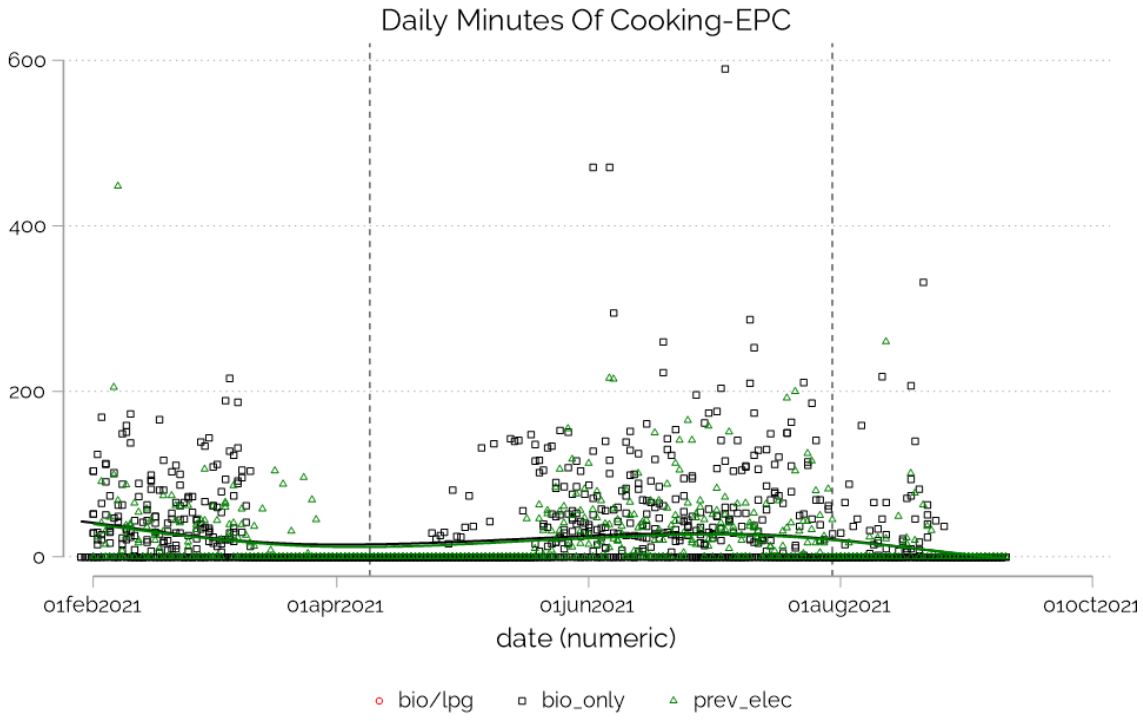


Figure 3: Daily Minutes of Cooking using Charcoal

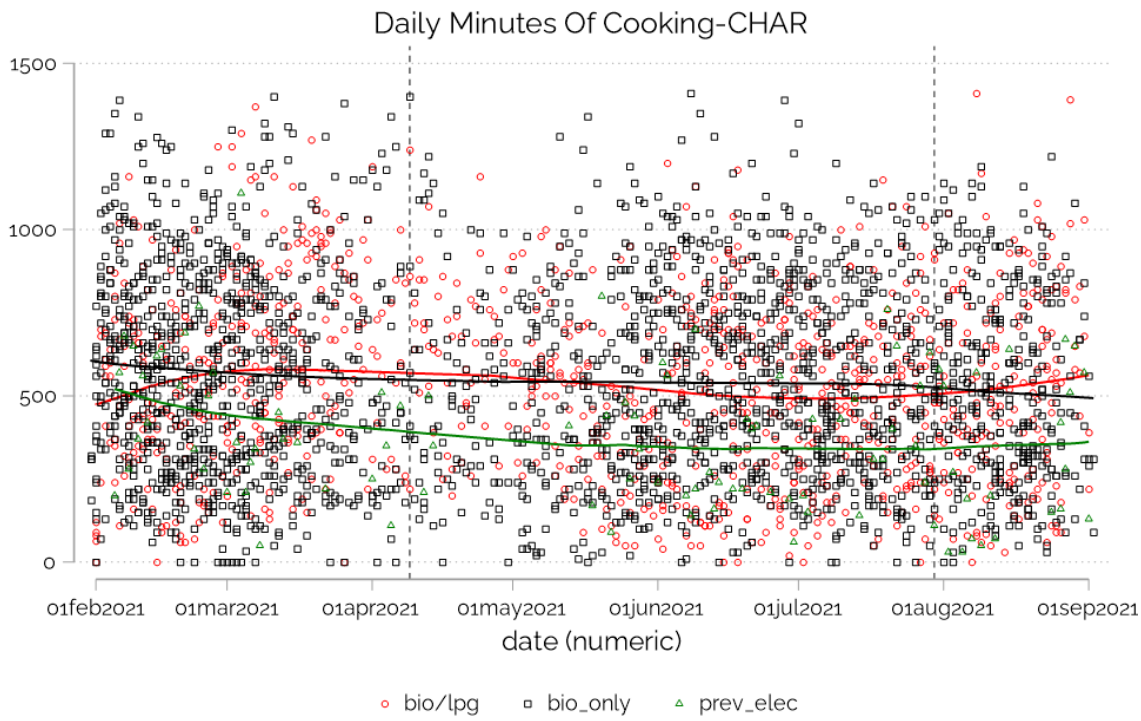
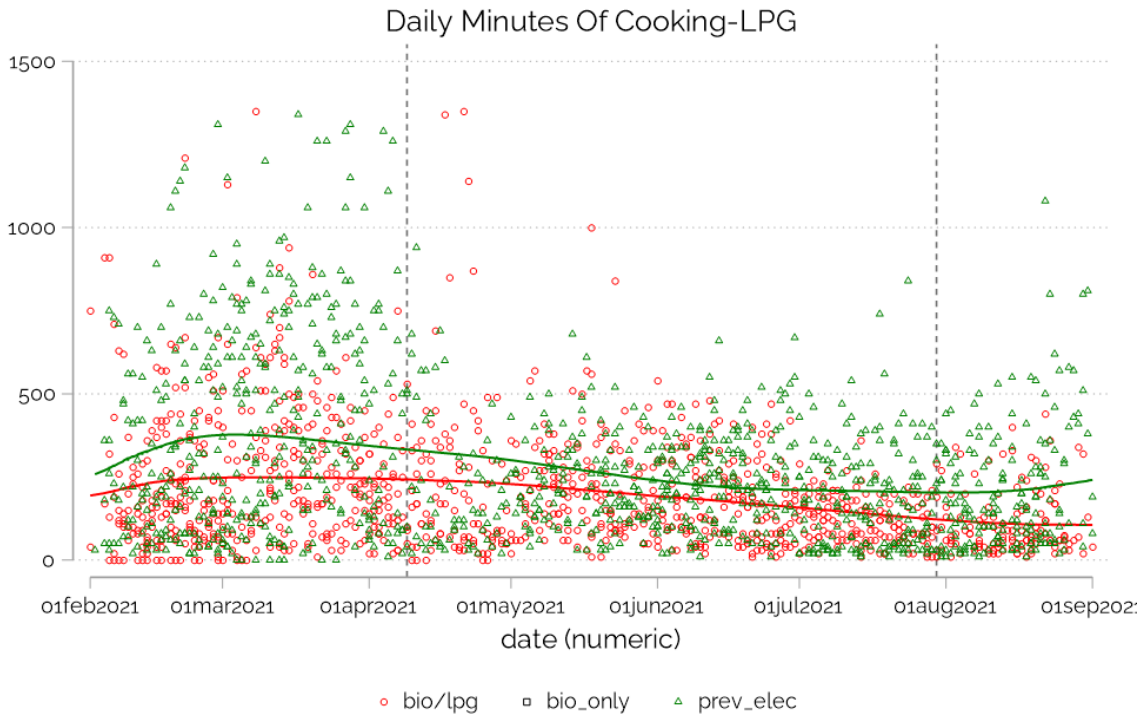


Figure 4: Daily Minutes of Cooking using LPG



3.3 Per capita Energy Consumptions

In non-stacking events, wood and charcoal use consumed the highest amount of energy per capita. Table 10 and 11, totals indicate that cooking with charcoal uses at least more than 20 times as much energy as cooking with electricity. The introduction of EPC saw a decrease in per capita energy consumption per person served for all non-electric fuels from phase 1 to phase 2, but we observe a subsequent increase in both metrics as we move from phase 2 to phase 4. One possible explanation for these trends could be tied to the increase in number of people served in single fuel events. Wood, in particular, is associated with meals serving large numbers of people (an average of 9.1 per meal in phase 1 and 12.6 in phase 2). It is possible that while EPCs supplanted wood and charcoal use for typical daily meals, they are less likely to be used to cook the sorts of meals commonly associated with large gatherings and/or long cooking times. The number of people served may have changed over the course of the project, or reporting of number of people served may also have become less exact over time.

Table 10: Energy Consumption per Capita in single-fuel events by Fuel Type

	Phase 1	2	4	Total
Fuel Type				
Charcoal				
Calorific Value (single fuel events)	33.49	31.79	47.64	35.04
All People Served	5.03	5.23	5.48	5.19
Calorific Value/Person Served	7.44	6.97	8.62	7.42
LPG				
Calorific Value (single fuel events)	9.22	7.24	7.40	7.70
All People Served	4.14	4.42	4.49	4.37
Calorific Value/Person Served	2.37	1.81	1.60	1.89
Wood				
Calorific Value (single fuel events)	35.39	32.89	26.02	32.50
All People Served	9.09	8.60	12.62	9.55
Calorific Value/Person Served	5.16	4.92	4.32	4.89
Electric				
Calorific Value (single fuel events)	2.02	1.48	1.62	1.52
All People Served	4.08	4.56	5.22	4.68
Calorific Value/Person Served	0.51	0.37	0.34	0.37
Total				
Calorific Value (single fuel events)	29.25	17.25	26.27	22.22
All People Served	5.11	4.97	5.54	5.11
Calorific Value/Person Served	6.35	3.77	4.77	4.65

Table 11: Energy Consumption Per Capita (by household)

	Fuel Type																			
	Charcoal Phase				LPG Phase				Wood Phase				Electric Phase				Total Phase			
	1	2	4	Total	1	2	4	Total	1	2	4	Total	1	2	4	Total	1	2	4	Total
HHID																				
1	5.71			5.71		1.16	1.50	1.30						0.91	0.32	0.87	5.71	1.09	1.45	1.41
2	5.11	8.03		5.72					54.62			54.62		0.57		0.57	8.20	1.19		2.95
3					1.61	.	1.61							0.61	1.08	0.63		0.63	1.08	0.65
4	5.86	9.87	37.08	10.16	2.53	3.42		3.37						0.33	0.60	0.39	5.55	6.47	15.19	6.88
5		11.37		11.37		3.43		3.43						0.47	0.24	0.41		7.65	0.24	7.32
6	8.04	13.04		10.24			2.31	2.31						0.41	0.60	0.45	8.04	10.31	2.11	7.74
7	12.56			12.56	1.71	5.29		3.03						0.46	0.40	0.46	3.30	2.17	0.40	2.54
8	8.35	7.90	9.06	8.30			5.44	5.44						0.26		0.26	8.35	5.42	8.15	7.08
9	8.24	10.29	6.21	8.09	1.55	2.52	1.41	1.90						0.38	0.23	0.28	4.06	2.74	1.83	3.08
10		8.86	6.71	8.60		0.66	1.63	0.81		5.41		5.41						5.27	4.17	5.13
11	4.19	4.51	6.10	4.61										0.22	0.00	0.17	4.19	4.35	5.23	4.42
12	7.51	4.52		5.62										0.24	0.20	0.23	7.51	1.72	0.20	2.15
13	6.68	3.87		4.37									1.57	0.30	0.20	0.41	3.89	1.60	0.20	1.68
14	9.51	7.74	10.13	8.67	1.72			1.72					0.08			0.08	5.54	7.74	10.13	7.81
15	5.24	5.17		5.22										0.45	0.39	0.44	5.24	1.32	0.39	1.99
16	4.95	5.06	4.69	4.90	0.80			0.80	3.80			3.80		0.38	0.32	0.38	3.66	2.10	4.05	3.01
17	4.52	2.65	3.60	3.46					1.51			1.51		0.25	0.24	0.25	4.46	2.23	3.09	3.06
18	4.96	3.31	3.36	3.86										0.16	0.25	0.20	4.96	2.61	2.32	3.16
19	5.38	5.47	4.25	5.02		0.97		0.97						0.20	0.24	0.21	5.38	2.72	3.77	3.78
20	6.39			6.39	0.95	0.87	0.60	0.81	3.65			3.65	0.10	0.26	0.25	0.22	3.54	0.70	0.48	1.71
21	3.65	4.44		4.18										0.16		0.16	3.65	4.21		4.03
22	4.91			4.91	8.56	3.12		4.42					0.55	0.47		0.50	2.99	1.75		2.22
23	6.70	20.02	17.55	12.05		3.43		3.43						0.31	0.54	0.34	6.70	6.58	11.88	7.03
24	10.49	3.52		9.91										0.41	0.60	0.41	10.49	0.56	0.60	3.98
25	6.56	6.40	6.21	6.44	1.76	0.63	0.72	0.94						0.21		0.21	3.05	1.40	1.47	1.79
26	2.95	7.38	4.31	5.77	1.06	5.40		1.93						0.36	0.24	0.35	1.82	4.85	4.07	4.14
27	5.49	4.23	5.09	5.02	0.98	1.13		1.10	10.30			10.30		0.16	0.14	0.15	5.23	1.08	2.26	2.14
28		5.14	9.33	5.98					2.88	2.82	3.21	2.93		0.09	0.09	0.09	2.88	2.91	3.31	3.00
29	10.12	4.19	277.61	69.24	1.99			1.99						0.28		0.28	7.55	0.49	277.61	30.80
30	16.40	8.06		10.38			0.31	0.31						0.14	0.35	0.33	16.40	7.50	0.33	5.35
31	6.66			6.66	4.53	1.23	2.56	1.95						0.18	0.20	0.19	6.40	1.19	2.25	3.32
32	5.77	5.46	5.94	5.71										0.33	0.26	0.31	5.77	4.16	4.78	4.85
33	5.49	4.60	10.73	6.24					3.23	0.88	6.54	4.11		0.22		0.22	4.95	3.83	8.88	5.61
34	4.63	3.11	2.66	3.52										0.12	0.15	0.14	4.63	3.00	2.54	3.43
35	16.41	5.39	7.09	10.38										0.40	0.27	0.38	16.41	3.79	6.57	8.83
36	8.07			8.07	5.77	3.02	1.49	3.11					0.10	0.23	0.16	0.17	7.22	2.88	0.97	4.10
37	5.81	7.10		6.41										0.28		0.28	5.81	4.25		4.88
38	7.70	4.22	2.75	4.88	0.00			0.00						0.29	0.20	0.24	7.30	3.24	0.88	3.29
39	6.14	6.46		6.35										0.33	0.38	0.36	6.14	4.83	0.38	3.90
40	6.89	5.57	6.22	6.03										0.09		0.09	6.89	5.51	6.22	5.99
41	13.02	9.61	.	11.02	2.72	1.55	.	2.46						0.23	.	0.23	7.77	4.49	.	5.76
42	9.32			9.32	3.98	1.37		2.01					0.31	0.26		0.27	5.64	0.81		2.29
43	6.14	7.97	3.29	5.49		1.28	0.00	1.09						0.21	0.75	0.37	6.14	0.97	1.68	2.40
44	6.94	9.69	3.64	7.55		1.79		1.79						0.26	0.75	0.44	6.94	5.31	2.20	4.76
45	7.82	8.24	2.79	7.12					6.59	10.72	3.76	8.25		0.18	1.44	0.22	7.07	6.22	2.99	6.26
46	8.79	6.61	10.86	7.78	12.88	1.88		2.60						0.27		0.27	9.33	3.75	10.86	5.32
47	11.51	8.00		9.50										0.20		0.20	11.51	4.36		6.40
48	8.43	16.88	22.04	15.34										0.42		0.42	8.43	16.32	22.04	15.08
49	13.31	9.12		10.73													13.31	9.12		10.73
50		7.47		7.47		3.80		3.80						0.79		0.79		1.07		1.07
Total	7.44	6.97	8.62	7.42	2.37	1.81	1.60	1.89	5.16	4.92	4.32	4.89	0.51	0.37	0.34	0.37	6.35	3.77	4.77	4.65

3.4 Meals Cooked

Table 12 shows that the most common dishes cooked remained largely consistent across phases, with shifts in phase 3 being attributable to the differences in data collection during that phase. Unsurprisingly, Beans, leafy vegetables, rice, and ugali are the most commonly cooked dishes in this sample. Across phases 1 to 3 we also observe increased trends for cooking some of the common meals such as beans, makande (cooked beans and maize/corn) and rice while trend for cooking ugali declined. In addition to responses from exit survey, introduction of EPC did not cause households to change meal from what they were used to instead increased or reduced

frequencies of cooking some food. This suggests that EPC was compatible with households' menus.

Table 12: Dishes Cooked (Percent of Total Dishes per Phase)

dish	Phase 1	2	3	4
Bananas (hard)	2.13	2.82	3.30	2.12
Beans	10.45	10.63	14.13	11.11
Beef/Goat	7.41	7.32	8.18	6.97
Boiled potatoes	0.98	0.98	2.44	0.60
Cassava leaves	0.91	1.70	0.51	0.65
Chapati	1.75	1.89	0.05	1.36
Chips	0.52	0.56		0.71
Dagaa (dried)	3.53	3.20	0.97	3.92
Dagaa (fresh)	0.07	0.19	0.05	
Duck/chicken stew	1.26	1.06	2.29	0.98
Eggs	0.80	1.11	0.76	0.93
Fish stew (boiled)	3.74	4.59	1.37	3.87
Fried cassava	0.07	0.28	0.41	0.22
Fried fish	0.56	0.43	0.10	0.16
Fried potatoes	1.08	0.46	0.30	0.49
Leafy veg	12.06	9.41	3.35	8.39
Maandazi	0.17	0.24		0.05
Makande	1.15	2.17	3.51	3.27
Matoke	2.13	1.20	1.63	1.20
Mlenda	0.63	1.11	0.20	0.49
Okra	0.77	0.30	0.05	0.22
Other	3.43	2.56	3.46	2.83
Pasta	0.77	1.37	0.86	1.09
Peas	0.98	1.17	1.52	1.42
Pilau	1.15	1.61	1.12	2.89
Porridge	6.54	6.33	1.27	5.50
Rice	14.65	16.32	35.92	17.86
Sweet potatoes/cassava/taro root	1.01	2.19	6.81	3.32
Ugali	19.29	16.82	5.44	17.37

Table 13 shows the relative frequency of dishes by the meal in which they are prepared. Porridge, rice, sweet potatoes, and chapati are the most common dishes prepared for breakfast, while

ugali, leafy vegetables, beans and beef/goat are most consistently prepared for lunch and supper (with rice also commonly being prepared for supper as well).

Table 13: Dishes Cooked by Meal, phases 1, 2, and 4 (percent of each meal events reporting that dish being prepared)

Dish	Meals		
	Breakfast	Lunch	Supper
Bananas (hard)	4.35	1.29	3.00
Beans	5.89	11.36	12.02
Beef/Goat	3.07	7.96	8.45
Boiled potatoes	3.07	0.28	0.75
Cassava leaves	0.58	1.57	1.30
Chapati	7.30	0.19	0.95
Chips	1.09	0.12	0.85
Dagaa (dried)	0.06	6.03	2.20
Dagaa (fresh)		0.26	0.02
Duck/chicken stew	0.26	1.17	1.37
Eggs	3.20	0.42	0.55
Fish stew (boiled)	1.02	4.65	5.02
Fried cassava	1.15	0.02	
Fried fish	0.13	0.47	0.45
Fried potatoes	0.45	0.21	1.12
Leafy veg	1.15	15.86	7.75
Maandazi	0.64	0.07	0.05
Makande	1.54	1.78	2.52
Matoke	2.05	0.89	1.90
Mlenda		1.78	0.27
Okra	0.06	0.84	0.12
Other	5.83	1.97	2.30
Pasta	0.96	0.33	2.15
Peas	0.26	0.96	1.80
Pilau	0.77	1.57	2.27
Porridge	32.14	0.77	1.15
Rice	13.44	5.30	28.46
Sweet potatoes/cassava/taro root	8.83	0.28	0.70
Ugali	0.70	31.57	10.49

Table 14, there are no major changes in relative frequency of different meals across phases (with the exception of phase 3, which only recorded one dish per cooking event). Here we observe rice

stand out as a common food preferred for supper whereas ugali is much more preferred for lunch and this seem to be consistent across phase 1, 2 and 4. Comparing the proportions for rice preparation for supper across meal and phases, we observe sharp increase in phase 3 from 29.35 to 61.74 whereas we observe sharp decrease for ugali preparation for lunch in phase 3 to 11.07 from 30.94 in phase 2.

Table 14: Dishes Cooked by Meal and Phase (Proportions)

	Meals and Phase											
	Breakfast				Lunch				Supper			
Dish	1	2	3	4	1	2	3	4	1	2	3	4
Bananas (hard)	5.24	3.66	7.51	5.88	1.08	1.63	2.77	0.57	2.18	3.56	2.87	2.63
Beans	4.99	5.75	2.35	8.33	10.14	11.71	26.97	12.48	13.35	11.85	7.90	10.75
Beef/Goat	3.49	3.03	1.88	2.45	8.13	7.97	14.80	7.60	8.52	8.53	5.13	8.12
Boiled potatoes	3.49	3.03	10.33	2.45	0.15	0.31	0.69	0.43	1.14	0.81	1.95	0.12
Cassava leaves	0.75	0.63	0.47		0.93	2.20	1.11	0.72	0.95	1.66	0.10	0.84
Chapati	5.99	7.63		8.33	0.31	0.13	0.14	0.14	1.14	1.00		0.60
Chips	1.75	0.84		0.98	0.08	0.13		0.14	0.57	0.85		1.19
Dagaa (dried)		0.10			5.80	5.77	2.21	7.32	2.46	1.94	0.31	2.51
Dagaa (fresh)					0.15	0.40	0.14			0.05		
Duck/chicken stew	0.25	0.31			1.39	1.06	1.66	1.15	1.52	1.42	3.38	1.08
Eggs	2.24	3.55	6.10	3.43	0.31	0.53	0.14	0.29	0.47	0.52		0.72
Fish stew (boiled)	1.00	1.15	0.94	0.49	3.95	5.06	2.07	4.59	4.45	5.64	0.92	4.18
Fried cassava	0.25	1.46	3.76	1.47		0.04						
Fried fish	0.25	0.10			0.62	0.44	0.14	0.29	0.66	0.47	0.10	0.12
Fried potatoes	0.50	0.31	0.47	0.98	0.15	0.18	0.41	0.43	2.27	0.85	0.21	0.36
Leafy veg	0.25	1.46	0.47	1.47	18.96	15.23	6.36	12.20	9.19	6.97	1.95	7.89
Maandazi	0.25	0.84		0.49	0.15	0.04			0.19			
Makande	1.25	1.67	2.35	1.47	0.77	1.80	6.09	3.59	1.52	2.84	1.95	2.99
Matoke	3.49	1.88	0.94		0.77	0.92	1.66	1.00	3.50	1.23	1.64	1.55
Mlenda					1.32	2.29	0.55	1.00	0.09	0.38		0.24
Okra	0.25				1.39	0.62	0.14	0.57	0.28	0.09		
Other	7.73	5.33	6.10	4.41	2.40	1.72	3.60	2.01	2.37	1.90	2.15	3.23
Pasta	0.25	1.46	1.41		0.15	0.44	0.14	0.29	1.80	2.32	1.33	2.15
Peas	0.25	0.21		0.49	0.77	1.06	2.07	1.00	1.61	1.75	1.54	2.15
Pilau	0.25	0.73	0.94	1.96	1.63	1.14	2.21	2.87	0.85	2.56	0.41	3.35
Porridge	37.66	30.51	7.51	28.92	1.08	0.62		0.72	0.38	1.38	0.10	1.55
Rice	13.72	13.58	9.39	12.25	4.49	5.37	11.34	6.60	26.61	29.35	61.74	28.55
Sweet potatoes/cassava/taro root	3.99	9.93	37.09	13.24	0.23	0.26	1.52	0.43	0.09	0.71	1.54	1.43
Ugali	0.50	0.84		0.49	32.66	30.94	11.07	31.56	11.84	9.34	2.77	11.71

Table 15: Number of Dishes per meal (percent of events by phase)

	Phase			
	1	2	4	Total
Meals				
Breakfast				
dishcount=0	24.58	29.71	22.05	27.61
dishcount=1	43.02	50.29	55.90	49.34
dishcount=2	25.98	16.60	17.44	18.83
dishcount=3	5.59	3.20	4.62	3.92
dishcount=4	0.84	0.19	0.00	0.32
dishcount=5	0.00	0.00	0.00	0.00
watercount=0	11.45	11.07	25.13	12.89
watercount=1	68.16	63.01	45.64	62.03
watercount=2	20.39	25.92	29.23	25.08
Lunch				
dishcount=0	0.18	0.19	0.00	0.15
dishcount=1	11.31	20.44	21.71	18.08
dishcount=2	47.94	47.68	58.00	49.59
dishcount=3	36.27	27.81	19.71	28.77
dishcount=4	3.95	3.22	0.57	2.95
dishcount=5	0.36	0.66	0.00	0.46
watercount=0	80.97	88.46	89.43	86.51
watercount=1	16.16	9.74	9.14	11.46
watercount=2	2.87	1.80	1.43	2.04
Supper				
dishcount=0	1.23	1.65	0.64	1.34
dishcount=1	27.59	41.98	40.69	38.17
dishcount=2	55.18	45.99	44.97	48.05
dishcount=3	14.06	9.20	7.07	9.97
dishcount=4	1.58	0.86	3.64	1.60
dishcount=5	0.35	0.31	3.00	0.87
watercount=0	72.58	79.48	78.80	77.64
watercount=1	26.01	17.61	13.06	18.76
watercount=2	1.41	2.91	8.14	3.60
Total				
dishcount=0	6.47	9.79	4.55	8.04
dishcount=1	25.20	37.75	37.06	34.45
dishcount=2	45.42	37.51	44.17	40.67
dishcount=3	20.35	13.22	10.97	14.64
dishcount=4	2.29	1.40	1.88	1.71
dishcount=5	0.27	0.33	1.38	0.50
watercount=0	60.98	61.33	72.13	63.11
watercount=1	32.48	29.06	17.98	28.01
watercount=2	6.54	9.62	9.88	8.88

Table 15, following introduction of EPCs, we see fewer multiple-dish meals at breakfast and supper and more at lunch, suggesting shifts in the times of day during which households did additional cooking. Overall, it is much more likely for households to heat water while preparing breakfast than it is during lunch or supper (although we observe a decrease in water heating during breakfast from 89 percent of breakfast events in phases 1 and 2 to 75 percent of breakfast events in phase 4).

Table 16, there were few changes in the relative proportions of dishes cooked across phases using charcoal stoves. EPC dish preparation did not change much from phase 2 to phase 4 following its introduction. We observe some shifts in phase 3, but those are likely attributable to the different data collection strategy deployed during that phase. We also observe consistence and increase use of electricity in cooking some of the heavy dishes such as beans and makande and the other food such as rice and pilau across phase 2, 3 and 4

Overall, wood stoves were used in fewer dishes in phase 4 than in earlier stages. As such, the relative proportion of dishes cooked using wood like beans, dagaa, pilau, porridge, and rice increased. Given the relative stability of wood's use in cooking events overall, this appears to suggest outsourcing of dishes like bananas, meat, potatoes, and vegetables to other means of cooking, rather than an increase in use for the aforementioned dishes. The most notable shifts in LPG preparation are reflected in an increase in ugali from 17 percent of LPG dishes in phase 1 to 24 percent in phase 2, and a relative decrease of about 50 percent in porridge and rice as a share of dishes prepared using LPG.

Table 16: Percentage of Cooking Events in which Dishes are prepared (by Fuel Type and Phase)

	Fuel Type and Phase															
	Charcoal				Electric				Wood				LPG			
Dish	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Bananas (hard)	2.24	1.49		1.79		5.61	3.30	4.25	4.70	1.35			0.75	1.79		0.74
Beans	11.09	9.85		11.52		14.23	14.13	14.23	10.74	9.46		14.04	7.46	7.14		6.45
Beef/Goat	7.96	6.02		6.38		9.65	8.18	7.86	2.68	3.38			6.72	7.14		8.19
Boiled potatoes	1.01	0.82		0.22		1.69	2.44	1.49	0.67				1.00	0.40		0.50
Cassava leaves	1.01	2.38		1.01		0.66	0.51			1.35			0.50	1.79		0.74
Chapati	1.89	2.74		2.01			0.05			2.70			1.00	2.28		1.74
Chips	0.31	0.55		0.45									1.99	1.49		2.23
Dagaa (dried)	3.61	4.46		5.37		0.90	0.97	1.27	6.71	3.38		7.02	2.24	3.87		3.47
Dagaa (fresh)	0.09	0.27					0.05							0.30		
Duck/chicken stew	1.23	0.90		1.01		1.09	2.29	0.42					1.99	1.59		1.74
Eggs	0.62	0.78		0.34		0.90	0.76	0.85		1.35			2.24	2.08		2.48
Fish stew (boiled)	3.92	5.20		4.03		3.02	1.37	2.12	2.68	7.43		1.75	2.99	5.06		5.46
Fried cassava	0.09	0.39		0.22		0.06	0.41			1.35		1.75		0.20		0.25
Fried fish	0.35	0.51		0.22		0.12	0.10						1.99	0.60		0.25
Fried potatoes	1.01	0.47		0.11		0.12	0.30	0.64					1.99	1.09		1.24
Leafy veg	12.41	10.95		9.51		4.64	3.35	2.55	10.74	4.73		3.51	11.19	14.19		13.65
Maandazi	0.22	0.43		0.11										0.20		
Makande	1.06	0.78		2.13		5.55	3.51	8.49	4.70	1.35		1.75	0.50	0.30		
Matoke	2.24	0.63		0.45		2.59	1.63	2.97					2.49	0.60		0.74
Mlenda	0.57	1.41		0.56		0.06	0.20		0.67	5.41			1.00	1.49		0.99
Okra	0.57	0.47		0.22		0.18	0.05	0.42	4.70				0.50	0.10		
Other	2.64	3.13		1.45		2.05	3.46	2.97	2.68	1.35		7.02	6.72	1.88		5.21
Pasta	0.66	1.09		0.78		1.99	0.86	1.70	0.67				1.49	1.29		1.24
Peas	1.10	1.21		0.45		1.51	1.52	3.40					0.75	0.69		1.49
Pilau	1.19	1.64		2.46		1.45	1.12	4.03	1.34	1.35		7.02	1.00	1.88		1.99
Porridge	5.10	5.36		6.94		4.70	1.27	1.06	12.08	6.76		15.79	12.44	11.61		6.20
Rice	15.05	14.46		16.22	100.00	26.18	35.92	29.94	12.75	13.51		21.05	10.45	5.36		5.71
Sweet potatoes/cassava/taro root	1.06	1.56		3.47		3.44	6.81	3.82		6.08			1.24	1.09		2.98
Ugali	19.71	20.05		20.58		7.60	5.44	5.52	21.48	27.70		19.30	17.41	22.52		24.32

3.5 Reheating Food

Table 17: Fresh or Reheated by event and phase (frequencies)

	Phase		
	1	2	4
Meals			
Breakfast			
(sum) freshcount	**317**	**742**	**180**
(sum) partcount	**1**	**7**	**1**
(sum) reheatcount	**94**	**218**	**22**
Lunch			
(sum) freshcount	**1153**	**2054**	**645**
(sum) partcount	**59**	**103**	**35**
(sum) reheatcount	**90**	**118**	**17**
Supper			
(sum) freshcount	**817**	**1815**	**734**
(sum) partcount	**74**	**87**	**32**
(sum) reheatcount	**180**	**218**	**80**

As can be seen in Table 17, regardless of meal, dishes are much more likely to be prepared fresh than reheated. See subsequent tables for further discussion of the trends in fresh/reheated dishes by meal and phase.

Table 18: Percent of Meal Occurrences Prepared Fresh or Reheated by Phase and Heating Event

	Phase and Meals								
	1			2			4		
fresh	Breakfast	Lunch	Supper	Breakfast	Lunch	Supper	Breakfast	Lunch	Supper
Fresh	76.94	88.56	76.28	76.73	90.29	85.61	88.67	92.54	86.76
Partially precooked	0.24	4.53	6.91	0.72	4.53	4.10	0.49	5.02	3.78
Reheated	22.82	6.91	16.81	22.54	5.19	10.28	10.84	2.44	9.46

Table 18, we generally observe increases in fresh meal preparation across phases and heating event and the opposite is true from reheated/partially precooked meals. This might be attributed by introduction of EPC as also supported by responses from exit survey where household perceived that cooking using EPC is faster and affordable hence eliminating the need for precooking food for later use. This may lead to improved diet and health and possibly lower energy consumption from refrigeration (although the refrigeration point needs to be verified in terms of behaviour dynamics (switching on/off or constantly on) and energy consumption).

Table 19: Percentage of Fresh Prepared or Reheated Dishes (sorted from most to least commonly prepared fresh)

	Fresh	Partial	Reheated
Eggs	100.0	0.0	0.0
Fried cassava	100.0	0.0	0.0
Maandazi	100.0	0.0	0.0
Dagaa (fresh)	100.0	0.0	0.0
Porridge	99.7	0.0	0.3
Ugali	99.7	0.1	0.3
Chapati	99.4	0.0	0.6
Fried potatoes	98.5	0.0	1.5
Chips	98.3	0.0	1.8
Sweet potatoes/cass..	96.6	0.5	2.9
Mlenda	95.4	0.0	4.6
Okra	95.2	0.0	4.8
Pasta	93.0	0.0	7.0
Leafy veg	92.5	0.4	7.1
Dagaa (dried)	90.4	1.7	7.8
Boiled potatoes	90.2	0.0	9.8
Matoke	88.4	1.4	10.2
Fried fish	87.5	7.5	5.0
Bananas (hard)	86.9	2.0	11.2
Rice	85.5	0.1	14.5
Other	84.2	5.4	10.4
Peas	83.8	6.8	9.4
Pilau	82.7	0.6	16.8
Duck/chicken stew	73.0	9.9	17.1
Makande	71.9	8.6	19.5
Beef/Goat	70.5	13.3	16.3
Cassava leaves	65.9	11.6	22.5
Fish stew (boiled)	65.4	13.4	21.2
Beans	57.7	14.5	27.8
Total	85.24	3.99	10.77

As can be seen from Table 19, there are a number of dishes which are never reheated (such as eggs, cassava, mandazi, and fresh dagaa). The most commonly fresh prepared dishes (e.g. porridge, ugali, chapati) are similarly very rarely reheated. Reheating behavior is much less common overall than preparing dishes fresh. Conversely, fish stew, beans, cassava leaves, and meat dishes are much more likely to be reheated than others, although the relative proportion being reheated is low, with the most commonly reheated dish only being reheated 28% of the time.

Table 20, dishes like rice and ugali are much more likely to be prepared fresh each meal, while beans and meat dishes are more likely to be reheated (relative to those other dishes).

Table 20: Dishes Prepared Fresh or reheated (limited to top three of each)

	fresh			
	Fresh	Partially precooked	Reheated	Total
Dish				
Beans	**621**	**156**	**299**	**1,076**
Beef/Goat	**515**	**97**	**119**	**731**
Fish stew (boiled)	**274**	**56**	**89**	**419**
Leafy veg	**928**	**4**	**71**	**1,003**
Rice	**1,371**	**1**	**232**	**1,604**
Ugali	**1,770**	**1**	**5**	**1,776**
Total	**5,479**	**315**	**815**	**6,609**

As per Table 21, ugali, rice, and leafy vegetables are the most commonly prepared fresh dishes. By contrast, neither ugali nor leafy vegetables are commonly reheated. Rice, though, makes up one fifth of reheated dishes across phases, second only to beans in terms of frequency. Beans join meat dishes as the most common dishes to be partially reheated, although phase 4 saw beans make up more than half of partial reheating events, while beef/goat dipped form 34% of reheating events in phase 1 to 12% in phase 4. A more direct comparison of the frequencies of these commonly cooked dishes can be found in Table 22.

Table 21: Dishes Most Commonly Prepared Fresh or Reheated by Phase (dish commonality, percent)

	Fresh, Partially Precooked, or Reheated and Phase								
	Fresh			Partial			Reheated		
Dish	1	2	4	1	2	4	1	2	4
Bananas (hard)	2.04	2.90	2.28	0.74	1.53	1.45	3.35	2.51	0.75
Beans	5.78	7.75	8.01	38.52	35.20	50.72	29.12	26.34	29.32
Beef/Goat	4.91	6.28	6.91	34.07	21.94	11.59	13.66	10.39	6.02
Boiled potatoes	0.96	1.08	0.68				1.55	0.54	
Cassava leaves	0.65	1.32	0.55	2.96	5.61		1.55	3.58	2.26
Chapati	2.04	2.08	1.48					0.18	
Chips	0.61	0.63	0.80				0.26		
Dagaa (dried)	3.95	3.34	4.13		2.55	1.45	2.58	2.33	3.01
Dagaa (fresh)	0.09	0.22							
Duck/chicken stew	0.87	1.02	0.86	5.19	1.02	2.90	2.32	1.43	1.50
Eggs	1.00	1.26	1.05						
Fish stew (boiled)	2.78	3.42	3.21	8.15	18.37	13.04	7.73	9.14	6.02
Fried cassava	0.09	0.32	0.25						
Fried fish	0.61	0.39	0.18	0.74	1.02		0.26	0.18	
Fried potatoes	1.30	0.54	0.55				0.26		
Leafy veg	13.72	10.11	8.94	0.74	1.53		6.70	6.45	6.77
Maandazi	0.22	0.28	0.06						
Makande	0.83	2.01	2.40	2.22	3.57	11.59	2.84	3.05	9.77
Matoke	2.48	1.13	1.29	0.74	0.51		0.77	2.15	
Mlenda	0.74	1.23	0.55				0.26	0.54	
Okra	0.91	0.32	0.25				0.26	0.18	
Other	3.13	2.49	2.96	4.44	3.06	4.35	3.35	2.69	0.75
Pasta	0.96	1.43	1.17					1.25	0.75
Peas	1.04	1.17	1.23	0.74	2.55	2.90	0.77	0.72	3.01
Pilau	1.17	1.60	2.59		0.51		1.55	2.15	8.27
Porridge	7.95	7.41	6.17				0.26		0.75
Rice	14.16	16.24	18.19	0.74			20.10	22.94	19.55
Sweet potatoes/cassava/taro root	1.22	2.45	3.64		0.51		0.26	0.54	1.50
Ugali	23.84	19.56	19.61		0.51		0.26	0.72	

Table 22: Dishes Fresh or reheated by phase (limited to top three of each)

	fresh															
	Fresh Phase				Partially precooked Phase				Reheated Phase				Total Phase			
	1	2	4	Total	1	2	4	Total	1	2	4	Total	1	2	4	Total
Dish																
Beans	133	358	130	621	52	69	35	156	113	147	39	299	298	574	204	1,076
Beef/Goat	113	290	112	515	46	43	8	97	53	58	8	119	212	391	128	731
Fish stew (boiled)	64	158	52	274	11	36	9	56	30	51	8	89	105	245	69	419
Leafy veg	316	467	145	928	1	3		4	26	36	9	71	343	506	154	1,003
Rice	326	750	295	1,371	1			1	78	128	26	232	405	878	321	1,604
Ugali	549	903	318	1,770		1		1	1	4		5	550	908	318	1,776
Total	1,501	2,926	1,052	5,479	111	152	52	315	301	424	90	815	1,913	3,502	1,194	6,609

Table 22, we observe increased frequencies of preparing fresh food from phase 1 to 2 and decreased precooking of most of the food from phase 2 to 4. The findings are also supported by the exit survey where household perceive reduction in cost and time required for preparing

heavy food where EPC was used leading to reduce the tendency to saving precooked food for later use.

Table 23: Dishes Fresh or reheated by phase (limited to top three of each, percentages are within columns)

	fresh and Phase								
	Fresh			Partially preco			Reheated		
Dish	1	2	4	1	2	4	1	2	4
Beans	8.86	12.24	12.36	46.85	45.39	67.31	37.54	34.67	43.33
Beef/Goat	7.53	9.91	10.65	41.44	28.29	15.38	17.61	13.68	8.89
Fish stew (boiled)	4.26	5.40	4.94	9.91	23.68	17.31	9.97	12.03	8.89
Leafy veg	21.05	15.96	13.78	0.90	1.97		8.64	8.49	10.00
Rice	21.72	25.63	28.04	0.90			25.91	30.19	28.89
Ugali	36.58	30.86	30.23		0.66		0.33	0.94	

Table 23 conveys the same information included in Table 20 above, but depicts relative proportions among those most common foods, rather than frequencies.

Table 24: Per Capita Energy Consumption by Meal Type (Fresh and Reheated)

	Fuel Type											
	Charcoal Phase			LPG Phase			Wood Phase			Electric Phase		
	1	2	4	1	2	4	1	2	4	1	2	4
Fresh or Reheated												
Fresh												
Meals												
Breakfast	8.22	7.17	7.42	3.13	1.41	1.90	4.38	8.51	2.33	0.96	0.38	0.41
Lunch	8.25	7.94	8.99	2.54	2.03	1.49	7.97	4.40	2.26	0.79	0.40	0.33
Supper	8.20	7.38	11.27	3.98	2.55	1.76	5.32	3.20	3.39	0.44	0.36	0.38
Partly Cooked												
Meals												
Breakfast		3.24			1.15							
Lunch	5.23		2.19		0.34	0.23					0.18	0.54
Supper	5.23	6.71			2.33	0.34		2.01			0.10	
Reheated												
Meals												
Breakfast	4.92	3.96	5.66	0.76	1.23		3.58	6.09	2.84		0.21	0.26
Lunch	2.68	2.13	3.47	1.14	1.49						0.30	
Supper	2.53	2.40	2.82	0.76	0.69	0.63	1.45		6.29	0.24	0.39	0.10

Table 24, overall energy consumption decreased with the introduction of EPCs. The patterns of fresh/reheat by meal type by fuel type are pretty widely varied.

3.6 Cooking Devices

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

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

The fuel types used to cook individual foods are presented in Table 25.

Table 25: Frequency and Percentage of Events Using Each Fuel Type

Fuel Type	Phase 1	2	3	4
Charcoal	2,274	2,558		894
	80.44	47.60		48.99
Electric	2	1,660	14,082	471
	0.07	30.89	100.00	25.81
Wood	149	148		57
	5.27	2.75		3.12
LPG	402	1,008		403
	14.22	18.76		22.08

Table 25, charcoal stove use declined as a share of device use from phase 1 to phase 2 and remained at the lower level into phase 4

Table 26: Utensil Use

	Phase 1	2	4
(sum) suf_big	87	83	25
(sum) suf_med	1850	2173	712
(sum) suf_sm	749	1227	565
(sum) fry	166	248	59
(sum) ket	0	0	0
(sum) oth	4	10	0

Table 26, medium and small sufurias saw the most consistent use across phases (with the largest relative increase among the small sufuria).

Table 27: Utensil Use by fuel type

	Equip, Dish 1 char Phase			firewood Phase			gas Phase		
	1	2	4	1	2	4	1	2	4
(sum) suf_big	22	23	2	11	4	3	1	9	0
(sum) suf_med	193	221	74	14	26	20	34	106	27
(sum) suf_sm	49	139	63	2	2	3	21	83	32
(sum) fry	50	79	18	0	4	1	13	37	16
(sum) ket	0	0	0	0	0	0	0	0	0
(sum) oth	0	1	0	0	2	0	0	0	0

Table 27, these utensils were most consistently used with charcoal stoves, although the increase in medium sufuria use appears to be driven by higher levels of LPG utilization, with increased

preparation of porridge and rice using a medium sufuria on LPG devices in phase 2 and sweet potatoes in phase 4.

Table 28: Lid Use by Device Type

	Phase		
	1	2	4
Equip, Dish 1			
Charcoal stove			
(sum) lidnocount	808	840	347
(sum) lidsomecount	121	269	112
(sum) lidyescount	1283	1238	360
Electric hotplate			
(sum) lidnocount	2		
(sum) lidsomecount	0		
(sum) lidyescount	8		
Electric pressure cooker			
(sum) lidnocount	1	126	35
(sum) lidsomecount	0	40	19
(sum) lidyescount	0	137	35
Firewood stove			
(sum) lidnocount	59	64	24
(sum) lidsomecount	14	23	9
(sum) lidyescount	70	58	22
Gas stove			
(sum) lidnocount	167	367	138
(sum) lidsomecount	28	165	74
(sum) lidyescount	192	360	110
Microwave			
(sum) lidnocount	0	1	
(sum) lidsomecount	0	0	
(sum) lidyescount	0	1	
Other			
(sum) lidnocount	5	4	
(sum) lidsomecount	0	0	
(sum) lidyescount	1	0	
Rice cooker			
(sum) lidnocount	1	0	3
(sum) lidsomecount	0	0	0
(sum) lidyescount	1	0	0

Table 28 aims to shows the connection between the cooking device and the use of lid in different phases. Lid usage didn't change much across phases, with dishes cooked without lids hovering around 40% of dishes cooked on all stove types across phases.

3.7 Time Taken

Table 29: Dish Cook time by Fuel Type

	Mean					Median				
	Charcoal	Electric	Wood	LPG	Total	Charcoal	Electric	Wood	LPG	Total
Dish										
Bananas (hard)	46	28	30	28	36	36	30	30	26	30
Beans	71	62	66	14	62	34	54	64	10	40
Beef/Goat	45	34	57	28	39	41	30	20	22	31
Boiled potatoes	34	29	58	24	31	31	20	58	22	29
Cassava leaves	42	42	28	23	39	33	39	28	16	28
Chapati	82		19	32	71	75		19	31	56
Chips	47			35	40	45			28	32
Dagaa (dried)	27	25	20	20	25	25	22	19	17	23
Dagaa (fresh)	33			10	27	33			10	23
Duck/chicken stew	40	35		29	36	34	33		25	30
Eggs	11	16	6	7	10	8	13	6	5	9
Fish stew (boiled)	29	25	18	23	27	24	21	15	19	23
Fried cassava	42	40	22	24	37	35	40	20	27	32
Fried fish	33	17		27	30	26	17		25	26
Fried potatoes	64	30		36	51	57	30		32	43
Leafy veg	17	20	12	13	16	15	15	13	12	14
Maandazi	46			38	45	45			38	45
Makande	147	73	111	6	95	130	70	105	5	73
Matoke	52	32		25	41	50	32		29	35
Mlenda	20	27	22	16	19	17	27	19	14	17
Okra	19	37	22	19	22	18	40	21	18	20
Other	55	32	54	20	42	36	30	46	13	30
Pasta	35	23	25	27	29	32	20	25	25	28
Peas	54	25		32	41	54	23		16	32
Pilau	64	37	53	38	52	65	30	48	40	50
Porridge	32	24	59	20	29	28	20	63	16	24
Rice	45	30	43	27	38	45	30	49	28	35
Sweet potatoes/cassava/taro root	36	25	28	30	31	34	21	23	25	29
Ugali	30	30	27	22	28	29	29	26	20	26
Total	41	36	39	22	37	30	30	27	17	28

Table 29, both mean and median cook times tend to be lower on electric devices than others (when it comes to high-cook time dishes). EPC cook times, though, are often equal to or higher than those of other fuel types for short-cook time dishes.

Figure 5: Average Duration of Cooking Event by Food and Fuel Type

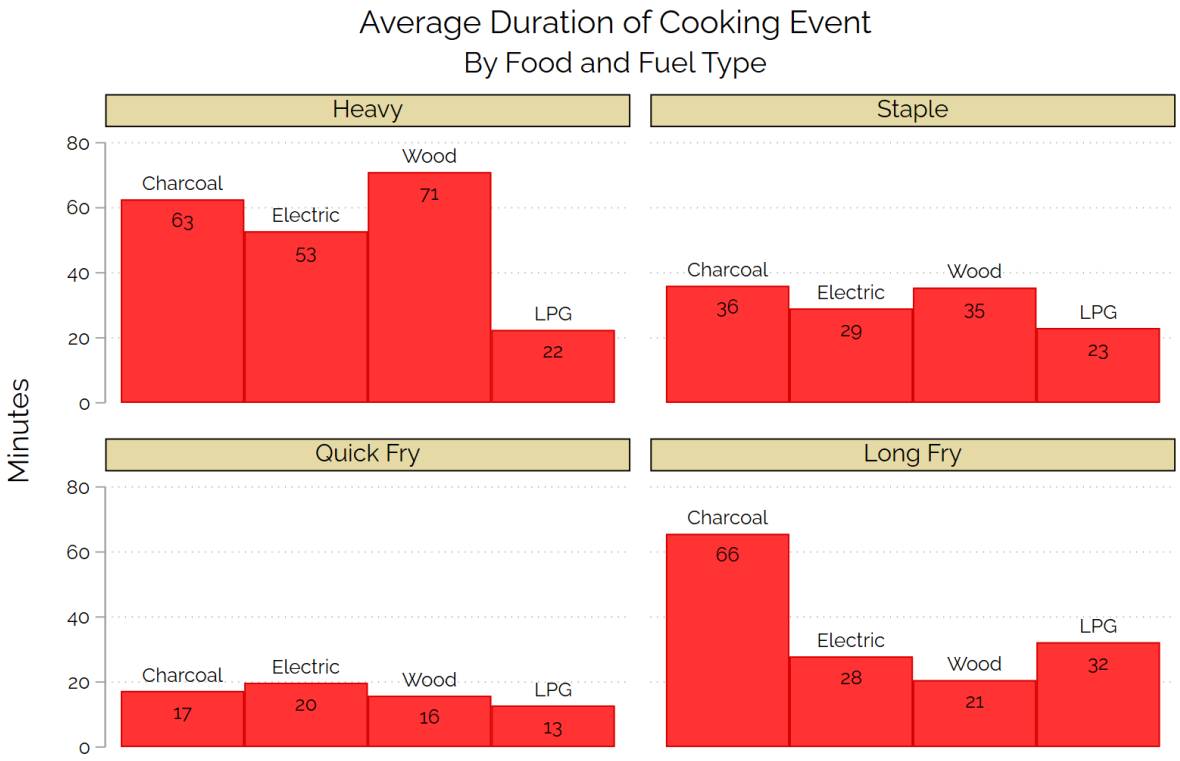


Figure 5, LPG stoves had the lowest overall average cook times when preparing heavy, staple, and quick-fried foods, although electric and wood stoves yielded shorter cook times for long-frying dishes. This difference was especially notable when preparing heavy foods, with LPG stoves showing less than half the time necessary to cook heavy foods than any other fuel type. EPCs evinced lower average cook times than charcoal stoves across food types. When frying (both quick and long-frying dishes), woodstoves show much lower cook times relative to other fuels than when preparing heavy foods and staples. It should be also noted that some of the household had tendency to use the traditional pressure cooker in preparing some of the heavy foods which might have impacted the results.

Table 30: Preparation Time by Meal and Fuel Type

	Meals					
	Breakfast		Lunch		Supper	
	phase		phase		phase	
	1	2	1	2	1	2
Fuels						
Wood						
Mean	56.02941	46.36364	88.37143	87.81579	85.63636	121.7273
Median	51	44	65	68.5	71.5	93.5
LPG						
Mean	77.28571	64.66667	93.82979	67.69643	76.64865	70.82877
Median	33.5	40	64	51.5	57.5	59.5
Electric						
Mean	69.08333	64.5	205.8	95.27092	116.8	70.94079
Median	40.5	38.5	106	74	56.5	55.5
Charcoal						
Mean	80.47982	88.45933	138.9278	121.5757	109.1169	104.9385
Median	71	68	109	97	90	98

Table 30, in general, cook time declined for each fuel type from phase 1 to phase 2.

Table 31: Meal start time

	Phase			
	1	2	3	4
Meals				
Breakfast				
Mean	07:21	07:33	07:40	07:35
Median	07:15	07:27	07:37	07:31
Lunch				
Mean	11:49	12:26	12:01	11:56
Median	12:02	12:30	12:08	12:04
Supper				
Mean	18:21	18:26	18:31	18:01
Median	18:27	18:40	18:38	18:10

Table 31, the average meal start time is later in phase 4 than in phase 1 for all meals except supper (which moved later throughout phases 2 and 3, before becoming substantially earlier in phase 4). According to the exit survey, EPC changed the household time for cooking. Time for preparing meals, especially dinner changed, they start a bit late from normal experience as they passive EPC cooks faster.

3.8 Effect of EPC Use on Electrical Supply and the Grid

Figures 6 and 7 show indications of the EPC electrical load profile and how EPC may affect power availability. Figure 6 shows average energy consumed by EPCs by time of day, showing peaks during meal times, in particular during the supper hours. Figure 7 shows the nearly identical pattern of number of events by time of day, showing that EPCs events are most common in the evening, with more even usage in the morning and afternoon. The highest likelihood of affecting the grid therefore comes around 17:00-18:00 when households begin cooking dinner. This raises an important question of what would be the impact of expanded eCook usage on the national grid.

From the exit survey, few outages were reported to happen and these last for few minutes or hours. Depending on stage of cooking reached for the case of outage, as the EPCs kept pressure not all the time food were shifted to alternative fuel.

Figure 6. Average energy consumed by EPCs throughout the day (all 50 households)

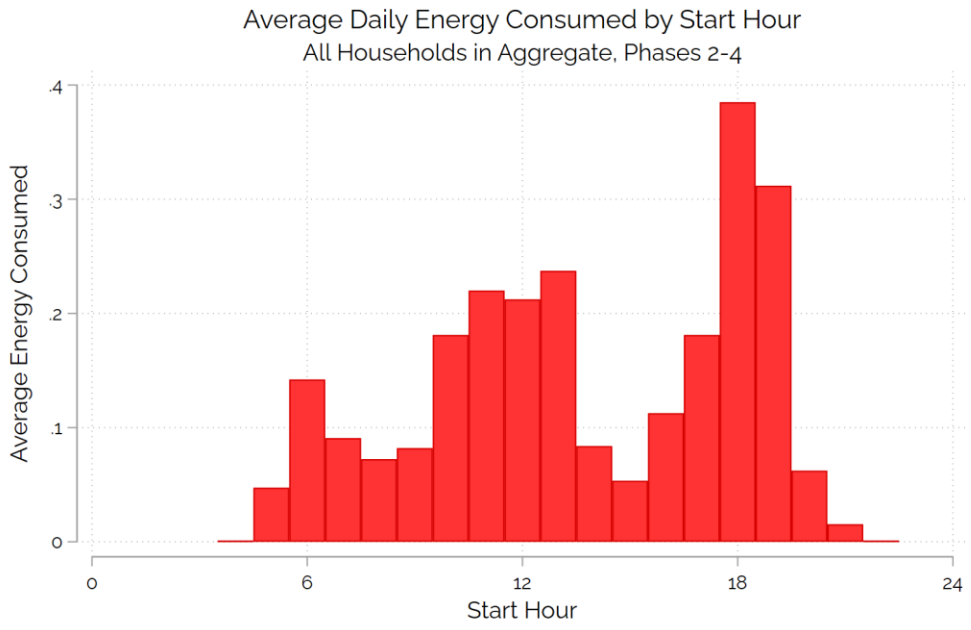
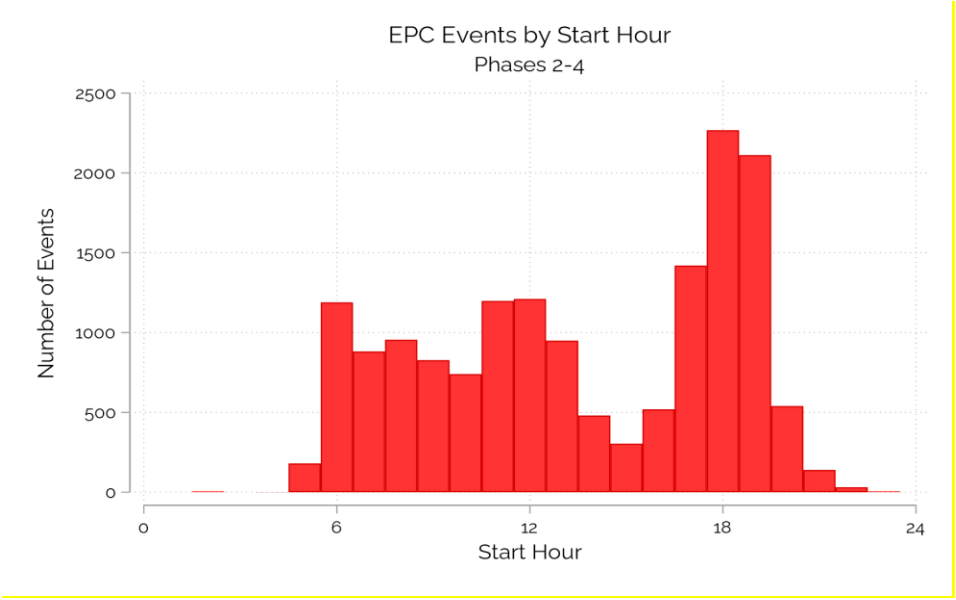


Figure 7. EPC Cooking event start times



3.9 Data Logging Technology and Analytics

TrekAMPs were installed on household non-EPC electric appliances (again to inform the "stack" of total household cooking) and also on 10 of the EPCs in addition to the energy meters in order to compare the insights from the TrekAMPs vs. the manual meters. TrekAMP and energy meter data track closely together, as shown in the Figure 7, which compares logs of cook time and events between diaries (manual energy meters) and TrekAMP. We are in the process of comparing actual energy use as logged by TrekAMP vs. the energy meters using the wattage of the EPCs combined with the amperage data. If the kWh aligns as closely as the even and time logs, then automated data loggers such as TrekAMP hold promise for studies and research into electric cooking use, as it would substantially reduce the burden on the household to log the meter readings, and would reduce inaccuracy due to user error or households forgetting to log the readings, etc.

Figure 7: EPC Usage

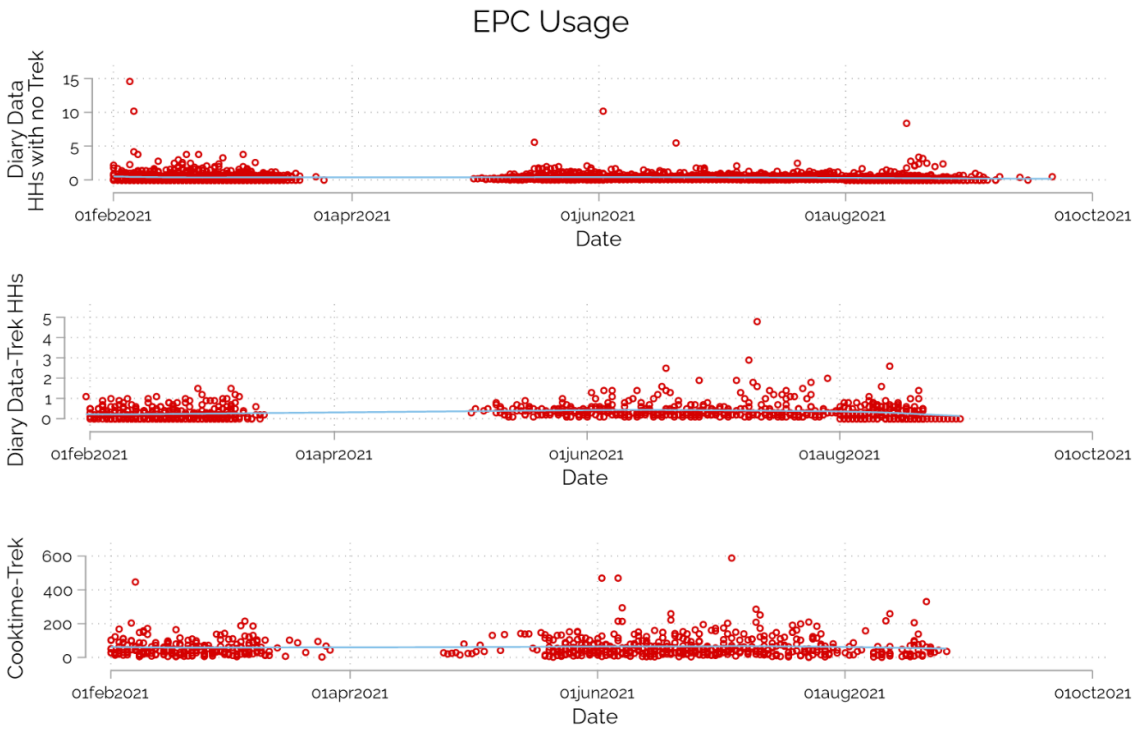


Figure 7, the application of 'use data' here has primarily been for understanding how EPCs are used by households, and findings appear to point towards their general viability and potential to substitute dirty fuels such as charcoal. Moving forward, continued application of use data could play a significant role in supporting electricity supply planning efforts, as well as life cycle analysis. The data on time of day of usage is potentially extremely valuable for understanding when electrical grids are likely to be overtaxed if substantial numbers of households are using EPCs. Monitoring of usage over time can also help to inform, combined with survey data, the longevity of EPC promotion and distribution programs. Since studies thus far have been relatively short-term (~6 months), we do not yet know if EPCs can sustainably maintain functionality for longer periods in order to be truly incorporated into household cooking habits in the long term. For example, when does repairs and break downs begin to occur, and how much will these impact usage? To what extent households will have access to repair services or warranty-related exchanges? Long-term monitoring of some households may be valuable in informing breakdown and repair rates, which could in turn inform EPC design and after sales service models. Breakdown and repair data could also be gathered through self-report through messaging services or other low-cost methods, however, so the practicality of use data vs. self-reported data should be evaluated for any long-term studies.

3.10 Testing Business Model for EPC Distribution

Given that EPC was not a common appliance used for cooking in Tanzania, including the project area, hence the need for popularization. Awareness-raising meetings and demonstrations on the use of EPC were organized for the community and various micro financing institutions located in Morogoro Municipality. For the fifty (50) households that participated in the study, EPCs were availed to them as motivation to provide cooking diary data for the whole period of the study.

For the case of micro financing institutions, Community level VICOBAs were approached with the intention to partner in EPCs business but it was found to be not feasible because most of their members were not grid connected. Higher level teachers SACCOs were also approached; they claimed to have limited experience on goods lending and their constitution does not allow this. From practice it was learnt that promotion of EPC through lower level community micro financing mechanisms might not be feasible due to their setup and the associated socioeconomic challenges.

On 29th July 2021, SESCOM managed to sign an agreement with the Sokoine University Graduate Entrepreneurs Cooperative (SUGECO) to collaborate in EPC business. SUGECO is a membership-based organization with more than 600 members throughout Tanzania from the student and academic population that also includes government and corporate representation engaged in various agribusinesses entrepreneurial activities. To start with, SESCOM provided 22 EPCs to SUGECO on credit basis charged at a wholesale price of Tsh 150,000 per piece. SUGECO is lending the EPCs to their members at a retail price of Tsh 180,000 per piece. SUGECO is following up payments from loaned members and depositing such amounts to the SESCOM account. Whenever a certain amount is paid back, SESCOM provides more EPCs to SUGECO equivalent to the amount of funds deposited. To maximize profit from EPC business, SUGECO intends to explore the possibility to integrate EPCs with devices that can switch off the appliance in case customers delay to make repayment.

The model enables members of the cooperative to access electric cooking who could not pay upfront for the appliance. In general, the rate of uptake was not very high. The main barrier was because SUGECO did not pay SESCOM for the appliances upfront but only when they begin to receive cash payments from their members. When there were insufficient cash payments, then SESCOM could not release a second round of appliances for others in the cooperative to access. An alternative might be to use the M-Kopa model where the device is switched off if payments are not made. However, there are uncertainties over whether that would increase the speed of payments (likely depends on how much customers value electric cooking). Experience indicated that this electric cooking appliance financing model is best suited to economic groups with a regular flow of income that ensures timely repayments. Therefore, while targeting other

segments of the community especially the poorer another type of financing model should be considered.

Another positive response was received from UWATAFO (*Umoja wa Wanawake* TAFORI). This is a women employee micro financing facility at TAFORI. The agreement required SESCOM to supply EPCs to UWATAFO at a wholesale price on credit arrangement. UWATAFO lends EPCs to their members at the same price and bears the responsibility to follow up payments from members and repayment to SESCOM. At a start, six members benefited through the arrangement, while others were in the process of acquiring EPC in the following rounds. It was also learnt that an employee financing facility can provide an opportunity to reach a large number of formally employed workers because they have stable income and they are more willing to adopt once they know the benefits of the product.

3.11 Scaling up Electric Cooking

Transition to electric cooking

Electric cooking is likely to be one of the fuel in the energy mix used for cooking in the country, ranking the second or third after charcoal especially in urban areas. According to results of the exit survey, EPC is perceived to be well suited to the cooking needs of the community in Morogoro Municipal. The best thing households liked about cooking with EPC is quick cooking and time saving. Other perceived qualities of EPC include saving money, simplified cooking, safe and easy to operate and improved food taste, see figure 8.

Figure 8: Shows what People like Most about Cooking using EPC

Remaining Barriers on scaling up electric cooking in Tanzania

Awareness and knowledge gap on the usefulness of EPC is one of the key barriers to scale up electric cooking. At the moment the coverage of the population with information is still low. Once at least more than 25% of the Tanzanian population is informed about EPC, adoption will rise. Civil Society Organizations (CSOs) and media could facilitate capacity building of the communities and massive awareness raising campaigns to get a large number of Tanzanians informed on EPC. Another barrier to scale up electric cooking is affordability and reliability of electricity supply. This

will impact the willingness of households to use electric cooking. The medium and long-term national strategy should focus on ensuring attractive tariffs, stability and reliability of electricity. The Tanzania government through the electricity supply company (TANESCO) and Electricity and Water Regulatory Authority (EWURA) are important stakeholders to facilitate this. Government to institute supportive policies including development of EPC standards and enforcement (through Tanzania Bureau of Standards (TBS)), ensuring affordability of EPCs (either through subsidies or tax exemption). CSOs can push for supportive policies through lobbying and advocacy. It is also important to ensure there are qualified technicians to provide after sale services all over the country, the private sector can play a role in ensuring supply of EPCs meet demand and repair maintenance whenever required.

3.12 Effect of COVID 19 to Project

Re-emerging of the COVID 19 in Tanzania (the second wave) which happened at the midst of the project implementation was one of the issues that needed efforts in safeguarding the health of the actors involved in the project. To ensure safety, implementation of the project activities were executed cautiously by observing necessary health and safety measures including wearing masks and sanitizing hands during the training on the use of EPC, installation of devices and social distancing whenever gathering was required.

From observation and responses from households that participated in the study, Covid-19 did not affect the supply of food to the market neither cooking practices nor did energy use changed due to Covid19 impact; this might be because there was no lock down in Tanzania.

4.0 Social Inclusion

Equal opportunity to all was demonstrated by the project where both men and women were given chances to serve as enumerators based on their skills and capability to deliver. Some of the households participated in the project were female-headed households while others have family members with different disabilities. Also by knowing the economic status of most women, the project made an effort to link interested customers of EPCs with micro financing institutions to be able to acquire EPCs through flexible payments.

5.0 Gender

In Tanzania women and girls are the main provider of domestic chores, including fetching water, cleaning, cooking, looking after children/siblings and collecting household energy supplies - firewood and charcoal. The long distances they walk, puts women and girls at risk of sexual and gender based violence, obstructs their access to education and is a time-consuming and physically burdensome activity. The continued reliance on inefficient cookstoves and fuels leads to health and economic burdens that disproportionately impact women and girls, resulting in

women unfairly bearing the burden of energy poverty, exposed to significant health and safety risks from household air pollution and from carrying heavy fuel loads.

This project was trying to address issues related to cooking where women bear the main responsibility. It focuses on understanding and addressing specific needs of cooks in Morogoro Municipality in relation to the use of electric pressure cooker.

Cooking Diary data collection happened in households where the majority of the cooks were women and girls. More than 90% of the people trained on how to use EPCs were women and girls, for example, out of 61 people (from households that participated in cooking diary) trained on EPCs, there were only 5 men.

6.0 Next Steps

The results from this project will be used to build an evidence based case that will help to convince policymakers/key stakeholders to enact proactive eCooking policy and invest in the sector. They are useful to policy/decision makers, development partners, private sector, CSOs and community. The findings of the study will be shared with these stakeholders through relevant meetings and workshops organized at national, district and street/village level. The report will be published and be accessible online. Policy briefs will be developed and shared with policy/decision makers, development partners and other relevant stakeholders.

Furthermore the results will be used to develop effective strategy for large scale EPC market promotion to create demand. SESCOM is planning to look for more funding opportunities to disseminate the results and scale up the use of EPCs. The scale-up efforts will focus on major cities as they are the main users of charcoal which are sourced unsustainably. More partners including potential media will be contacted in order to join efforts to reach a wide area and more people.

Meanwhile, exploring the potential and possibility to collaborate with existing media platforms including Nukta Africa, a Tanzanian digital media and technology company through JIKO POINT (www.jiko point.co.tz), an online platform special for clean energy. Jiko Point is a one stop centre for clean cooking energy news, tutorials providing different clean cooking skills and e-commerce platform Jiko Sokoni. SESCOM will also continue to identify potential economic groups such as SUGECO to partner with in accelerating uptake of EPCs.

Steps to scale up the results of the project

First step will be to share the findings of the study with stakeholders of clean cooking including policy and decision makers, donor community, private sector, CSOs, academia institutions. This will be achieved through various means including publishing the report through the SESCOM website, sharing through emails, participating and presenting the results in meetings and workshops either invited or organized by SESCOM. Also policy briefs will be developed which will be used for lobbying and advocating for supportive policies and strategies to scale up EPC

adoption and sustain its use. SESCOM through its own initiatives and whenever possible solicits funds from existing and emerging potential sources for scaling up adoption of EPCs by ensuring continuous supply of genuine EPCs and market promotion.

7.0 Conclusion and Recommendations

The key findings are that use of efficient electric pressure cookers fit the cultural processes of cooking in the Morogoro region in Tanzania. EPC was compatible with households' menus, its introduction did not cause households to change meal from what they were used to instead increased or reduced frequencies of cooking some food.

Furthermore, introduction of EPC increases fresh meal preparation as household perceived cooking using EPC was faster and affordable and there was no need for precooking food for later use, the need for boiling heavy food such as beans and saving in the refrigerator for later use decreased. This may lead to improved diet and health and possibly lower energy consumption from refrigeration (although the refrigeration point needs to be verified in terms of behaviour dynamics (switching on/off or constantly on) and energy consumption).

Time for preparing meals, especially dinner changed, they start a bit late from normal experience as they found EPC cooking faster. Following introduction of EPCs, the diaries show fewer multiple-dish meals at breakfast and supper and more at lunch, suggesting shifts in the times of day during which households did additional cooking. The diaries also show a general increase in fresh meal preparation as opposed to partially pre-cooked or re-heated over the phases.

Once EPCs were introduced, there were a very large increase in cooking with electricity accompanied by a correspondingly large drop off in charcoal use for cooking. This usage of EPCs were consistent across the 6 month pilot.

Results also indicated that fuel stacking increased since EPCs were introduced. There was evidence of some stacking behaviour before EPCs were introduced. The transition to phase 2, though, saw increased adoption of electric cooking (28% of cooking events) and electric-included stacks; charcoal-electric made up 6.44% of events in phase 2, and LPG/Electric made up an additional 3.8% and trends were largely consistent into phase 4. The apparent displacement effect of electricity on charcoal use after the introduction of EPCs is very encouraging for the potential of EPCs to reduce reliance on charcoal and bring numerous health and climate benefits. Local and national energy planning should consider EPCs as part of strategies to reduce charcoal use and wider scale projects should be monitored to verify if charcoal displacements trends hold true on a larger scale and over a longer period of time.

Findings also indicated that previous experience with electricity is not a large factor in EPC adoption. The Stovetrace data showed that EPC usage was similar throughout the pilot among

households who already had an electric cooking appliance versus those who did not. While the sample size is small, the experience of these 50 households is therefore encouraging for efforts to scale EPCs into the population more broadly, and that households not already using modern energy and electricity may be able to adapt equally well to use of an electric appliance.

From the exit survey, few outages were reported to happen lasting for few minutes or hours, as EPCs kept heat and pressure, people did not stop cooking with electricity despite those few outages.

Result also indicated that EPC usage was consistent as there was a clear evening peak, the highest likelihood of affecting the grid comes around 17:00-18:00 when households begin cooking dinner. This raises an important question of what would be the impact of expanded eCook usage on the national grid.

Findings from this pilot project also indicated that opportunities exist to accelerate distribution of EPC through electric cooking appliance financing model. The model seems to fit well with economic groups which have regular flow of income. This implies that, while targeting other segments of the community especially the rural poor another type of financing model should be considered.

Furthermore, employee financing facility can also provide an opportunity to reach a large number of formally employed workers because they have stable income and they are more willing to adopt once became knowledgeable of the EPCs.