Discrete Choice Modelling Survey,
Draft report for Comment, Uganda

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This is the data and analysis report, intended to inform work strategies in Ghana.

It is a precursor to public promotional material and academic papers.

Contents

1 Introduction

The primary purpose of the Discrete Choice Modelling surveys was to explore people's preferences regarding various aspects of the design and functionality of cooking devices. The survey has also been used to gather valuable data on cooking practices (e.g. the mix of fuels used and the timing of meals), and the quality of electricity supplies. Data on expenditure on cooking fuels is especially useful as this represents disposable income that can be substituted for modern fuel devices.

Discrete choice modelling was proposed as the theoretical construct to be used in these surveys, to identify the key characteristics (or parameters) that each product should have in order to find ready acceptance with consumers. The methodology has considerable advantages over stated preference, particularly in this case of exploring a market for a future product, as it is difficult for a consumer to state what they would like about a product if they do not yet have exposure to the product. Choice models are set up using choice cards, based on the key parameters identified, each of which has a limited number of 'levels'. The respondent must then choose one of the two cards presented. Discrete choice models predict the probability that an individual will choose an option, based on the levels of each parameter given in the option.

Parameters were divided into three sections covering cooking processes (e.g. speed of cooking), stove design (e.g. smoke emissions), and functionality (e.g. financing plans). Each section was assigned four or five parameters, each parameter having between 2 and 4 levels. Each section included a cost parameter (the capital cost of the device), which was considered to be a continuous variable. This enables willingness to pay figures to be calculated for different features of a cooking device. The analysis used binary logistic regression to fit predictive models to the data for each section. The results provide an understanding of the strength of preference for each attribute, reflecting how important it is in decision making.

Descriptor data was also gathered from respondents, such as age, gender, level of education and so on. Two composite descriptor variables have been calculated representing characteristics of households that might be expected to influence attitudes towards, and eventual adoption of, modern energy cooking devices. A poverty index has been calculated from five variables including the level of education of the respondent and the quality of the dwelling. A technological aptitude index has been calculated from variables representing personal use of media, phones and the internet services. Preferences have then been disaggregated by descriptors and indices to highlight particular aspects that may be more important to specific customer segments.

The surveys were carried out by the Centre for Research in Energy and Energy Conservation (CREEC), Makerere University. A team of enumerators conducted face to face interviews and responses were recorded using the Kobo Collect Android application on a tablet.

2 Overview of data

2.1 Geographical locations

The sample of 315 was drawn from urban areas around Kampala and mostly from urban settlements – see Table 1 and Figure 1. Mukono is the town furthest from Kampala, and has the highest proportion of rural respondents.

Table 1 Settlements and type of settlement

Settlement	3. Is your household in an urban or rural area?		
	rural	urban	Total
Banda	10	49	59
Bweyogerere	3	71	74
Kauga	7	50	57
Kikoni	11	86	97
Kireka	3	12	15
Mukono	6	5	11
Kinawataka	0	2	2
Total	40	275	315

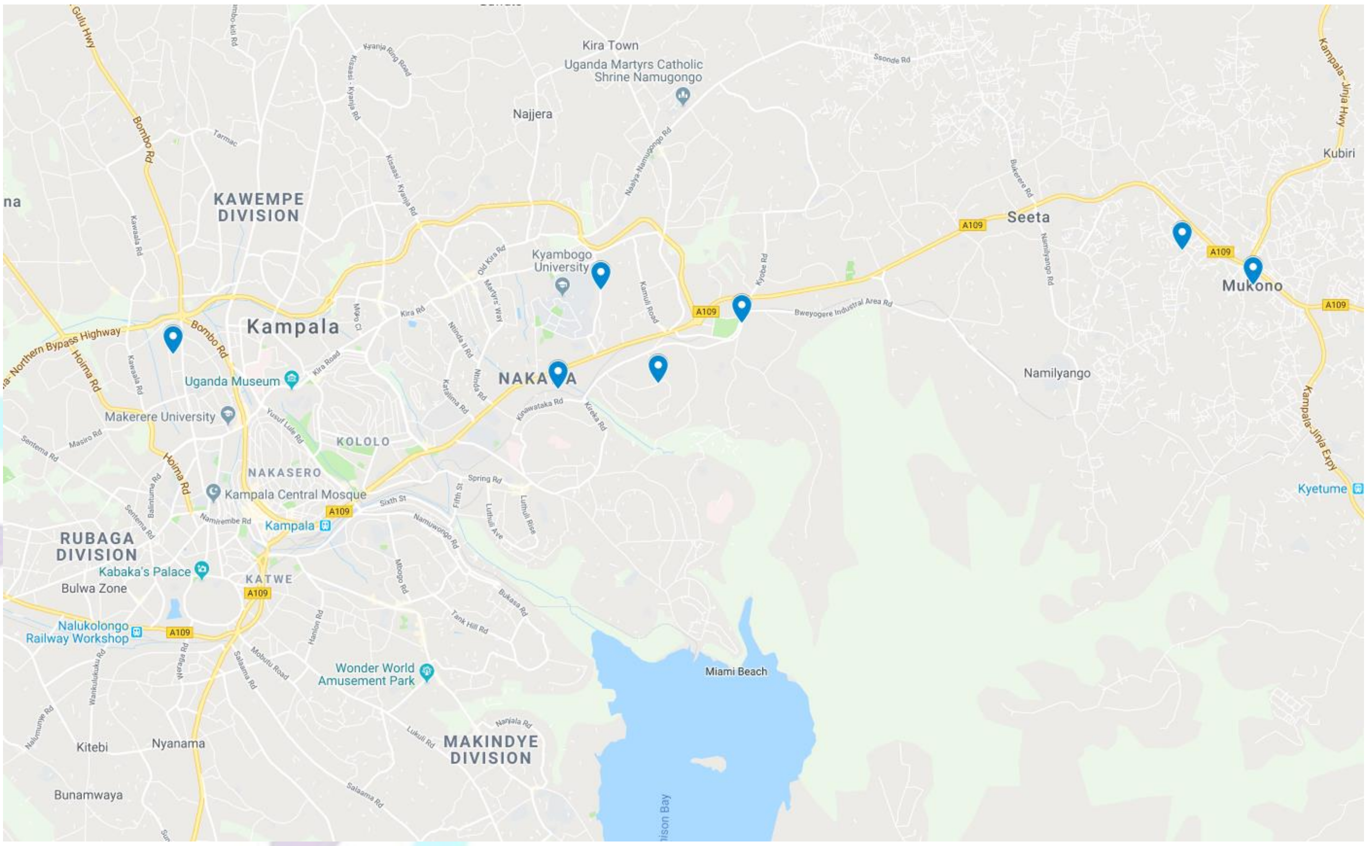

Figure 1 Geographical spread of survey

Table 2 shows that urban residents were more isolated from commercial centres, which is a characteristic of peri-urban settlements.

Table 2 Remoteness - time taken to walk to nearest market place

3. Is your household in an urban or rural area?	Mean	N
rural	19.0	39
urban	31.2	268
Total	29.7	307

2.2 Respondent characteristics

2.2.1 Personal characteristics

The sample was predominantly female – 38:62 (male:female).

74% of respondents were either the head of household or the spouse of the head of household.

The mean age of respondents was 32.8 years, but the sample included respondents of a wide age range – see Figure 2.

The sample has a high educational status, given that over one quarter of respondents had some form of post-secondary education (see Table 3).

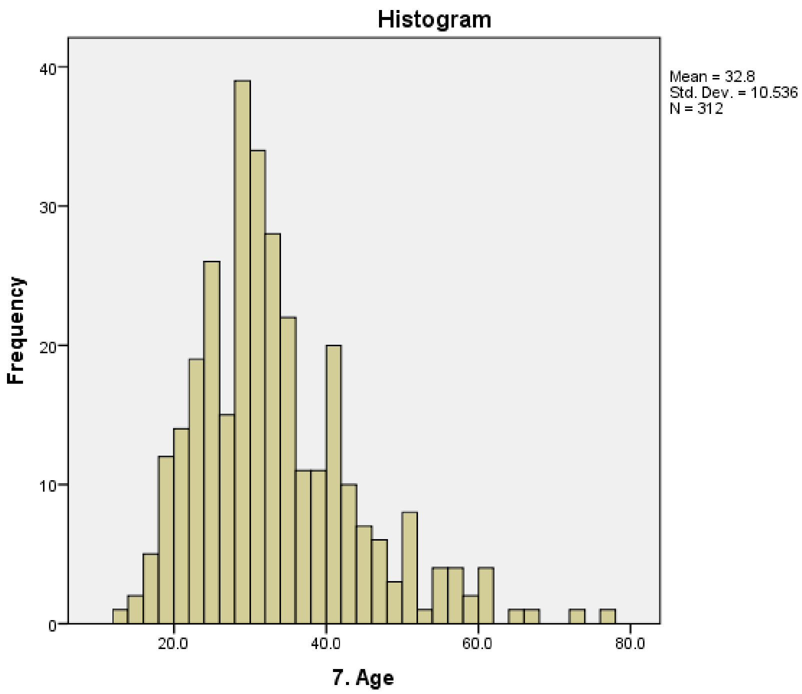

Figure 2 Age distribution of respondents

Table 3 Highest level of education attained

		Frequency	Percent
Valid	none	15	4.8
	incomplete primary	23	7.3
	completed primary	51	16.2
	incomplete secondary	67	21.3
	completed secondary	73	23.2
	higher than secondary	86	27.3
	Total	315	100.0

2.2.2 Personal use of technology

Most respondents watch TV daily, more than listen to the radio daily (Table 4). Among respondents who access both media, use correlates positively, indicating that people who consume more media, consume more of both radio and TV ($r_s = 0.23$, $p = 0.001$) i.e. they do not substitute for one another. 6% (n=18) were isolated in not accessing either of these types of broadcast media.

Table 4 Frequency of use of broadcast media

	Radio		TV	
	Frequency	Percent	Frequency	Percent
not at all	60	19.0	57	18.1
less than once a week	41	13.0	15	4.8
at least once a week	67	21.3	32	10.2
daily	147	46.7	210	66.7
Total	315	100.0	314	99.7

Patterns of mobile phone use can serve as a proxy for technical proficiency and ability to adapt to technological innovations. 91% of respondents owned a mobile phone (or SIM card), and most of these were smartphones (Table 5). Although most respondents used a phone several times a day, there remains a sizable minority (9%) who did not use a phone at all (Table 6).

Literacy clearly acts as a barrier to fully exploiting the potential of mobile phones, but only 10% of respondents were not able to read SMS texts for themselves (n=31). However, over half of these had used a phone in the last month, indicating that literacy does not necessarily prevent people taking advantage of the phone.

Table 5 Type of phone most commonly used

		Frequency	Percent
Valid	Smart phone	161	51.1
	Feature phone	54	17.1
	Basic phone	72	22.9
	Total	287	91.1
Missing	System	28	8.9
Total		315	100.0

Table 6 Frequency of use of mobile phone (in last month)

		Frequency	Percent
Valid	not used	28	8.9
	weekly	20	6.3
	once or twice a day	32	10.2
	several times a day	234	74.3
	Total	314	99.7

In terms of innovative services, Table 7 to Table 8 show that 55% of respondents used the internet yet 61% used social media services (e.g. Facebook, WhatsApp). This indicates that some social media users do not recognise this as use of the internet. Table 9 shows that social media is used quite intensively – 52% of users access it several times a day. Table 10 indicates that the penetration of mobile money services is high (88% of respondents used).

Table 7 Frequency of use of internet (in last month)

		Frequency	Percent
Valid	not aware of internet	10	3.2
	not used	132	41.9
	weekly	32	10.2
	once or twice a day	34	10.8
	several times a day	107	34.0
	Total	315	100.0

Table 8 Use of social media

		Frequency	Percent
Valid	Yes	191	60.6
	No	118	37.5
	not aware of Facebook/WhatsApp	3	1.0
	Total	312	99.0
Missing	System	3	1.0
Total		315	100.0

Table 9 Frequency of use of social media (among users)

		Frequency	Valid Percent
Valid	no longer used	24	12.6
	weekly	31	16.3
	once or twice a day	36	18.9
	several times a day	99	52.1
	Total	190	100.0
Missing	System	125	
Total		315	

Table 10 Frequency of use of MTN Mobile Money (or other)

		Frequency	Percent
Valid	not used	36	11.4
	1 or 2 times a month	150	47.6
	3 - 10 times a month	76	24.1
	daily	52	16.5
	Total	314	99.7
Missing	System	1	.3
Total		315	100.0

A factor analysis has been conducted, and a single factor extracted based on the following variables, which show a good deal of internal consistency (Cronbach alpha = 0.743):

- Frequency of use of mobile phone
- Type of phone used (including none)
- Ability to read SMS
- use of internet
- use of social media
- use of mobile money services

The sample has then been split into two roughly equal parts on the basis of this factor score (see Table 11).

Table 11 Composite technical proficiency classification

		Frequency	Percent
Valid	low	153	48.6
	high	154	48.9
	Total	307	97.5
Missing	System	8	2.5
Total		315	100.0

2.2.3 Household characteristics

The mean household size was 4.5 (including children). The distribution of household sizes is presented in Figure 3. 58% of households had at least one child under the age of 5 years.

Details of dwelling constructions are presented in Table 12 to Table 14. The households' main sources of drinking water are presented in Table 15.

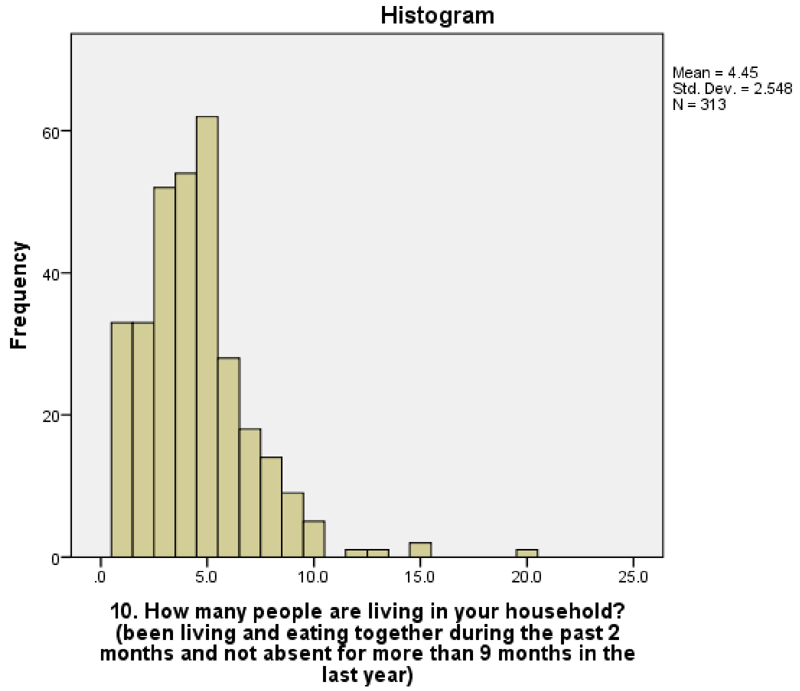

Figure 3 Distribution of household size (adults + children)

Table 12 Dwelling construction - floor

		Deprived	Frequency	Percent
Valid	Dirt/Mud/Dung	X	18	5.7
	Cement screed		244	77.5
	Tiles		50	15.9
	Other	X	2	.6
	Total		314	99.7
Missing	System		1	.3
Total			315	100.0

Table 13 Dwelling construction - walls

		Deprived	Frequency	Percent
Valid	Wood / mud / thatch	X	11	3.5
	Mud bricks (traditional)	X	14	4.4
	Corrugated iron sheet	X	21	6.7
	cement block (plastered or unplastered)		135	42.9
	Bricks (burnt)		132	41.9
	Other	X	1	.3
	Total		314	99.7
Missing	System		1	.3
Total			315	100.0

Table 14 Dwelling construction - roof

		Deprived	Frequency	Percent
Valid	No roof	X	1	.3
	Thatch/palm leaf	X	2	.6
	Wood	X	10	3.2
	Corrugated iron / cement sheet		275	87.3
	Cement		22	7.0
	Tiles		3	1.0
	Other	X	1	.3
	Total		314	99.7
Missing	System		1	.3
Total			315	100.0

Table 15 Main source of drinking water

		Deprived	Frequency	Percent
Valid	Piped into dwelling		36	11.4
	Piped into yard		57	18.1
	Public standpipe		96	30.5
	Tube well/borehole		86	27.3
	Protected dug well		12	3.8
	Unprotected dug well	X	9	2.9
	Protected spring		3	1.0
	Unprotected spring	X	3	1.0
	Rain water		4	1.3
	Tanker truck	X	4	1.3
	Bottled water		1	.3
	other	X	3	1.0
	Total		314	99.7
Missing	System		1	.3
Total			315	100.0

A poverty index has been created on the basis of the following variables:

- Level of education of respondent
- Dwelling construction materials (floor, walls and roof)
- Main source of drinking water.

Households have been classified as deprived as indicated in Table 12 to Table 15. They have been classified as deprived on the education indicator if the respondent had no education or primary education only. These five dichotomous indicators show poor internal consistency (Cronbach alpha = 0.419). This is due to the high degree of homogeneity in dwelling characteristics (relatively few households use ‘deprived’ materials or have unprotected water supplies), yet there is a wide spread of level of education (Table 3). Nevertheless, a composite poverty index has been created by summing the number of aspects in which the household is deprived – see Table 16. For the purposes of the analysis, the sample has been split into two parts: 57% non-deprived, and 43% that are deprived in at least one indicator.

Table 16 Composite Poverty index (max 5)

		Frequency	Percent
Valid	0	178	56.5
	1	102	32.4
	2	25	7.9
	3	5	1.6
	4	3	1.0
	5	2	.6
	Total	315	100.0

3 Characteristics of cooking practice

3.1 Meals and timing

On average, households cooked 2.4 meals/day (mean). Households most commonly cooked three meals per day (median) (see Table 17).

Table 17 Number of meals cooked per day

		Frequency	Percent
Valid	.0	2	.6
	1.0	57	18.1
	2.0	72	22.9
	3.0	164	52.1
	4.0	7	2.2
	Total	302	95.9
Missing	System	13	4.1
Total		315	100.0

The most common times to star cooking meals (modes) were:

- Breakfast: 8.00
- Lunch: 12.00
- Dinner: 17.00

The distributions of starting times are presented in Figure 4 and show that 90% of households start cooking:

- breakfast between 6.00 and 10.00
- lunch between 10.00 and 14.30
- dinner between 16.00 and 21.00.

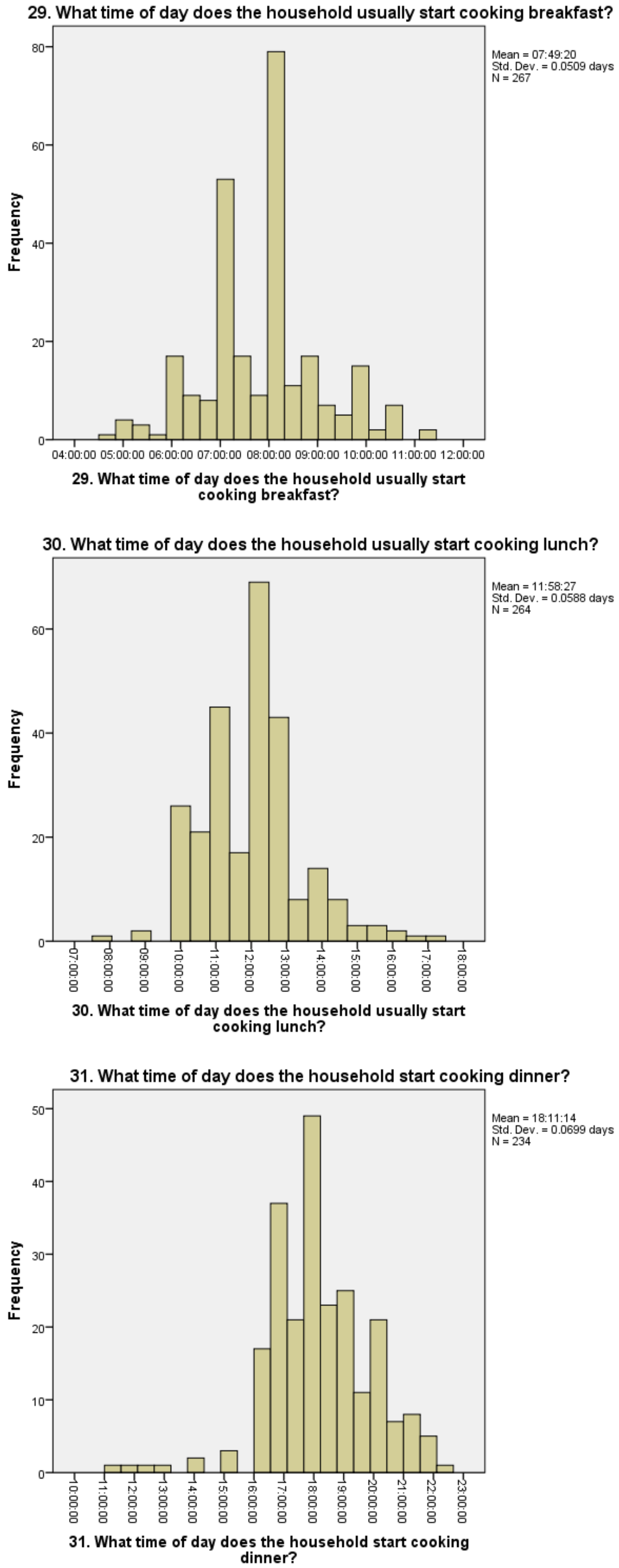

Figure 4 Distribution of times for starting to prepare meals

Households spend an average of 3.9 hours/day cooking (median = 4.0 hours/day). Figure 5 shows that the mode is 5 hours/day. As might be expected, there is a strong correlation between time spent cooking and the number of meals cooked per day ($r = 0.581$, $p < 0.001$).

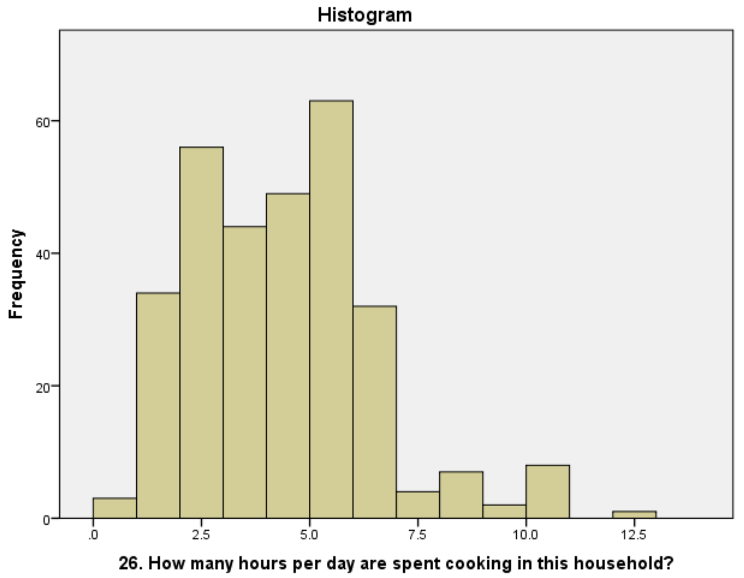

Figure 5   Distribution of time spent cooking (hours/day)

It appears that breakfast is the most commonly cooked meal. Among households that prepared 3 meals/day, 99% gave a time for preparing breakfast, 96% gave a time for preparing lunch, and 93% gave a time for preparing dinner. Note that the number of responses for these timings does not correspond with the number of meals typically cooked e.g. people who tend to cook only one meal per day may have given timings for two or three meals – it may not necessarily be the same meal that they cook each day, and there will be days in which they cook more than one meal.

In 82% of households, it was a woman who did most of the cooking, and in 11% of households a man did the majority of the cooking; only in 7% did men and women shared cooking. The norm was a female spouse of the head of the household to do the majority of the cooking (see Table 18). It was rare for men and women to share the majority of the cooking, but this does not exclude men assisting with occasional cooking.

Table 18   Gender of persons who do the majority of cooking in the household[1]

Description	Gender			Total	Percent (n=307)
	Male	Female	Both		
Head of household	21	46	3	70	23%
Spouse of head	0	145	5	150	49%
Other family member	6	39	8	53	17%
Maid / cook	0	65	4	69	22%
Other	8	11	10	29	9%

[1] This was asked as multiple response question, so totals add up to more than 100%.

3.2 Cooking fuels

Charcoal was clearly the fuel most commonly used for cooking (Table 19). Only one quarter of households used multiple fuels for cooking (Table 20). Of the 90% of respondents who did not use electricity for cooking, 43% had some prior experience of cooking with electricity, suggesting that people are reasonable aware of how to cook with electricity.

Among households using only a single cooking fuel, the vast majority chose charcoal (see Table 21). The pairing of cooking fuels among those households using two cooking fuels is presented in Table 22, along with the split of fuels regarded as the main cooking fuel. This shows that:

- LPG and kerosene were most commonly used in conjunction with charcoal, but charcoal was usually chosen as the main fuel.
- Where electricity was used for cooking, it was usually as a backup fuel. Only in one household was electricity used as the main cooking fuel (in conjunction with kerosene).
- When wood and charcoal were used together, there was no clear preference to use one or the other as the main fuel.

Table 19 Cooking fuels

Fuel	Fuels used[2]		MAIN cooking fuel	
	Frequency	Percent (n=312)	Frequency	Percent (n=310)
Electricity	30	10%	4	1%
LPG	50	16%	24	8%
Biogas	2	1%	1	0%
Kerosene	20	6%	4	1%
Charcoal	273	88%	252	81%
Wood	28	9%	20	7%
Straw, shrubs, grass	1	0%		
Crops	1	0%		
No food cooked	2	1%	3	1%
Other	4	1%	2	1%
Total			310	100.0

Table 20 Number of cooking fuels used

		Frequency	Valid Percent
Valid	1	233	74.7
	2	62	19.9
	3	15	4.8
	4	1	.3
	5	1	.3
	Total	312	100.0
Missing	System	3	
Total		315	

[2] N.B. multiple response.

Table 21 Cooking fuel used - household uses single fuel only

	Frequency	Percent
Electricity	3	1%
Cylinder gas	9	4%
Kerosene	1	0%
Charcoal	202	87%
Wood	14	6%
No food cooked	2	1%
Other	2	1%
Total	233	100.0

Table 22 Combinations of fuels used for cooking (and MAIN cooking fuel) - households using two cooking fuels

	Electricity	LPG	Biogas	Kerosene	Charcoal	Wood	Straw, shrubs, grass
Electricity							
LPG	4 (LPG 4)						
Biogas							
Kerosene	1 (elec 1)	1 (LPG 1)					
Charcoal	8 (char 8)	22 (char 17)	2 (char 1)	14 (char 12)			
Wood					8 (wood 4)		
Straw, shrubs, grass						1 (wood 1)	

The sample was split fairly evenly between those who tended to cook indoors, outdoors, and both (Table 23) – fewer households cooked indoors. Breaking location down by main cooking fuel shows that only charcoal is mostly used outdoors (Table 24). Note that high proportions of wood and charcoal users cook indoors (60% of those using wood as their main fuel cook indoors, and 17% of those using charcoal).

Table 23 Cooking location (within the household)

		Frequency	Valid Percent
Valid	Indoors	76	24.9
	Outdoors	117	38.4
	Both	112	36.7
	Total	305	100.0
Missing	System	10	
Total		315	

Table 24 Cooking location broken down by main cooking fuels

Main cooking fuel	Cooking location			Total
	Indoors	Outdoors	Both	
Electricity	4	0	0	4
Cylinder gas	15	1	8	24
Biogas	0	0	1	1
Kerosene	2	0	2	4
Charcoal	42	108	98	248
Wood	12	6	2	20
Total	75	115	111	301

3.3 Cooking devices

Among households in the sample, basic stoves are by far the most commonly used cooking device (Table 25) followed by improved cookstoves. Nearly three quarters of households have only a single cooking device (Table 26). These households were less likely to have an improved cookstove, or to use a 3 stone fire (Table 27). This indicates that 3 stone fires are more likely to be used as a standby, and that when improved cookstoves have been bought, they are then stacked with stoves used previously.

Table 25 Number of households owning cooking devices

Device	Frequency	Percent
3 stone fire	34	11%
Basic stove (wood, charcoal, dung etc.)	219	70%
Improved biomass cookstove	77	24%
use kerosene to light biomass stove	13	4%
single kerosene burner	19	6%
double kerosene burner	1	0%
Gas burner (portable) - single	22	7%
Gas burner (portable) - double	11	3%
Gas cooker (rings and oven)	12	4%
Gas oven	5	2%
Electric hotplate - 1 hob	6	2%
Electric hotplate - 2 hob	2	1%
Electric hotplate - more than 2 hob	0	0%
Electric Cooker (rings and oven)	6	2%
Electric oven	3	1%
Electric water heater	12	4%
Microwave	8	3%
Toaster -	7	2%
Rice cooker	9	3%
Electric slow/multicooker (pressure cooker)	2	1%
Other	6	2%

Table 26 Number of cooking devices in the household

Number of cooking devices	Frequency	Valid Percent
1	220	72.1
2	48	15.7
3	18	5.9
4	8	2.6
5	4	1.3
6	2	.7
7	2	.7
9	2	.7
15	1	.3
Total	305	100.0

Table 27 Number of households owning cooking devices – households with single device

Device	Frequency	Percent (n=220)
3 stone fire	12	6%
Basic stove (wood, charcoal, dung etc.)	157	71%
Improved biomass cookstove	41	18.6%
Gas burner (portable) - single	4	2%
Gas burner (portable) - double	3	1%
Electric water heater	2	1%
Other	1	1%

The survey also asked about non-cooking electrical appliances; among those households that cook with electricity (n=30), 20 households had fridges, and 5 had freezers (all of which also had fridges, so these probably represent fridge-freezers) i.e. 21 (70%) of households using electricity to cook had either a refrigerator or fridge-freezer.

4 Fuel consumptions and costs

4.1 Electricity

The majority of households were connected to the national grid (Table 28) and amongst these households only 10% had some kind of informal connection. 13% of households have more than one source of electricity. These are mostly national grid backed up with an ‘other’ source (undisclosed), see Table 30. This leaves 7% with no electricity.

Table 28 Sources of electricity

Source of electricity	Frequency	Percent (n=315)
National grid	281	89
Local mini-grid	1	0%
Electric generator	1	0%
Solar home system	13	4%
Solar lantern / lighting	7	2%
Rechargeable battery	3	1%
Other	29	10%

Table 29 Number of sources of electricity

	Frequency	Percent
0	22	7.0
1	253	80.3
2	38	12.1
3	2	.6
Total	315	100.0

Table 30 Sources of electricity – households with 2 sources of electricity

Source of electricity	Frequency	Percent (n=38)
National grid	36	95%
Local mini-grid	0	
Electric generator	0	
Solar home system	8	21%
Solar lantern / lighting	5	13%
Rechargeable battery	2	5%
Other	25	66%

Respondents were asked for their monthly expenditure on electricity and how many units they used each month. The average paid by national grid users was 34,700 USH/month (USD 9.40/month[3]). The distribution presented in Figure 6 shows a broad range of monthly costs.

Respondents' estimates of energy consumptions (units used per month) were checked against consumption figures calculated from the monthly costs, which are likely to be recalled more reliably. Calculated consumptions were based on the following tariff structure[4]:

- 0-15 kWh 250 USH/kWh
- > 15 kWh 760 USH/kWh

The calculated consumptions correlated strongly with respondents' estimates ($r = 0.934$, $p < 0.001$), indicating that the estimates are reliable. Expenditure and unit consumption figures have been used to calculate equivalent unit price of electricity; the mode is 830 USH/kWh, which is similar to the UMEME published tariff of 760 USH/kWh[5] (see above). Although users usually have a more

[3] Exchange rate 3,700 USH/USD.
[4] https://www.umeme.co.ug/tariffs
[5] https://www.umeme.co.ug/tariffs

accurate recall of costs than energy consumptions, these figures suggest that the energy consumption figures appear credible.

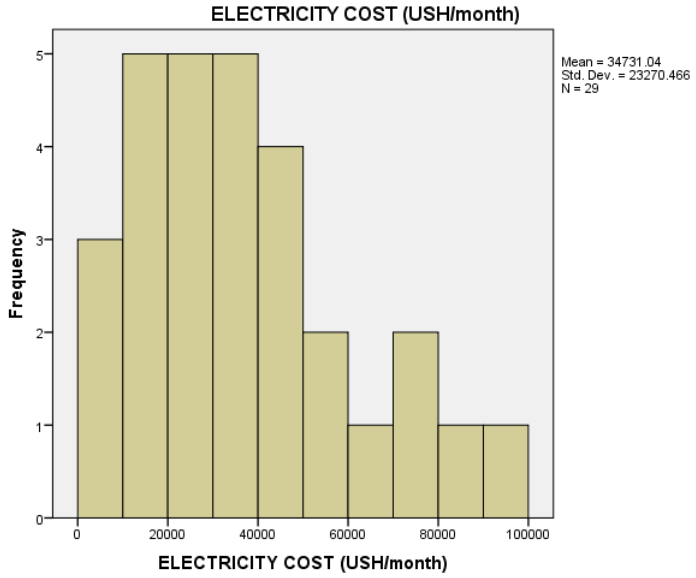

Figure 6 Monthly expenditure on electricity (USH/month) – National grid users

Table 31 Monthly expenditure on electricity (USH/month)

N	Mean	Median	Std.dev.	25% quartile	75% quartile
29	34,700	30,000	23,300	16,300	46,400

4.2 LPG

Respondents appeared to use a wide range of refill sizes (Table 32). The most common sizes were 6 kg and 12kg, which correspond with commonly available sizes. Larger cylinders can be 12, 12.5, 13, and 15 kg[6], and 40 kg[7] and 45 kg[8] cylinders are available.

Respondents all paid different prices for their cylinders, resulting in the distribution in unit prices paid presented in Table 33. The median calculated prices is 9,200 USH/kg and the range is relatively small. These calculated prices correspond well with published prices e.g. Shell prices range from 7,100 USH/kg to 9,500 USH/kg for 6 kg and 45 kg cylinders respectively[9].

Because LPG is used mostly as a backup fuel and each household will use it to a greater or lesser extent, there is a wide range in how long a cylinder will last (see Table 34). Nevertheless, the table shows peaks at 1, 3, and 4 months. Then mean monthly expenditure on LPG was 46,000 USH/month (Table 35) (USD 12.40/month).

[6] https://www.dignited.com/12873/cooking-gas-in-uganda-brands-prices-refilling-and-where-to-buy/
[7] https://www.oryxenergies.com/en/country/uganda/lpg
[8] https://www.conchgas.com/
[9] https://techpointmag.com/shell-gas-prices-uganda/

Table 32 Size of LPG cylinder refills

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.0	1	2.0	2.0	2.0
	5.0	2	4.0	4.0	6.0
	6.0	14	28.0	28.0	34.0
	9.0	4	8.0	8.0	42.0
	10.0	1	2.0	2.0	44.0
	12.0	20	40.0	40.0	84.0
	15.0	1	2.0	2.0	86.0
	20.0	4	8.0	8.0	94.0
	25.0	1	2.0	2.0	96.0
	30.0	1	2.0	2.0	98.0
	45.0	1	2.0	2.0	100.0
	Total	50	100.0	100.0	

Table 33 Calculated unit price of LPG (USH/kg)

		Frequency	Valid Percent
Valid	7111	1	2.2
	7500	1	2.2
	8222	1	2.2
	8333	4	8.7
	8889	1	2.2
	9167	16	34.8
	9231	4	8.7
	9500	5	10.9
	9833	1	2.2
	10000	9	19.6
	12308	1	2.2
	12500	2	4.3
	Total	46	100.0
Missing	System	269	
Total		315	

Table 34 Period of time that LPG cylinder lasts for (weeks)

		Frequency	Percent
Valid	.0	1	2.0
	2.0	1	2.0
	3.0	1	2.0
	4.0	7	14.0
	5.0	1	2.0
	6.0	4	8.0
	8.0	3	6.0
	10.0	2	4.0
	12.0	8	16.0
	14.0	2	4.0
	16.0	7	14.0
	18.0	1	2.0
	20.0	1	2.0
	24.0	1	2.0
	30.0	1	2.0
	31.0	1	2.0
	32.0	1	2.0
	36.0	1	2.0
	60.0	2	4.0
	90.0	1	2.0
	120.0	1	2.0
	150.0	1	2.0
	240.0	1	2.0
	Total	50	100.0

Table 35 Monthly expenditure on LPG (USH/month)

N	Mean	Median	Std.dev.	25% quartile	75% quartile
49	46,100	27,500	42,500	16,700	73,700

4.3 Kerosene

Respondents cooking with kerosene were asked for their monthly expenditure and volume consumption. This data was used to calculate a unit price (see Table 33). The mean price of 3,500 USH/litre seems reasonable (the press report figures of 4,000 USH/litre for diesel[10]), but the wide spread suggests that either expenditure or consumption figures are inaccurate. It is likely that people are probably more aware of expenditure, which varies from 2,000 USH/month to 30,000 USH/month.

[10] https://www.theeastafrican.co.ke/business/East-Africa-hit-by-rise-in-petrol-prices/2560-4886714-jy4lrs/index.html

This wide range because kerosene is mostly used as a backup fuel, so each household will use it to a greater or lesser extent. Then mean monthly expenditure on kerosene was 11,700 USH/month (Table 35) (USD 3.20/month).

Table 36 Calculated unit price of kerosene (USH/litre)

		Frequency	Percent
Valid	1000.00	1	5.0
	1333.33	1	5.0
	2000.00	1	5.0
	2500.00	1	5.0
	3000.00	5	25.0
	3100.00	1	5.0
	3333.33	2	10.0
	3500.00	1	5.0
	3750.00	2	10.0
	4000.00	1	5.0
	4129.00	1	5.0
	5000.00	1	5.0
	7000.00	1	5.0
	8333.33	1	5.0
	Total	20	100.0

Table 37 Monthly expenditure on kerosene (USH/month)

N	Mean	Median	Std.dev.	25% quartile	75% quartile
20	11,700	9,700	8,800	4,300	15,000

4.4 Charcoal

Only those respondents who used charcoal for cooking were asked for details of their consumption of charcoal. Charcoal consumption is difficult to assess because people usually buy it in a wide variety of measures e.g. bag, bucket, sack. The most common units are presented in Table 38 along with estimates of the mass of charcoal in each, based on an analysis of costs. Charcoal is most commonly bought in sacks but 35% of charcoal users usually buy charcoal in small amounts (5 kg or less, see Table 39).

Nearly one half of charcoal users buy charcoal every week or even more frequently; for example, 16% buy daily (Table 40). Nearly 20% buy on a monthly basis.

Table 38 Common units for charcoal purchase and estimated mass of charcoal

	N	Median unit price (USH)	Unit	Estimated mass of charcoal (kg)	Estimated price (USH/kg)
Polythene bag	17	2000	USH/bag	2	1000
Tin	25	1500	USH/tin	1.5	1000
Bucket	11	5000	USH/bucket	5	1000
Half sack	28	70000	USH/sack	50	700
Full sack	92	60000	USH/sack	100	600

Table 39 Amounts of charcoal bought (kg)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	9	3.3	4.0	4.0
	1.50	19	7.0	8.5	12.6
	2.00	27	9.9	12.1	24.7
	2.50	2	.7	.9	25.6
	3.00	10	3.7	4.5	30.0
	4.00	2	.7	.9	30.9
	4.50	1	.4	.4	31.4
	5.00	9	3.3	4.0	35.4
	6.00	2	.7	.9	36.3
	7.00	1	.4	.4	36.8
	10.00	2	.7	.9	37.7
	25.00	1	.4	.4	38.1
	40.00	1	.4	.4	38.6
	50.00	30	11.0	13.5	52.0
	60.00	1	.4	.4	52.5
	100.00	93	34.1	41.7	94.2
	120.00	1	.4	.4	94.6
	200.00	12	4.4	5.4	100.0
	Total	223	81.7	100.0	
Missing	System	50	18.3		
Total		273	100.0		

Table 40 Frequency of purchasing charcoal (days)

		Frequency	Percent
Valid	1.0	43	15.8
	2.0	28	10.3
	3.0	17	6.2
	4.0	10	3.7
	5.0	7	2.6
	7.0	11	4.0
	8.0	2	.7
	10.0	2	.7
	12.0	2	.7
	14.0	1	.4
	15.0	1	.4
	20.0	2	.7
	21.0	4	1.5
	25.0	1	.4
	29.0	2	.7
	30.0	39	14.3
	31.0	13	4.8
	32.0	2	.7
	34.0	1	.4
	37.0	1	.4
	38.0	1	.4
	40.0	5	1.8
	41.0	1	.4
	45.0	2	.7
	50.0	2	.7
	56.0	2	.7
	58.0	1	.4
	60.0	39	14.3
	61.0	3	1.1
	62.0	6	2.2
	65.0	1	.4
	74.0	1	.4
	90.0	16	5.9
	91.0	1	.4
	150.0	2	.7
	365.0	1	.4
	Total	273	100.0

Given that most people buy in large units (sacks), the mean unit price paid for charcoal is 790 USH/kg (Table 41). Among all charcoal users, there is a strong relationship between the price paid and the amount bought ($r = -0.600$, $p < 0.001$), confirming that those who buy in small quantities pay a premium.

Table 41 Calculated charcoal prices (USH/kg)

	N	Mean	Median	Std.dev.	25% quartile	75% quartile
Urban	222	790	700	420	540	1000

Table 42 Monthly expenditure on Charcoal (USH/month)

N	Mean	Median	Std.dev.	25% quartile	75% quartile
272	66,000	33,000	183,000	22,700	60,000

4.5 Wood

Only those respondents who used wood for cooking were asked for details of their consumption of wood. From the various descriptions of amount of wood purchased, three primary units have been identified, and per kg prices calculated from estimates of the mass of wood in each unit (see Table 43). Estimates of amounts of wood bought have been based on the unit mass figures in Table 43. The single most common amount of wood bought (mode) is a lorry load, estimated to be 1500 kg (see Table 44).

Table 43 Common units for wood purchase and estimated mass of wood

	N	Mean unit price (USH)	Unit	Estimated mass of wood (kg)	Estimated price (USH/kg)
Piece/stick	3	600	USH/stick	1	600
Bundle	8	8300	USH/bundle	20[11]	400
lorry	7	336000	USH/lorry	1500[12]	200

[11] http://www.museunacional.ufrj.br/arqueologia/docs/aulas/RitaMNA787/Tabutietal_2003.pdf
[12] Authors' estimate based on trucks of 2-3 tonne capacity, and low density of loosely packed wood.

Table 44 Amount of wood collected or bought (kg)

		Frequency	Valid Percent
Valid	2	1	5.6
	3	1	5.6
	4	1	5.6
	20	3	16.7
	40	1	5.6
	60	4	22.2
	750	1	5.6
	1500	5	27.8
	3000	1	5.6
	Total	18	100.0
Missing	System	10	
Total		28	

Most wood users (52%) buy their wood weekly or more frequently. Only 16% of households purchased wood on a quarterly to annual basis (Table 45).

Table 45 Frequency of collecting or purchasing wood (days)

		Frequency	Valid Percent
Valid	.0	1	4.0
	1.0	3	12.0
	2.0	3	12.0
	3.0	1	4.0
	4.0	1	4.0
	5.0	1	4.0
	7.0	3	12.0
	21.0	1	4.0
	30.0	2	8.0
	40.0	2	8.0
	56.0	1	4.0
	61.0	1	4.0
	74.0	1	4.0
	90.0	2	8.0
	150.0	1	4.0
	360.0	1	4.0
	Total	25	100.0
Missing	System	3	
Total		28	

Prices paid for charcoal have been calculated from amounts paid and estimates of the amounts procured. Given that most people buy in large units (a lorry load), the mean unit price paid for charcoal is 330 USH/kg (Table 41). Among all wood users, there is a strong relationship between the price paid and the amount bought ($r = -0.512$, $p = 0.030$), confirming that those who buy in small quantities pay a premium.

Table 46 Calculated wood prices (USH/kg)

	N	Mean	Median	Std.dev.	25% quartile	75% quartile
Urban	20	330	230	290	90	560

Table 47 Monthly expenditure on wood (USH/month)

N	Mean	Median	Std.dev.	25% quartile	75% quartile
25	73,000	42,000	114,000	20,000	90,000

4.6 Energy consumptions

Energy consumptions have been based on the calorific values given in Table 48.

Table 48 Calorific values and conversion efficiencies[13]

Fuel	**Calorific value**
Wood	15.9 MJ/kg
Charcoal	29.9 MJ/kg
Kerosene	34.9 MJ/ltr
LPG	44.8 MJ/kg
Electricity	3.6 MJ/kWh

Figure 7 presents the total energy consumed in a month by all respondents in each settlement grouping (remember that the sample is predominantly urban (87%) - Table 1). This shows that charcoal is the main source of energy in both urban and rural areas of the sample. Note also that wood is used in urban as well as rural areas.

Note that these fuels will be used for a range of uses other than cooking, and these are explored in Table 50.

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

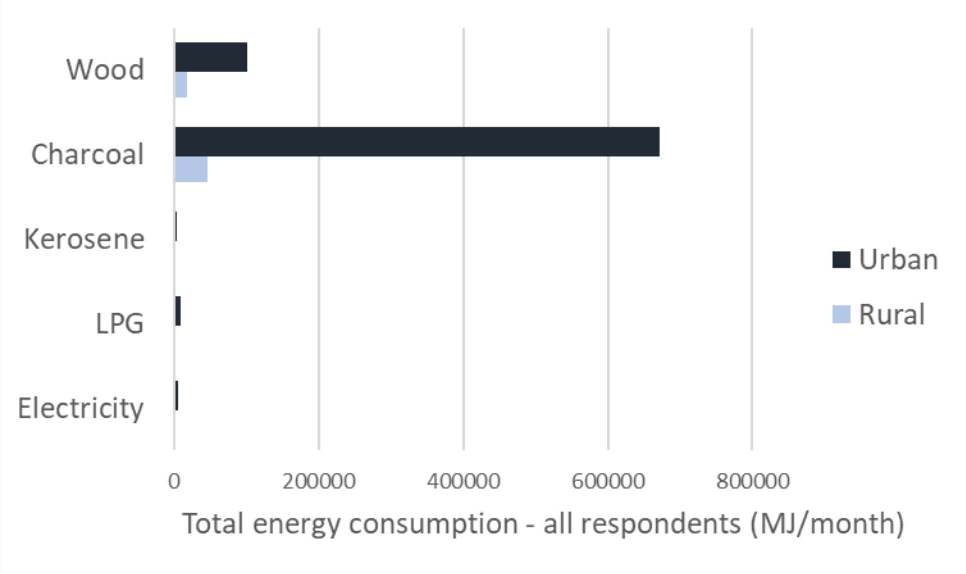

Figure 7 Energy consumptions (totals)

Energy consumptions have been divided by the number of household members to arrive at estimates of per capita energy consumptions for each fuel. Results in Figure 8 shows that, among respondents who use these fuels for cooking, specific consumption of wood is much higher in rural areas, whereas specific use of charcoal is similar across settlement types. The low specific consumption of electricity confirms its role as a backup or supplementary fuel.

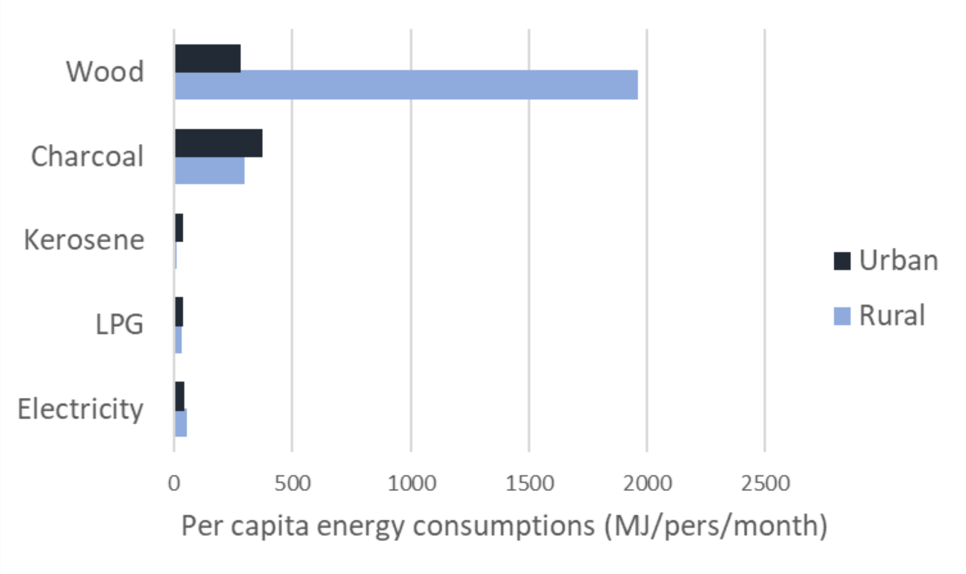

Figure 8 Per capita energy consumptions (valid users)

The analysis in Figure 8 simply considers differences between different fuels, and takes no account of fuel stacking – use of multiple fuels in a household. The main sources of energy used for cooking, including combinations of fuels, are presented in Table 49 (N.B. only 5% of households use combinations of energy not included in this typology).

Table 49 Fuels used for cooking (by more than 2 households)

		Frequency	Percent
Valid	None	4	1.3
	Electricity	3	1.0
	LPG	9	2.9
	Charcoal	203	64.4
	Wood	14	4.4
	Elec & LPG	4	1.3
	LPG & Charcoal	22	7.0
	Charcoal & wood	8	2.5
	Kerosene & charcoal	15	4.8
	Electricity & charcoal	8	2.5
	Electricity, LPG, & charcoal	9	2.9
	Total	299	94.9
Missing	System	16	5.1
Total		315	100.0

Charcoal is clearly most commonly used as a cooking fuel (Table 50). The survey went on to explore additional uses of fuels that were used for cooking. Table 50 shows that fireplaces or stoves (charcoal and wood) were used for space heating. However, there is insufficient detail to determine whether fires were lit specifically for space heating (i.e. additional energy consumption), or whether once a stove was lit for cooking, it provided an additional benefit of space heating (no additional energy consumption). Note that all fuels were widely used for heating water. Again, there is insufficient detailed to determine what the water was heated for (e.g. bathing, tea, purifying water), or what the associated energy consumption might be. A substantial minority of households used each of these fuels for 'other' purposes not specifically addressed in Table 50; further research is required to explore what these uses include. All five main fuels are used for water heating, and for some 'other', undisclosed purposes.

Table 50 Non-cooking uses of fuels used for cooking

	Used as cooking fuel		Non-cooking uses of fuel					
	N	Percent	Lighting	Refrigeration	Water heating	Space heating	Space cooling	Other
Electricity	30	10%	97%	77%	90%	3%	0%	30%
LPG	50	16%	2%	2%	92%	0%	n/a	26%
Kerosene	20	6%	42%	0%	74%	0%	n/a	21%
Charcoal	273	88%	n/a	n/a	86%	13%	n/a	27%
Wood	28	9%	n/a	n/a	74%	15%	n/a	48%

There is no value in comparing total energy consumption between households that use multiple fuels, as different fuels will be converted at different efficiencies. If it is assumed that thermal energy loads are much higher than others such as refrigeration , light, and ‘other’, and that water heating loads are similar whatever fuel is used, then comparable energy consumptions can be calculated for:

- households that use only a single cooking fuel and use that fuel for heating water (Table 51).
- households that use only a single cooking fuel but do *not* use that fuel for heating water (Table 52).

These figures suggest an energy ratio for charcoal / LPG of around 9.

Table 51 Per capita energy consumptions (households using single fuel for both cooking and water heating) (MJ/per/month)

	N	Mean	Median	Std.dev.	25% quartile	75% quartile
Electricity	3	75	74	32	42	n/a
Cylinder gas	5	116	45	124	22	246
Charcoal	132	993	420	2739	275	560
Wood	5	647	681	432	272	1003

Table 52 Per capita energy consumptions (households using single fuel for cooking but NOT water heating) (MJ/per/month)

	N	Mean	Median	Std.dev.	25% quartile	75% quartile
Electricity	0					
Cylinder gas	3	66	60	65	4	n/a
Charcoal	32	520	336	487	196	589
Wood	4	2471	2424	1061	1391	3399

4.7 Total expenditure on cooking fuels

The purpose of this section is to calculate the disposable income that households spend on cooking fuels in a month. Expenditures have only been calculated for those households that have declared expenditure figures for *all* of the cooking fuels that they use (97% of households). Expenditure figures include the cost of any non-cooking uses of cooking fuels. This is justified as follows:

- water is likely to be heated on the same device that food is cooked on, and water is most commonly heated for hot drinks that can be considered to be part of a meal.
- Non-thermal loads will be an order of magnitude lower than thermal loads (cooking and water heating).

Figure 9 indicates that 50% of households paid more than 40,000 USH/month ($11/month).

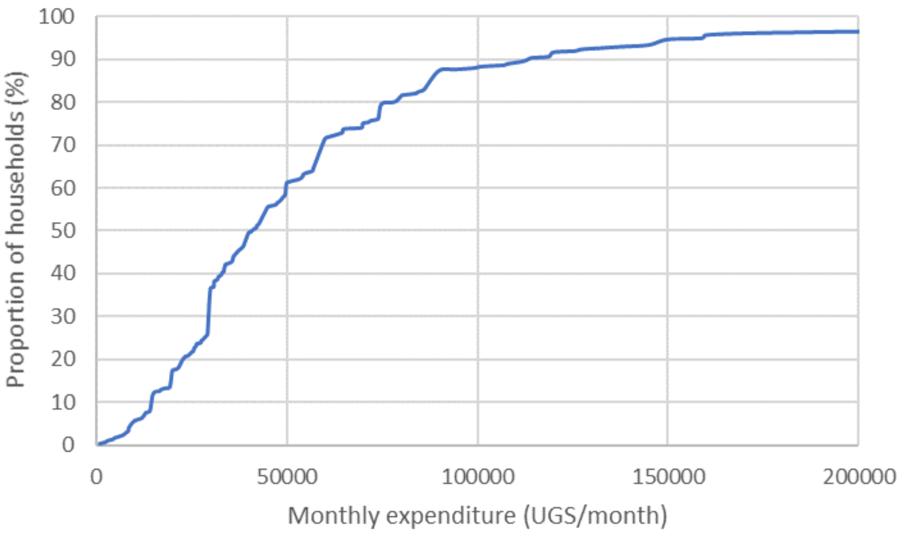

Figure 9 Monthly expenditure - cumulative distribution

4.8 Cooking times

Results in Table 53 suggest that it takes longest to cook with wood, then charcoal and kerosene take a similar time, and cooking with LPG is faster. Although the number of cases is too small to reach any firm conclusions, Table 53 indicates that households that cook mostly with electricity tend to be small (one or two people), and cook few meals. However, time spent cooking correlates strongly with the number of meals always cooked ($r = 0.634$, $p < 0.001$), suggesting that the effect may be due to cooking demand rather than fuel. A regression analysis confirms that time spent cooking depends mostly on the number of meals cooked, but also on the choice of main cooking fuel and the number of people in the household.

Table 53 Time spent cooking by choice of main cooking fuel

Means	Electricity (n)	LPG (n)	Kerosene (n)	Charcoal (n)	Wood (n)
Time spent cooking (hour/day)	0.9 (4)	3.1 (21)	3.8 (4)	4.0 (250)	4.8 (18)
Number of people in household	1.5 (4)	3.2 (24)	3.0 (4)	4.5 (250)	6.7 (20)
Number of meals cooked per day	1.3 (4)	2.0 (22)	2.3 (4)	2.4 (246)	2.6 (20)

5 Characteristics of household electricity supply

5.1 Sources of electricity

Sources of electricity are presented in Table 54. Table 55 shows that 7.0% of respondents had no electricity (n=22). Most respondents had a single source of electricity, but 13% had multiple sources (Table 55); 95% of these had grid connections supplemented by a solar home system or lantern or ‘other’.

Respondents with connections to the national grid were asked to give details of the type of connection; 10% of those who responded said they had informal connections.

Table 54 Sources of electricity

Source of electricity	Frequency	Percent (n=315)
National grid	281	89%
Local mini-grid	1	0%
Electric generator	1	0%
Solar home system	13	4%
Solar lantern / lighting	7	2%
Rechargeable battery	3	1%
Other	29	10%

Table 55 Number of sources of electricity

	Frequency	Percent
0	22	7.0
1	253	80.3
2	38	12.1
3	2	.6
Total	315	100.0

5.2 Household electrical appliances

Only those respondents who said they had no electricity were asked which appliances they had – see Table 56.

Table 56 Household ownership of electrical appliances

Appliance	Frequency	Valid percent
Radio (battery powered)	161	55%
Music system (mains powered)	99	34%
Mobile phone	247	84%
Non mobile phone	3	1%
Television	221	75%
refrigerator	103	35%
Electric kettle	102	35%
Electric water heater	29	10%
Fan	33	11%
Air conditioner	7	2%
Electric lights	237	81%

5.3 Quality of supply

Respondents who accessed electricity via the national grid were asked a series of questions relating to quality of supply. Only 11% of grid users suffered regular blackouts (at least once a week), and the majority (69%) reported no problems with load shedding. Blackouts are of limited duration, for example, among those reporting blackouts, 69% report that blackouts last only an hour or less (Table 58). Few respondents felt able to identify specific months in which blackouts occurred, implying that there is no clear seasonal trend (Table 59).

Table 57 Frequency of blackouts

		Frequency	Valid Percent
Valid	once a month	31	11.2
	twice a month	27	9.7
	once a week	15	5.4
	twice a week	11	4.0
	every other day	2	.7
	many times a day	1	.4
	No load shedding	190	68.6
	Total	277	100.0
Missing	System	4	
Total		281	

Table 58 Duration of blackouts (National grid users)

		Frequency	Valid Percent
Valid	under 5 minutes	15	5.4
	10 mins	21	7.6
	30 mins	33	11.9
	1 hour	11	4.0
	2 hours	5	1.8
	4 hours	4	1.4
	8 hours	2	.7
	1 day	7	2.5
	several days	1	.4
	a week	1	.4
	No load shedding	178	64.0
	Total	278	100.0
Missing	System	3	
Total		281	

Table 59 Months in which load shedding is experienced (National grid users)

	Frequency	Valid percent (n=277)
Jan	2	0.7
Feb	1	0.4
Mar	0	0.0
Apr	1	0.4
May	3	1.1
Jun	4	1.4
Jul	0	0.0
Aug	2	0.7
Sep	1	0.4
Oct	0	0.0
Nov	0	0.0
Dec	3	0.0

Among national grid users with experience of load shedding, 10% had received some kind of information about a schedule (Table 60). Among those who did receive information, SMS and the internet were the channels most commonly used to get this information.

Table 60 Received information on load shedding schedule (National grid users who have experienced load shedding)

		Frequency	Percent
Valid	Yes	4	2.1
	No	168	88.4
	Sometimes	15	7.9
	Total	187	98.4
Missing	System	3	1.6
Total		190	100.0

Table 61 Sources of information on load shedding schedules

	Frequency	Valid percent (n=19)
radio	7	37%
Printed notice	1	5%
newspapers	6	32%
internet	11	58%
SMS	13	68%
neighbours	11	58%
other	1	5%

6 Beliefs and attitudes

6.1 Perceptions on fuels

Figure 10 and Figure 11 show that charcoal is clearly regarded as the safest and most readily accessible fuel[14] (N.B. electricity was not included in these questions). It is interesting to note that overall, LPG was regarded as the least safe fuel, followed closely by kerosene. LPG was also regarded as not easy to access; only wood had a poorer rating.

A further set of questions on various aspects of different fuels provides further insights (see Figure 12):

- The majority of respondents felt that smoke was a health problem (64%), but while firewood was widely regarded as harmful to health (57%), charcoal was not (only 30% agreed that cooking with charcoal is harmful to health). This indicates that people appreciate the health risks associated with wood smoke, but are unaware of the health implications of charcoal smoke.
- The majority of respondents felt that certain foods taste better when cooked on biomass fuels (72%)
- Charcoal was widely regarded as convenient to use for cooking (88%), but only 15% felt that cooking with firewood was convenient (N.B. these two questions were asked in opposite senses). However, among the small sub-sample who used firewood for cooking (n=26), most respondents (54%) felt that firewood was not a burden for their family.

[14] Coal is not available in Uganda and only six respondents felt able to provide data, so coal has been omitted from this analysis.

- There was almost universal agreement that electricity is expensive for cooking (89%), there was widespread agreement that LPG is expensive (63%), and even wood was regarded as expensive by 40% of all respondents.

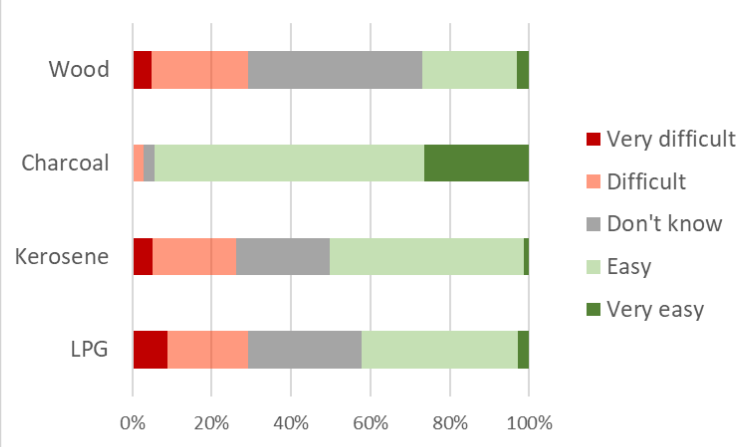

Figure 10 Ease of access to fuels

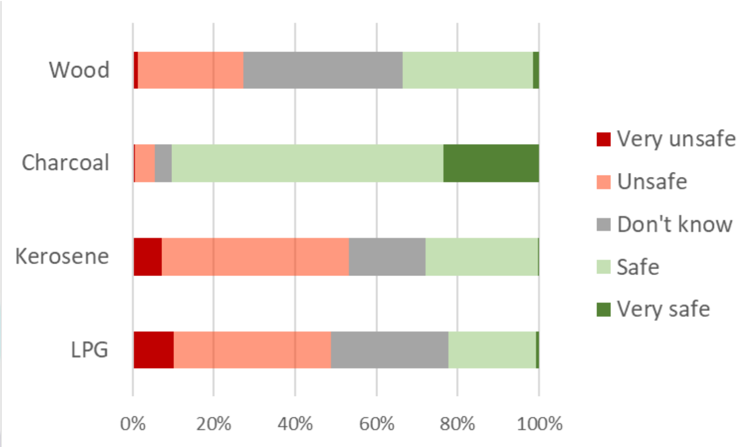

Figure 11 Safety of fuels

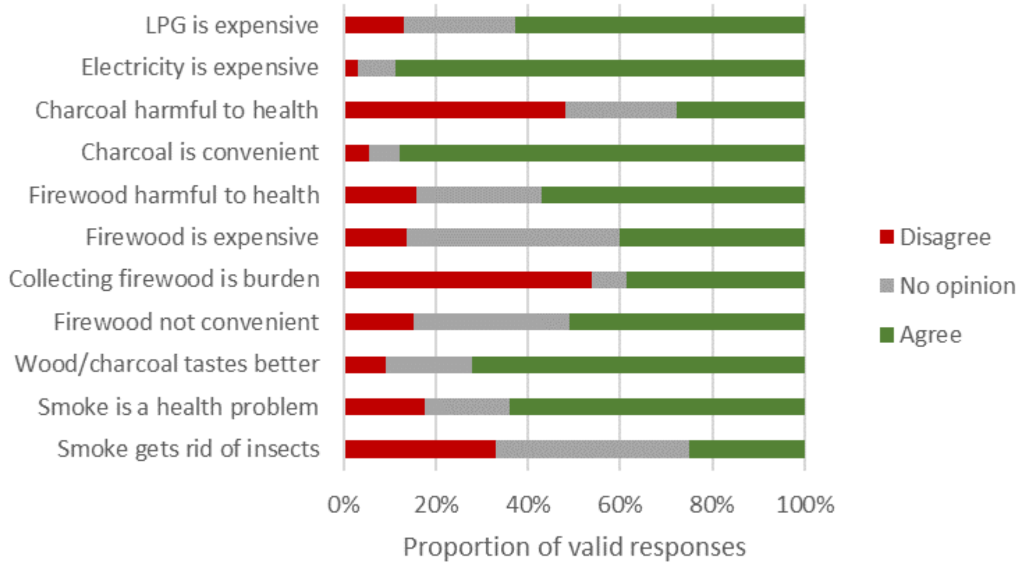

Figure 12 Perceptions relating to cooking fuels

Mean attitude scores have been calculated for groups of respondents that use each fuel as their main cooking fuel (Table 62). The following relationships can be seen:

- Perceptions concerning accessibility of fuels are clearly influential in choice of main cooking fuel; Note that mean accessibility scores for both LPG and wood were negative among non-users, but scores for charcoal were positive among non-users. This suggests that charcoal is widely available, whereas LPG and wood can only be purchased from specific locations.
- LPG users tend to regard it as a safe fuel, unlike everybody else, suggesting that negative perceptions on safety act as a barrier to use of LPG. Note that the mean score for safety of LPG among users is modest, indicating that even those who use LPG as their main fuel have concerns over its safety.
- Charcoal is widely regarded as safe, although less so among wood users, suggesting that concerns over the safety of cooking with charcoal may be driving use of wood.
- Views on the sfety of cooking with wood are neutral, although wood users themselves tend to feel it is safe.
- Kerosene is widely regarded as unsafe.
- Although smoke is widely regarded as a health problem in respondents' families, it is not influential in the choice of primary cooking fuel. This suggests that even those who use LPG as their main cooking fuel still suffer from smoke when using supplementary fuels.
- Cooking with firewood is widely regarded as harmful to health, so it is not influential in choice of fuel. In contrast. Neither are views on the harm caused by cooking with charcoal, which are broadly neutral.
- Charcoal users generally agree that charcoal is convenient. Scores among LPG and wood users are weaker but still positive. This indicates that there are some aspects of charcoal use that may be acting as a barrier preventing wood users from changing to charcoal (these are not specified but might include dirty, storage, time to light etc.).
- Biomass users feel LPG is expensive yet overall, LPG users do not, indicating that perceptions on the cost of LPG act as a barrier to using LPG as the main fuel. There is a strongly held view across all groups that electricity is expensive.
- The belief that smoke is good for controlling insects appears to act as a driver behind cooking with wood.

Table 62 Attitudes by choice of main cooking fuel (mean values)

	Range	What is your MAIN cooking fuel?			
		LPG	Charcoal	Wood	K-W P value
N		24	252	19	
How easy is it to access LPG?	-2 to +2	1.13	-0.05	-0.05	**0**
How easy is it to access kerosene?	-2 to +2	0.54	0.14	0.11	0.191
How easy is it to access charcoal?	-2 to +2	1	1.25	0.47	**0**
How easy is it to access wood?	-2 to +2	-0.04	-0.13	1.16	**0**
How safe is LPG?	-2 to +2	0.38	-0.46	-0.47	**0**
How safe is kerosene?	-2 to +2	-0.13	-0.34	-0.47	0.445
How safe is charcoal?	-2 to +2	1	1.15	0.37	**0**
How safe is wood?	-2 to +2	-0.13	0.07	0.53	**0.048**
Smoke from stove is good at chasing insects away.	-1 to +1	-0.08	-0.13	0.47	**0.004**
Smoke from cooking fuels is a big health problem.	-1 to +1	0.5	0.46	0.63	0.523
food tastes better when cooked with charcoal/wood	-1 to +1	0.52	0.65	0.74	0.804
Cooking with firewood is not convenient.	-1 to +1	0.67	0.35	0.16	0.114
Collecting/preparing firewood is a family burden	-1 to +1	1	0.14	-0.33	0.275
Firewood is expensive for cooking.	-1 to +1	0.17	0.25	0.37	0.355
Cooking with firewood is harmful to health.	-1 to +1	0.48	0.43	0.33	0.994
Charcoal is convenient to use for cooking.	-1 to +1	0.57	0.9	0.5	**0**
Cooking with charcoal is harmful to health.	-1 to +1	-0.25	-0.24	0.16	0.123
Electricity is expensive for cooking.	-1 to +1	0.91	0.84	0.78	0.458
LPG is expensive for cooking.	-1 to +1	-0.17	0.54	0.67	**0.001**

6.2 Purchasing preferences

When it comes to purchasing substantial household items, men are more likely than women to be involved. Men were more likely to be involved in making a decision to buy a cooking device (78% of households, compared with 62% for women), and to buy a solar panel (86% of households compared with 55% for women) (Table 63).

Table 63 Main decision maker for hypothetical household purchases

	Cooking device		Solar panel	
	Frequency	Percent	Frequency	Percent
male head of house	118	38	140	45
female head of house	69	22	45	14
joint decision	125	40	127	41
another relative	2	1	1	0
Total	314	100	313	100

A clear majority of respondents felt that people would like to rent equipment rather than buy it – see Table 64, and this was corroborated by the finding that 72% of respondents would prefer to pay for high value purchases (not specified) by monthly instalments rather than paying the total cost up front. Note that no respondents opted for weekly or monthly payments.

Table 64 How would people in your neighbourhood feel about the idea of renting equipment?

		Frequency	Percent
Valid	Very opposed	16	5.1
	Opposed	35	11.1
	No opinion	48	15.3
	Positive	182	58.0
	Very positive	33	10.5
	Total	314	100.0

6.3 Cooking device preferences

Overall, there appears to be a positive appetite for transitioning to cooking with some form of modern energy (see Table 65).

Table 65 How many people would switch to modern energy (gas/electric) if fuels cost were the same

		Frequency	Percent
Valid	none	20	6.4
	a few people	59	18.8
	some people	77	24.5
	many people	125	39.8
	Don't know	33	10.5
	Total	314	100.0

On details of any proposed design, 83% of respondents felt there was a need to a device to accommodate very large pots as well as medium sized ones. When presented with the three design configurations presented in Figure 13, preferences were split equally with a third of respondents voting for each. There was broad support for the idea of using a cooking device provided by the electricity utility company (see Table 66).

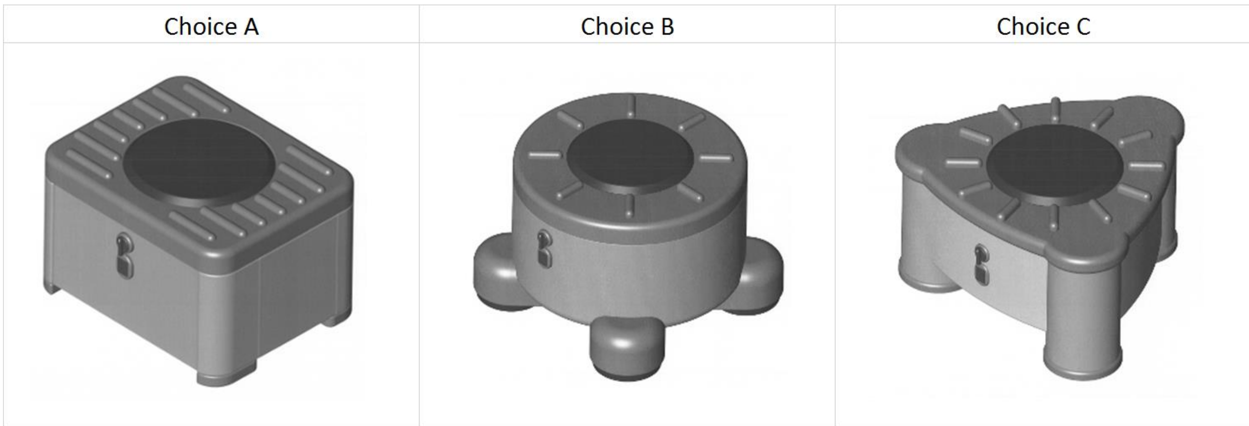

Figure 13 Hypothetical cooking device design options

Table 66 How would you feel about using a cooker provided by the electricity utility (UMEME)?

		Frequency	Percent
Valid	Very opposed	17	5.4
	Opposed	49	15.6
	No opinion	34	10.8
	Positive	168	53.5
	Very positive	45	14.3
	Total	313	99.7
Missing	System	1	.3
Total		314	100.0

When asked about preferences for improved cookstoves over a three stone fire, the majority of wood users said they would prefer to use a three stone fire (59%), highlighting resistance to change from traditional cooking practices.

7 Choices

7.1 Methodology

Discrete choice modelling was used as a means of exploring the key characteristics (or parameters) that cooking devices should have in order to find ready acceptance with consumers. Choice models are set up using choice cards, based on the key parameters identified, each of which has a limited number of ‘levels’. The respondent must then choose one of the two cards presented. Discrete choice models predict the probability that an individual will choose an option, based on the levels of each parameter given in the option.

Three sets of choices were posed to respondents, representing different aspects of cooking device design:

- Cooking processes – boiling and frying, speed (power), use of lid, number of hobs.

- Stove – capacity, smoke emissions, portability and looks.
- Additional functionality – lights, mobile phone charging, TV, financing options, ability to clean.

Fractional orthogonal design[15] was used to limit the number of choices to 16 choice cards per design aspect (Mangham, Hanson, & McPake, 2009). A simple constant comparator approach was used (De Bekker-Grob et al., 2010), in which one of the 16 choice cards was used as a 'reference'[16], and the 15 resulting pairs presented respondents with a choice between this comparator and each of the other choice cards. The literature suggests that respondents get fatigued when presented with too many choices, and a review suggested studies rarely used more than 16 choices (De Bekker-Grob, Ryan, & Gerard, 2012). For each technology the choice cards were therefore split in two sets (with 7 & 8 pairs in each), included in a Questionnaire A and Questionnaire B. Previous experience suggests that respondents can then successfully move on to further sets of 7 or 8 pairs of choices.

The analysis used binary logistic regression to fit predictive models to the data for each technology because the dependent variable was a dichotomous categorical variable (representing whether the choice card was chosen or not). All of the parameters were entered into the model, which calculated regression coefficients for each, along with p values indicating whether the parameter was significant in the model. The modelling was done using SPSS, and the output tables are presented in Section 7.2. The two main figures to look for in these tables are the beta coefficients (B), which reflect the strength of preference for each attribute, and whether each coefficient is significant in the model (Sig). If a variable is significant (Sig<0.05), then the larger the B value (positive or negative), the more important it is in the making a choice. Other statistics presented include the standard error (S.E.), which is a measure of how precise the beta value is likely to be – a large standard error means that that the actual beta value may lie within a wider range. The odds ratio (Exp(B)) is the change in odds resulting from a unit change in the predictor variable, and is another measure of the influence the variable has on people's choice, as is the Wald statistic. As all variables have been separated out into dichotomous dummy variables, the degrees of freedom (df) for all variables is 1.

Where the cost variable is significant in a model, a measure of willingness to pay (also known as implicit price) can be derived for each attribute from the ratio of the coefficients (Hanley, Mourato, & Wright, 2001):

$$WTP = \frac{-\beta_x}{\beta_c}$$

where:

β_x = coefficient of any parameter

β_c = coefficient of cost parameter

[15] Using SPSS software.

[16] The constant comparator choice card was selected on the basis that the mix of levels represented a mid-level of attractiveness, so one would expect the number of times the comparator was chosen and reject to be roughly balanced.

7.2 Discrete choice modelling results

7.2.1 Cooking processes

The variables used in the analysis are:

Cooking:
- 0 = boil only
- 1 = boil & fry

SpeedMed
- 0 = slow
- 1 = normal

Speedfast
- 0 = slow
- 1 = fast

Flavour
- 0 = no smoky flavour
- 1 = smoky flavour

Potlid
- 0 = no lid
- 1 = pot with lid

Pot sealed
- 0 = no lid
- 1 = sealed pot

2 hob:
- 0 = 1 hob
- 1 = 2 hob

4 hob:
- 0 = 1 hob
- 1 = 4 hob

Results from the binary logistic regression are presented in Table 67.

Table 67 Binary logistic regression – cooking processes

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Cooking(1)	.275	.089	9.616	1	.002	1.317
	SpeedMed(1)	-.410	.115	12.662	1	.000	.664
	SpeedFast(1)	-.334	.112	8.820	1	.003	.716
	Flavour(1)	-.181	.102	3.138	1	.076	.835
	PotLid(1)	.257	.145	3.137	1	.077	1.293
	PotSealed(1)	-.020	.113	.032	1	.858	.980
	@2hob(1)	.850	.104	66.503	1	.000	2.339
	@4hob(1)	.591	.118	25.108	1	.000	1.806
	CPCOSTC	-.392	.021	343.148	1	.000	.676
	Constant	1.334	.158	71.302	1	.000	3.795

Note: Compared against a constant only model, the model was significant (χ^2 = 589, p < 0.001, with df = 9); Nagelkerke R^2 = 0.157. Prediction success = 64.3%.

Those design features that appear to be most important to consumers are (see Table 68 for estimates of willingness to pay):

- Hobs – people have a strongest preference for double hobs, but would also prefer 4 hobs over just one.
- Cooking – prefer to be able to both boil and fry.
- Speed – it appears that people have no preference for a powerful device, rather they even prefer a slower device.
- Taste – there was no preference one way or the other for a smoky flavour, which contradicts the expressed belief that certain foods taste better when cooked on biomass (smoky) fuels (Figure 12).
- Cost.

Table 68 Willingness to pay for priority characteristics - cooking process

Feature	Willingness to pay (USH)
2 hob	22,000
4 hob	15,000
Slow (rather than normal)	10,000
Slow (rather than fast)	9,000
boil & fry	7,000

7.2.2 Stove

The variables used in the analysis are:

STPeople6:
- 0 = cooks for 4 people
- 1 = cooks for 6 people

STPeople8:
- 0 = cooks for 4 people
- 1 = cooks for 8 people

STSupplementSometimes
- 0 = always need to use with other stove
- 1 = sometimes need to use with other stove

STSupplementAll
- 0 = always need to use with other stove
- 1 = you can do all your cooking on it

STWoodSmoke
- 0 = no smoke
- 1 = gives same smoke as wood fire

STCharcoalSmoke
- 0 = no smoke
- 1 = gives same smoke as charcoal fire

STPortable
- 0 = cannot be moved (too heavy)
- 1 = can be carried in/out of the house

STLooks
0 = looks plain
1 = Looks good

Results from the binary logistic regression are presented in Table 69.

Table 69 Binary logistic regression – stove design

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	People6(1)	-.241	.107	5.060	1	.024	.785
	People8(1)	.442	.092	23.186	1	.000	1.556
	SomeCooking(1)	.063	.102	.386	1	.534	1.066
	AllCooking(1)	.122	.102	1.409	1	.235	1.129
	WoodSmoke(1)	-.371	.103	12.858	1	.000	.690
	CharcoalSmoke(1)	-.242	.110	4.871	1	.027	.785
	Portable(1)	.508	.083	37.018	1	.000	1.661
	Looks(1)	.049	.083	.344	1	.557	1.050
	STCOSTC	-.253	.018	197.448	1	.000	.777
	Constant	.994	.148	45.003	1	.000	2.701

Note: Compared against a constant only model, the model was significant ($\chi^2 = 332$, $p < 0.001$, with df = 9); Nagelkerke $R^2 = 0.092$. Prediction success = 59.9%.

Those design features that appear to be most important to consumers are (see Table 70 for estimates of willingness to pay):

- Portable – people would like a device that can be carried in/out of the house
- Capacity – people want to be able to cook for larger numbers of people (8 people). Interestingly, a device that cooks for 6 people appears to be no more attractive (actually, less attractive) than one that cooks for 4 people.
- Smoke – people would prefer a device that avoids generating any kind of smoke, but avoiding woodsmoke is particularly important.
- Cost.

Table 70 Willingness to pay for priority characteristics – stove design

Feature	Willingness to pay (USH)
Can be carried in/out of the house	20,000
Can cook for 8 people	17,000
Has no smoke (compared to wood smoke)	15,000
Has no smoke (compared to charcoal smoke)	10,000
Can cook for 4 people (rather than 6)	10,000

7.2.3 Device Functionality

The variables used in the analysis are:

FULED
0 = 2 hobs
1 = 2 hobs + 3 LED lights
FUMob
0 = 2 hobs
1 = 2 hobs + charge mobile phone
FUTV
0 = 2 hobs
1 = 2 hobs + television
FUAvailabe
0 = only works on sunny days
1 = works on sunny and rainy days
FU6yr
0 = pay each month (utility)
1 = lease over 6 years
FU3yr
0 = pay each month (utility)
1 = lease over 3 years
FUCleaning
0 = awkward to clean
1 = easy to clean

Results from the binary logistic regression are presented in Table 71.

Table 71 Binary logistic regression – device functionality

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	LED(1)	.218	.113	3.686	1	.055	1.243
	Mob(1)	.679	.125	29.648	1	.000	1.973
	TV(1)	.708	.124	32.616	1	.000	2.031
	Availabe(1)	-.161	.080	3.978	1	.046	.852
	@6yr(1)	.619	.112	30.512	1	.000	1.857
	@3yr(1)	.568	.090	39.706	1	.000	1.765
	Cleaning(1)	.324	.083	15.172	1	.000	1.382
	FUCOSTC	-.235	.017	184.387	1	.000	.790
	Constant	.219	.143	2.349	1	.125	1.245

Note: Compared against a constant only model, the model was significant (χ^2 = 371, $p < 0.001$, with df = 8); Nagelkerke R^2 = 0.101. Prediction success = 61.9%.

Those design features that appear to be most important to consumers are (see Table 70 for estimates of willingness to pay):

- Additional functionality – the strongest preference was for a device that can power other electrical appliances, especially TV and charging a mobile phone.
- Finance – people have a strong preference for leasing models over simply making regular monthly payments (for as long as they used the system). There was a mild preference for a 6 year lease period over a 3 year period. These findings are potentially difficult to interpret, as people were not given any detail on the relative magnitudes of payments.
- Having a device that was easy to clean.
- Availability – people appeared willing to accept a device that works only on sunny days, and even expressed a mild preference.

Table 72 Willingness to pay for priority characteristics – device functionality

Feature	Willingness to pay (MMK)
Device can power TV (as well as 2 hobs)	30,000
Device can charge mobile phone (as well as 2 hobs)	29,000
lease over 6 years	26,000
lease over 3 years	24,000
easy to clean	14,000
Works only on sunny days	7,000