Understanding the impact of Electric Pressure Cookers (EPCs) in East Africa

A Synthesis of Data from Burn Manufacturing's Early Piloting

May 2023 Working Paper

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Acknowledgments

This analysis was the result of a collaboration between the Shell Foundation, Burn Manufacturing, and the MECS team based at Gamos and Gamos East Africa. The Burn Manufacturing team designed and implemented a series of pilots to explore the product/market fit of EPCs in East Africa from 2019-2022. UK Aid supported several of these early pilots via the MECS programme, with further support for the commercialization of EPCs in East Africa through the Shell Foundation. The data analysed in this report was curated by Burn Manufacturing and analysed independently by the Gamos and Gamos East Africa teams as core partners on the MECS programme. The methodology for the analysis was co-created by Shell Foundation and MECS. The results of the analysis were collaboratively peer-reviewed by Shell Foundation, MECS, and Burn Manufacturing.
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Shell Foundation (SF) is a registered charity, founded by Shell in 2000, that exists to support people living in low-income communities to escape poverty and ease hardship. We create and scale business solutions to enhance access to energy and affordable transport as a means to achieve this.

BURN Manufacturing designs, produces and distributes Africa's best-selling, fuel-efficient biomass, electric, hybrid and liquid fuel cooking appliances. With more than 2.8 Million+ stoves sold since commencing manufacturing operations in 2013, BURN has established itself as Africa's most trusted cookstove brand thanks to our unwavering commitment to innovative research and design, manufacturing excellence, and customer care. Our research with low-income grid-connected households shows that Africa is ready for electric cooking and BURN is committed to helping families transition up the "energy ladder" towards zero-emission electric cooking.

Modern Energy Cooking Services (MECS) is an 8-year UKAid-funded research and innovation programme designed to enable households, businesses and institutions who cook with biomass to transition directly to modern energy.

Funded by:

Coordinated and implemented by:

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

Executive Summary

This study sought to understand the impacts of Electric Pressure Cookers (EPC) in East Africa by exploring the experience of customers who have purchased Burn's early models of EPC in commercial pilots of their *ecoa*-branded Electric Pressure Cooker (EPC) in Kenya, Uganda, and Tanzania.

Methodology

The analysis was guided by the following research questions:

1. What is the feedback from customers about the cost, performance, and other benefits of using BURN's EPC?
2. What is the usage profile of the EPC for different segments of the market?
3. What does the data flow say about energy use and time-saving?

The analysis involved cutting across data collected from customers before and after the introduction of the EPC using a variety of methodologies. These included surveys, cooking diaries, Kitchen Performance Tests (KPTs), and cross-referencing customer billing data from the utility. Data were collected from 200 households in Uganda, 24 in Tanzania, and 100 in Kenya.

Key findings

The results of the analysis show that there are considerable cost and time savings for households acquiring an EPC, in particular for households that are currently using charcoal as their primary fuel. There is a learning curve that needs to be overcome to maximize the benefits of the new appliance, however, Burn's sales and marketing team have refined their approach throughout this early piloting. Their established team in Kenya is now able to offer comprehensive training and after-sales support to new customers to make the most of their new appliance. Once new customers overcome this initial hurdle, the modern cooking experience combined with the substantial cost and time savings creates a strong driver for sustained use. This is evidenced by the high levels of sustained use seen in the Kenya pilot (43% of the menu cooked with the EPC 1 month after purchase) and much more moderate levels of use in Uganda (11%) and Tanzania (23%), where new and inexperienced sales and marketing teams were running the trials. What is more, in Uganda, training and after-sales service were also severely disrupted by covid lockdowns. This study highlights the fact that there is also a learning curve for new organizations/country teams, as the sales, marketing, and after-sales support services all need to be carefully crafted to enable new customers to understand the versatility of the EPC, or the usage rates (and therefore impact) of EPCs will be low.

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Figure 1: Burn's ECOA Electric Pressure Cooker with a customer participating in one of their early pilots in East Africa. Photo credit: Burn Manufacturing.

Detailed findings

The following sections dive deeper into the key findings from this cross-cutting analysis.

Cost savings

Figure 2 shows that when the total expenditure across all fuels is divided by the total number of respondents, the average household expenditure on cooking fuels at baseline was 3,400 KES/month (25.8 $/month[1]), and 1,850 KES/month (18.2 $/month) at the 3 months survey, representing an overall cost saving of 45%. This implies that the average customer saved 1,550 KES/month (11.8 $/month), which means that within around 7 months they could pay back the upfront cost of the EPC (assuming $70 upfront cost).

[1] Google Finance 29/3/23: KES/USD = 131.57

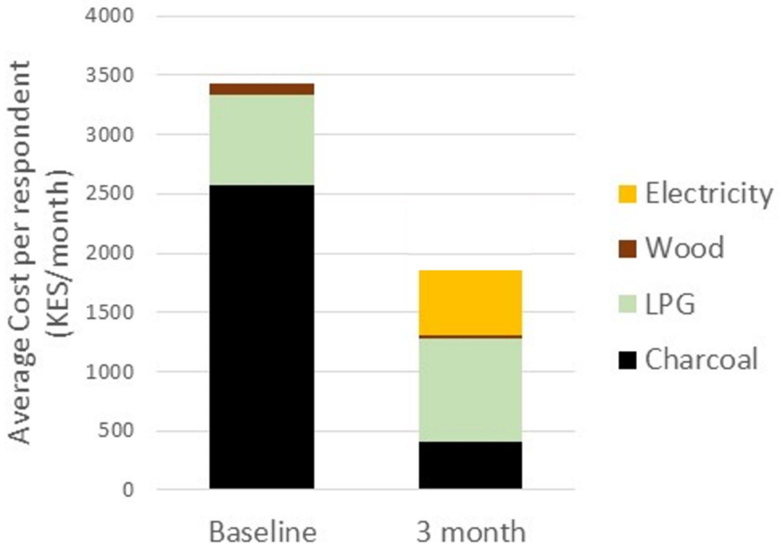

Figure 2: Average expenditures on cooking fuels and electricity for cooking from the Kitchen Performance Test (KPT) carried out with participants in Kenya.

Data from the Kenya pilot (**figure 3),** suggests that EPCs could make a valuable contribution to demand stimulation by increasing electricity consumption for a typical customer by 50-100% as many customers started from very low levels of consumption (<50kWh/month). Importantly though, the data shows that the resulting increase in expenditure is lower than savings on cooking fuel for most urban customers who are already paying for their cooking fuel. Comparing the electricity consumption of the 25 households participating in the Kenya pilot for whom customer billing data was obtained from the utility, average consumption over a four-month period (May-August) was found to have increased by 44% from 2021 to 2022 (**figure 3**). This is equivalent to a monthly increase of 19.5 kWh/household, or $3.6 (390 KSh) at 0.183 $/kWh (20 KSh/kWh). KPT data collected over three days (at the time of the 3-month surveys), gives an average electricity consumption of 1.16 kWh/day, equivalent to approximately 35 kWh/month, which is the same order of magnitude as the example households given in **figure 3.** At 0.183 $/kWh (20KSh/kWh), this is equivalent to 0.21 $/day or 6.5 $/month. During the public engagement surrounding the 2023 electricity tariff review, KPLC reported that the average monthly consumption from households across their entire customer base is just 35kWh, with 60% consuming less than 15kWh per month.

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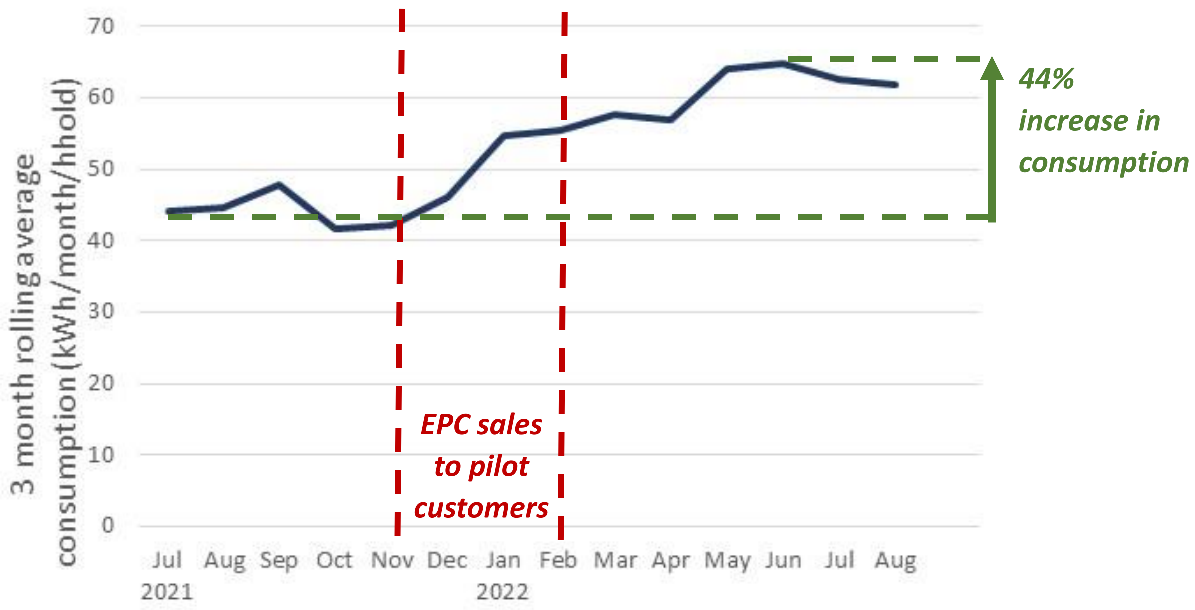

Figure 3 Trends in total household electricity consumption – 3-month rolling average (average across all 25 pilot customers where KPLC customer billing data was available, Kenya)

In Kenya, 77% of customers felt that their cooking fuel costs had decreased (**figure 4**) reporting a median drop in costs of 410 KES/week (3.1 $/week) or 1,640 KES/month (12.4 $/month). Compared to average baseline fuel expenditures of 3,400 KES/month (**figure 4**), this represents an estimated 48% saving. There was almost unanimous agreement that cooking with an EPC was affordable (97%). Less than half of respondents felt that their electricity bills had increased at all.

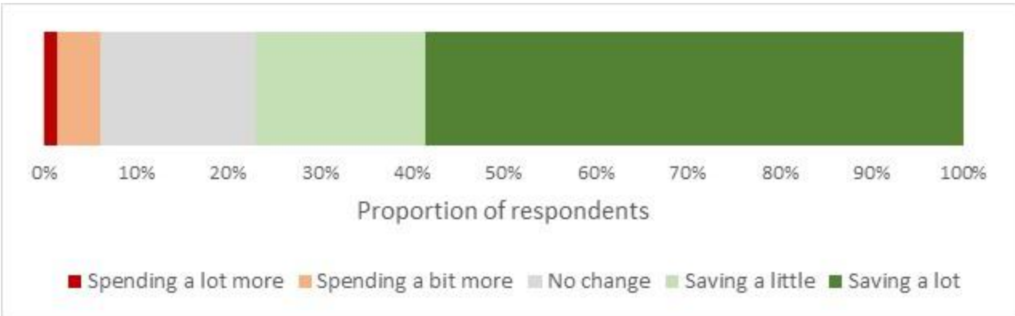

Figure 4:Perceived change in weekly fuel budget (3-month surveys)

In Uganda, the vast majority agreed that cooking with electricity is cheaper than their normal fuel (84%, **Figure 5**), and even more agreed that it was affordable (91%, **Figure 6**). Meanwhile, in Tanzania, 92% of customers felt that their cooking fuel costs had decreased. After acquiring an EPC, only 13% of respondents felt that their electricity bills had increased.

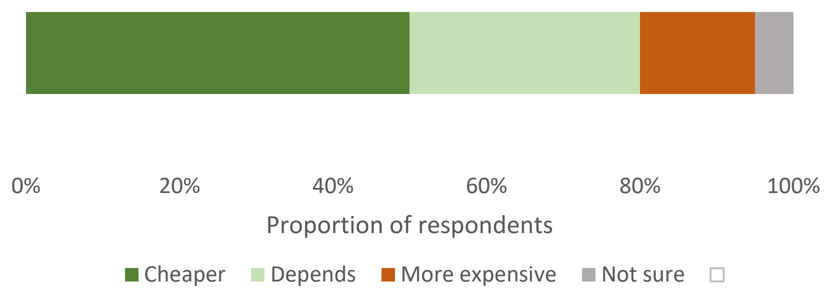

Figure 5: Is cooking with electricity cheaper or more expensive than using your normal fuel? (Uganda Exit survey)

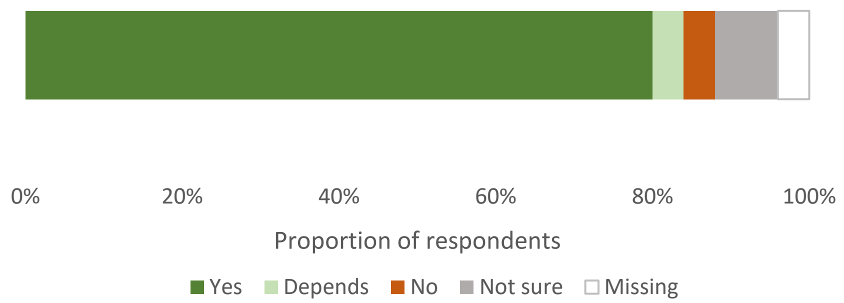

Figure 6: Do you think electric cooking is affordable? (Uganda Exit survey

Figure 7 shows that by the time of the 1-month survey in Kenya, participants had substituted the majority of their charcoal use with both electricity and LPG. The use of charcoal dropped from 75% of all dishes to 15%, with a total of 43% of dishes cooked with electricity. In Kenya, the ratios of energy use at the 3-month survey to the energy use at the baseline survey indicate that the adoption of EPC reduced charcoal use by over 90%.

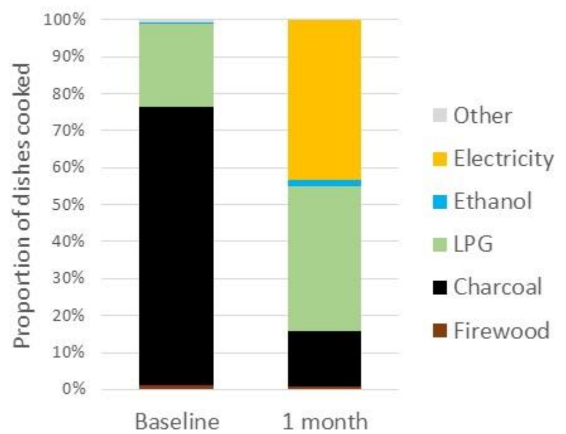

Figure 7:Fuels used to cook individual dishes (Kenya Cooking Diaries).

Table 1:Change in energy consumption and costs (Kenya KPT)

3-month data as a proportion of baseline data	Charcoal	LPG	Firewood
Relative consumption	9%	139%	44%
Relative cost	16%	114%	27%

Figure 8 shows that EPCs were used much less frequently in the Tanzania and Uganda pilots, making up just 23% and 11% of cooking events respectively. Relative costs were more difficult to calculate from the data available from the plots in these countries. In Uganda, EPCs were used in both the baseline and transition periods, meaning that a true before and after comparison was not possible. In Tanzania, although **figure 9** shows that electricity was used to cook substantially more meals after the introduction of the EPCs in the transition phase, electricity consumption appeared to decrease, which may be due to the use of inefficient electric appliances owned by participating households in the baseline period and/or inaccuracies in the self-reported data.

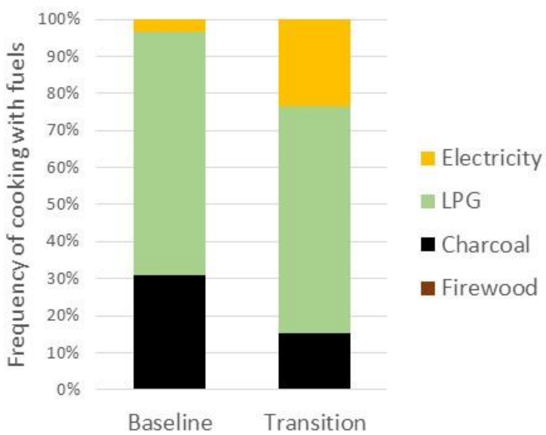

Figure 9:On the top, is the frequency of fuel used for cooking events in Tanzania (estimated from 3 month survey)

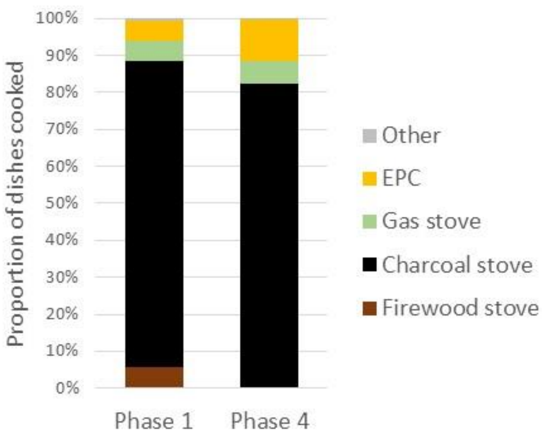

Figure 8: Proportion of dishes cooked is Uganda (from cooking diaries

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Findings from the MECS Electric Cooking Outreach (ECO) challenge fund offer a valuable reference point for Burn's data. 14 pilot studies in 9 countries across Africa and Asia were funded under the call, with 45-160 participants in each project trialling a range of energy-efficient eCooking appliances, including EPCs. Sieff's (2022) comparison of results from the ECO pilot studies conducted in Tanzania, Nepal, and Myanmar showed that the new electric events on average **(figure 10)**, appliances introduced during the studies were used for approximately one-third of cooking which is slightly lower than Burn's Kenya pilot (43%) and slightly more than their Tanzania pilot (23%). Electricity only became the primary cooking fuel in ECO pilots where multiple appliances were introduced (or where other electric appliances were already used before the pilot began, e.g. **figure 11** as a result, Burn may want to consider complementing its EPC with another appliance to electrify a greater proportion of its customers' cooking energy demand. However, the ECO pilot studies also highlighted the important role of LPG as a complimentary fuel that can enable households to move away from biomass and towards a completely clean fuel stack.

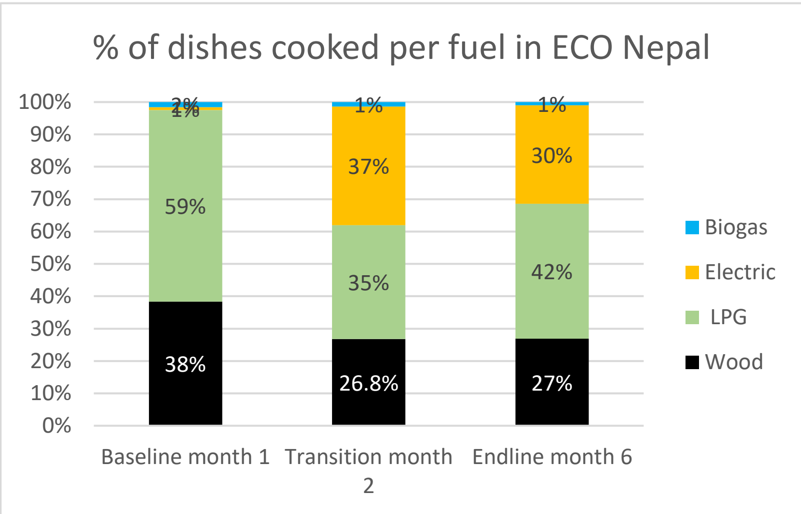

Figure 10:Percentage of dishes cooked per fuel across the different ECO pilots carried out in Nepal.

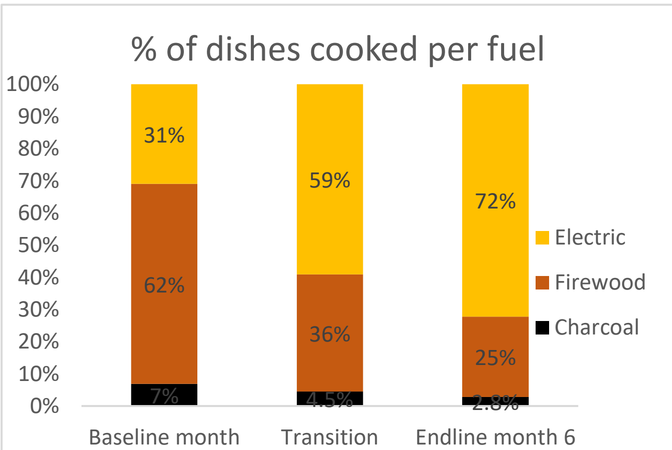

Figure 11: Percentage of dishes cooked per fuel in the ECO pilot study carried out by the Sustainable Energy Services Company (SESCOM) in Tanzania.

Time savings and other benefits

In Kenya, the 3-month surveys strongly highlighted time savings, taste, and safety as clear benefits of using the EPC **(figure 12),** 88% of respondents said that they spend less time cooking after using an EPC. Analysis of the reported cooking times during the baseline and transition periods revealed that cooking was approximately 43% quicker after adopting the EPC **(figure 13),** which equates to around 1 hour saved every day or almost a full working day saved every week. 97% of respondents said that food cooked in an EPC taste either 'good' or 'very good'. It also appears that after using the EPCs, people appreciated the clean cooking experience, along with the convenience of automation, pre-programmed buttons, and not needing to light a fire. EPCs appear to make the most difference when preparing dinners, which are the most labour-intensive meal, reducing the preparation time by over 50%.

Figure 12:Cooking events by fuel per phase by villages in rural Thazi (Myanmar) during the pilot by the French NGO, Geres

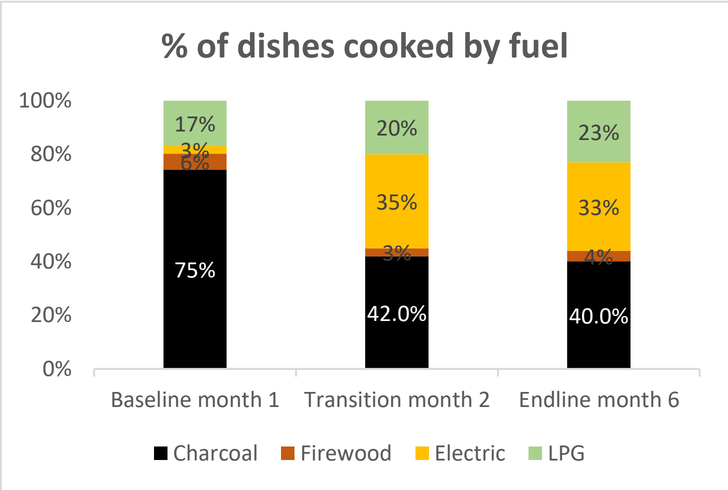

Figure 13:Comparing the experience of using EPC (3-month surveys) with expectations (Baseline) – Kenya.

Table 2: Time taken to cook meals (Kenya Cooking Diaries)

	Baseline		1 month	
	Time; median (minutes)	N	Time; median (minutes)	N
Breakfast	20	210	15	1758
Lunch	26	140	19	1267
Dinner	66	216	30	1905
Total	112		64	

The importance of the payment plan in enabling customers to make a purchase was highlighted by respondents in Tanzania **(figure 14)**. Top of the aspirational reasons for purchasing the EPC was wanting to improve the home environment, which covers cleanliness (clean kitchen and pots), and emissions (smoke).

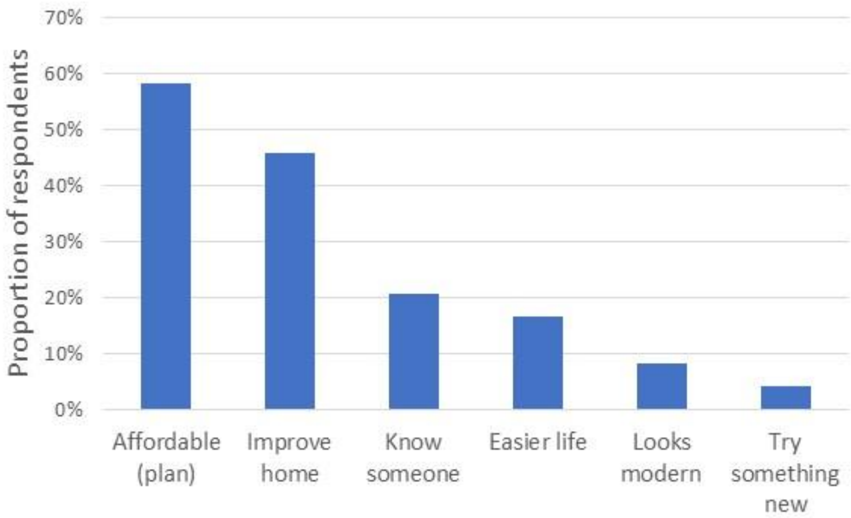

Figure 14: What made you purchase an EPC? (Tanzania Baseline survey)

During the 3-month surveys, customers were asked to think retrospectively about what their expectations had been when buying the EPC. The findings from Tanzania confirm the dominance of saving time in expectations, but they also indicate that the aspiration to a modern lifestyle is important (**Table 3**).

Table 3:'What problems did you want to solve when you bought the ECOA?' (3 months Survey)

Does not require full-time attention	96%
It's modern	50%
Fuel too expensive	17%
Saves space	13%
Health problems	8%
Unsafe fuel	4%

Aligning expectations with experience from before and after survey data showed that the EPC managed to deliver on the cost and time savings that it was marketed with. Whilst there were safety concerns initially, after using the EPC for 3 months, there was a unanimous view amongst Tanzanian participants that the *ecoa* was safe, with 96% saying it was 'very safe'. Customers' experience of using the EPC was overwhelmingly positive: 92% rated their experience as excellent, and none were negative. However, **figure 15** suggests that customers may not have found the EPC as easy to use as they had expected.

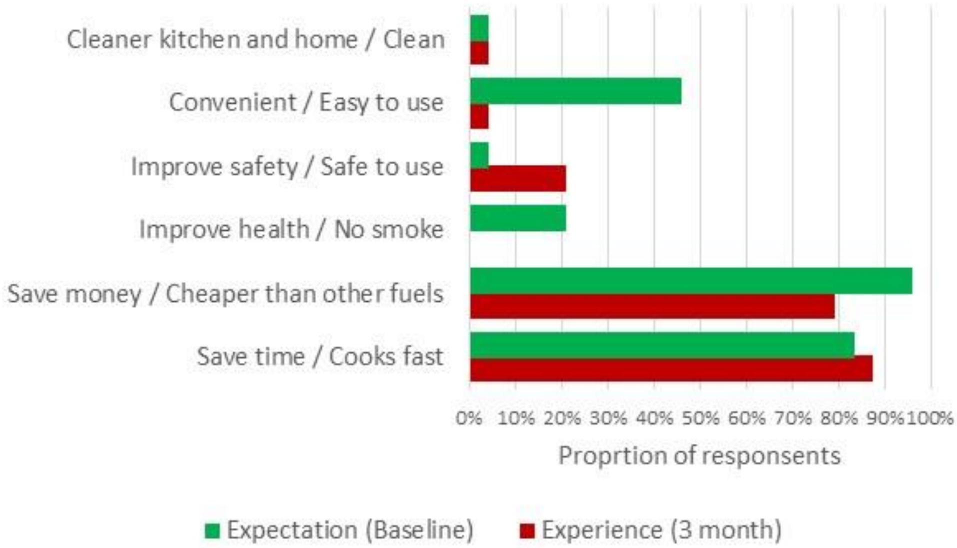

Figure 15: Comparing the experience of using EPC (3-month surveys) with expectations (Tanzania Baseline)

Nonetheless, it's important to note that the learning curve for EPCs keeps rising past the first 3 months. Many users adapt slowly to the easiest dishes first before they start exploring more complex dishes like ugali. Demonstrations, recipe books, video recipes, recipe-sharing groups, and other interventions have an important role to play in helping users to climb this curve as quickly as possible and start using their EPC as much as possible as early as possible. Design adaptations, such as the 'githeri button' on the Burn EPC can also play an important role in making the operation of the EPC as intuitive as possible and the accompanying recipe book can enable new users to understand the appliance's versatility.

In Uganda, 86% of respondents said that they had more time available once they started cooking with electricity. Some used the time to get on with other cooking tasks, such as washing up and preparing other food; others were able to get on with other household chores such as collecting water, washing clothes, and ironing; others used the time for income-generating activities. 90% indicated a preference for cooking with electricity, with breaking down the key reasons behind this.

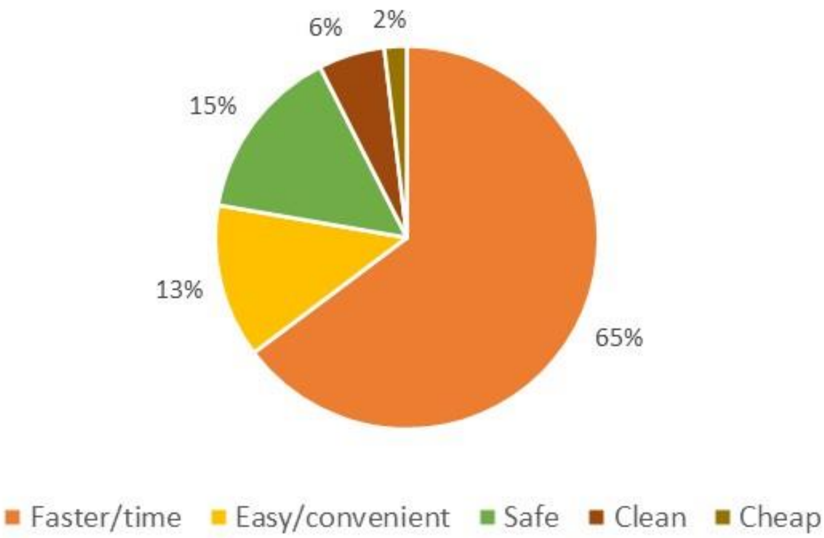

Figure 16: Reasons for preferring cooking with electricity over other fuels (Uganda Exit survey)

Across all of the dishes cooked in the Uganda Cooking Diaries study, median dish cooking times indicate that overall, dishes are cooked almost half the time when using LPG or EPCs (**table 4**). Further analysis of the Uganda cooking diaries data showed that cooking some dishes on LPG or the EPC, such as matoke, can save a lot of time compared to cooking on charcoal, whereas the time saving is more modest when cooking other foods such as soup and rice. Across all dishes where a comparison can be made, the average time saving when cooking with LPG was found to be 35% (compared to charcoal), but the average saving is 68% when cooking with an EPC. This is supported by analysis of the Kenya Cooking Diaries data, which also showed that cooking dishes such as cereals with the EPC can save a lot of time compared to cooking on charcoal, whereas the time saving is more modest when cooking other foods, such as porridge and meat stew.

Table 4: Dish cooking time – UG

Device	Number of dishes (N)	Cooking time (median)
Firewood	352	1:00
Charcoal	6330	1:18
LPG	540	0:45
EPC	404	0:35

Results in **table 5** show an NPS (Net Promoter Score) of 95 in Kenya. If the response categories used in the Uganda survey are mapped on to the NPS categories as in **table 5** then this implies an NPS score of 97. Similarly, responses from Tanzania Indicate high levels of customer satisfaction. There is no clear definition of how to interpret NPS scores, but scores of over 90 can safely be regarded as excellent.

Table 5: Customer satisfaction results – all countries (3-month surveys)

	Kenya	Tanzania	Uganda
n	65	24	90
Detractors/No	0%		1%
Passives/Undecided	5%		1%
Promoters/very likely/yes	95%	100%	98%

Challenges

Although the EPC is well suited to East African cuisine and many dishes can be cooked using an EPC, the customer feedback highlights a couple of notable constraints:

- **Adaptations to cooking practices:**
  - Firstly, having only a **single pot** makes it difficult to cook meals comprising more than one dish.
  - Secondly, **certain dishes** are not well suited to cooking in an EPC, such as chapati; however, it is suggested that most of the other complaints relating to difficulties cooking specific foods result from a lack of experience and understanding of how to cook using an EPC, e.g. getting the right amount of water or adjusting the cooking time. It is likely that users will learn how to adapt the cooking practices to overcome these difficulties in time. However, this process can be accelerated with carefully designed training materials for new users, including cooking demonstrations at the point of sale, recipe books, and video recipes.
- **The quality of the power supply** does not stop people from cooking with electricity, but it does limit the intensity of eCooking. Even though the proportion of customers affected by outages was similar in Kenya and Uganda, the quality of supply appears to be poorer in Uganda, given that outages were more frequent. Approximately half of the customers in both Kenya and Uganda felt that power outages had affected their use of EPCs; mostly by reverting to traditional fuels. It is not clear what 'reputational damage' this does for eCooking among potential customers, and this would merit further study.
- **Electrical safety** concerns were a priority among Ugandan customers (but this issue was not raised in Kenya). It is likely that these concerns relate to poor quality household wiring and damaged sockets and switches rather than EPCs themselves. Despite these concerns, electricity was still regarded as safer than other cooking fuels.

Potential impacts of scaled uptake

The final part of this study explored the likely costs and benefits for one simple illustrative scenario of scale-up of eCooking, drawing on and calibrating using the data from the Burn EPC pilots. The Kenya pilot was used as the basis for this analysis and the World Health Organisation' (WHO) revised "Benefits of Action to Reduce Household Air Pollution" (BAR-HAP) tool was applied to quantify the expected financial costs, and health and environmental benefits of the scale-up.

The results of the impact modelling showed that while this transition would cost the stove programme some $110 per household for equipment and programme costs ($20 mill/year for ten years, across 1.8 mill households), it would save households roughly four times that over the period, due to reduced energy bills each year. These numbers are all on an annualized basis from the full ten-year periods modelled and are thus not easy to relate to specific investments, however a simple calculation of the relative expenditures on charcoal and electricity before and after the introduction of the EPC showed that it's upfront cost would pay back in less than 8 months from savings on charcoal. Electricity tariffs are relatively high, but the EPC is highly efficient and fuel prices are also high. Furthermore, health benefits would include more than 130 lives saved per year and more than 7,000 cases of debilitating illness avoided per year. Some 1.4% of current unsustainable wood harvesting would be avoided (191,000 tonnes/yr). Some of these impacts may seem modest but this scenario is targeting only 12% of the national population (grid-connected charcoal users). From KPLC's perspective, the transition would bring a considerable increase in electricity demand, of some 285 GWh/year. The model did not look at power flows and thus the effect on loading of the grid is not known.

The transition from charcoal to electric cooking would make a significant reduction in greenhouse gas emissions, saving an estimated 1.1 million tonnes of CO2eq every year (4% of the total national cooking-related emissions). BAR-HAP monetises GHG emission reductions using a social cost of carbon, which they assume to be around $18/tCO$_2$. This is higher than typically achieved in the voluntary carbon market (where $8 would be more usual), but there is a significant opportunity to monetise the carbon savings to support the EPC transition using carbon credits.

The overall position is one of a large net social benefit from a transition to cooking with EPCs, offering more than $1,700 net social benefit per household over the ten-years considered[2]. The social benefits from avoiding time spent cooking are significant, reflecting time savings using an EPC (almost one hour per day), and the opportunity cost for peoples' time, as used in BAR-HAP.

However, by far the largest benefit comes from reduced fuel costs to households. Charcoal prices in urban areas were assumed to be $0.73/kg (KES80/kg), reflecting purchases in relatively small quantities), and the average spend on charcoal in the baseline case is KES2,500/month ($23/month). Even with electricity tariffs at $0.18/kWh (20 KES/kWh), the energy savings from the use of more efficient electric devices leads households to save almost $10 per month. The payback analysis showed that consumers would be able to pay off their investment in an EPC in less than eight months.

Key factors in achieving impact.

This is an impact analysis for one simple scenario of scaled uptake of EPCs, for just one particular segment (grid-connected charcoal users) of Kenya's population. The transition from charcoal to electric cooking offers considerable financial benefits for the user, although for many households some form of consumer finance or other support would be needed to break down the high initial investment. The modelling also shows that the transition at scale would bring very significant net

[2] The net social benefits are discounted over time, and the eCooking transition takes 5 years to build up, so as many of the benefits occur in the future, their net present value is heavily discounted.

social benefits for Kenya overall, based on the WHO's physical impact and impact monetization methodologies.

The variety of impacts and their level in any one country or region of course depends on many local conditions. Key factors that drive positive impacts for the transition to electric cooking include:

- Reliance on unsustainably sourced polluting fuels (notably firewood or charcoal) for large segments of the population.
- For use of an EPC, traditional and popular foods need to be suited to this device; e. g. beans and other long-boil dishes, such as stews.
- For grid eCooking: wide access to reliable grid electricity. However, it is possible to add a household battery to support cooking on less reliable grids and off-grid cooking with PV and battery (i.e. a large solar home system) is also becoming an increasingly viable option.
- The electricity supply (whether grid or mini-grid) should ideally be relatively low carbon. A high share of renewables is desirable, but even eCooking with electricity generated from natural gas can lead to lower emissions than cooking with charcoal.
- The relative price to households of electricity and traditional fuel is key. High electricity tariffs can still support eCooking if energy-efficient appliances are used and traditional fuel prices are also high.
- The price of EPCs (or other eCooking devices) is also important, underpinning payback times and overall economic benefit. The supply chains into countries, and border controls and tax policies vary widely and can significantly increase retail prices and create bottlenecks in the supply chain.

The above factors are all in place for Kenya, and hence the impacts are strongly positive. While the data from the pilot did not support similarly detailed modelling with BAR-HAP, the conditions in Uganda and Tanzania are broadly similar.

In Uganda, firewood and charcoal are the most widely used cooking fuels, with pressure on forests from intensive charcoal production. There has been limited use of LPG to date and electricity access rates have been historically low, but are growing steadily. The power supply is majority hydro, and there have been issues with load shedding in drought periods, but there has been considerable investment and a more diverse energy mix is in the pipeline.

In Tanzania, prospects are similarly positive. In particular, the lifeline tariff for electricity is very low, making eCooking financially attractive. Around 70% of urban households rely on charcoal and a presidential task force has recently been established to facilitate the adoption of alternative cooking fuels and technologies. LPG is seen by many as the most attractive alternative, in particular by high-level decision makers, and hence significant efforts would be needed to promote the transition to electricity as a viable and complementary strategy. Natural gas makes up the largest share of electricity generation, however, it is one of the cleanest fossil fuels and the Julius Nyerere hydropower station is due to double the national generation capacity in 2023.

Conclusion

The results of the analysis show that there are considerable cost and time savings for households acquiring an EPC, in particular for households who are currently using charcoal as their primary fuel.

There is a learning curve that needs to be overcome to maximise the benefits of the new appliance, however, Burn’s sales and marketing team have refined their approach throughout this early piloting and are now able to offer comprehensive training and after-sales support to new customers, which can enable them to make the most of their new appliance. Once new customers overcome this initial hurdle, the modern cooking experience combined with the substantial cost and time savings creates a strong driver for sustained use. This is evidenced by the high levels of sustained use seen in the Kenya pilot (almost 50% of the menu was cooked with the EPC 3 months after purchase) and much more moderate levels of use in both Tanzania and Uganda (where new teams who had not worked with EPCs before were responsible for setting up and supporting the EPC pilot). This was further exasperated in Uganda, where training and after-sales service were severely disrupted by covid lockdowns.

As a result, a key learning point from this study is that investment in training both end users and sales teams is critical for unlocking the social, economic, and environmental impacts that can be obtained from the adoption and sustained use of EPCs. Without this, EPCs tend to be used for a relatively limited set of dishes and therefore have minimal impact on the health, environmental and gender equity challenges that result from the use of biomass for cooking. Currently, EPCs are a niche technology in East Africa, so general awareness of how to cook popular local dishes is low. As they become more common, awareness will inevitably grow organically, however, concerted efforts will need to be made at this early stage to ensure that consumers are fully aware of the range of dishes that they can cook in an EPC and the specific adaptations that they need to make to their favourite recipes to achieve the same familiar taste. Only when customers are empowered with this knowledge can EPCs start to make a substantial contribution to reducing the use of biomass in kitchens across East Africa.

1 Introduction

1.1 Overview of this study

This study seeks to explore the experience of customers who have purchased Burn's early models of Electric Pressure Cookers (EPC) in commercial pilots conducted in Kenya, Uganda, and Tanzania. A number of surveys and action research trials were designed and implemented to understand the product/market fit of EPCs in East Africa.

This study involves reviewing Burn Manufacturing's data from the latest Electric Pressure Cooker (EPC) piloting carried out in Kenya, Uganda, and Tanzania. The analysis has been commissioned by Shell Foundation and was carried out by Gamos and Gamos East Africa on behalf of the MECS programme. The assignment seeks to explore the experience of customers who have purchased Burn's early models of EPC in commercial pilots and understand the product/market fit of EPCs in East Africa.

The analysis was guided by 3 research questions, which have been developed collaboratively by Shell Foundation, MECS, and Burn:

1. *What is the feedback from customers about the cost, performance, and other benefits of using BURN's EPC?*
2. *What is the usage profile of the EPC for different segments of the market?*
3. *What does the data flow say about energy use and time-saving?*

1.2 About Burn Manufacturing's Electric Programme

BURN Manufacturing designs, produces, and distributes Africa's best-selling, fuel-efficient biomass, electric, hybrid and liquid fuel cooking appliances. Not only do our products save money, fuel, and natural resources, but they also dramatically reduce harmful indoor smoke emissions which can cause significant health problems. With more than 2.8 Million+ stoves sold since commencing manufacturing operations in 2013, BURN has established itself as Africa's most trusted cookstove brand thanks to our unwavering commitment to innovative research and design, manufacturing excellence, and customer care. BURN has spent the last 3 years investing nearly $3 million in research, development and testing of its electric product suite, including the ECOA Electric Pressure Cooker (EPC). With pilots complete in Kenya, Uganda and Tanzania, and a validated consumer financing model in place, BURN is rolling out electric stoves to African countries with high grid access and affordable electricity. Our research with low-income grid-connected households shows that Africa is ready for electric cooking. BURN is committed to helping families transition up the "energy ladder" towards zero-emission electric cooking.

Figure 17: The Burn ecoa EPC used during the eCooking pilots described in this report.

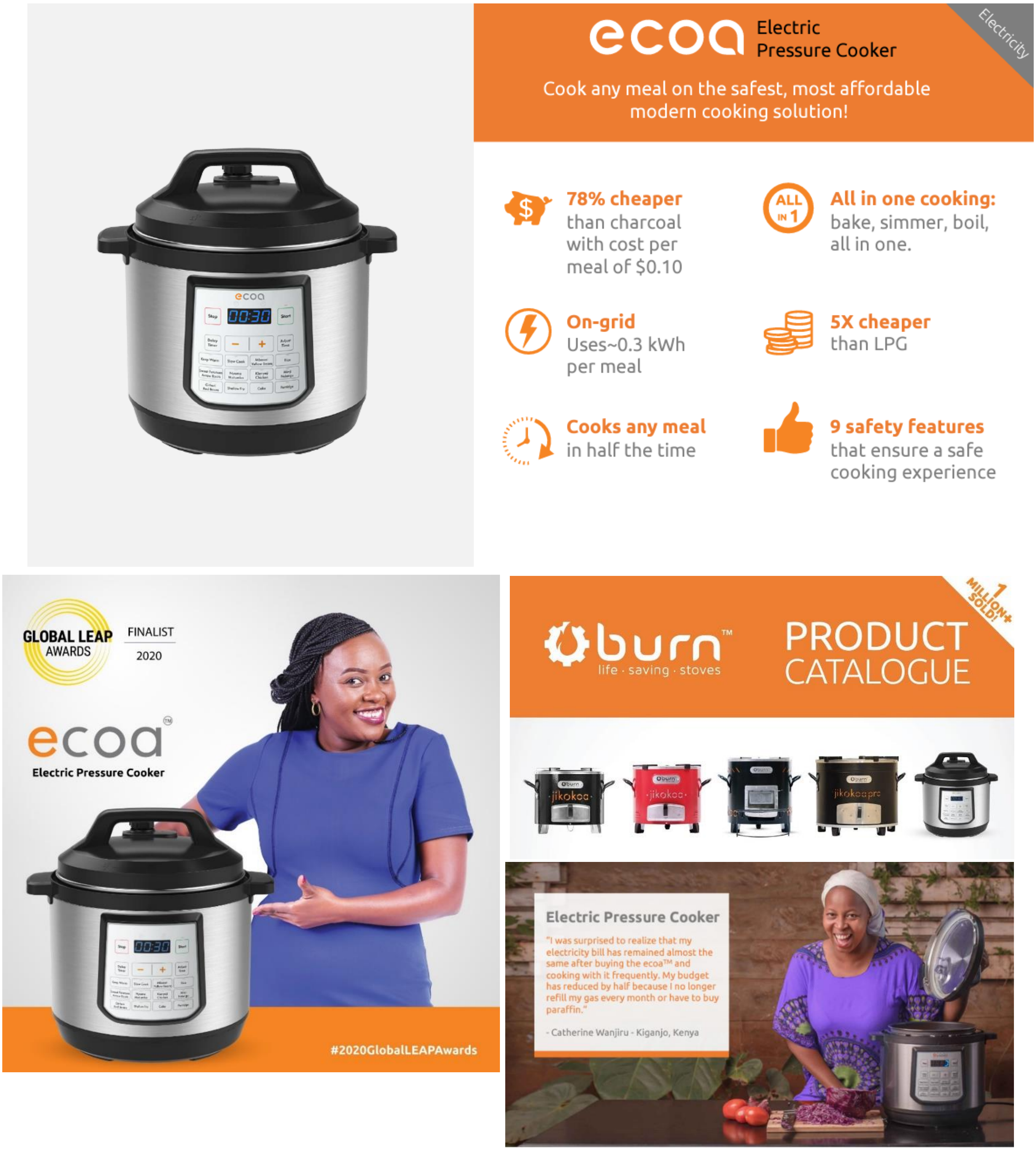

Figure 18: Promotional materials used by Burn Manufacturing to showcase their ecoa EPC.

BURN MY-8001

Large AC Power

FINALIST

SPECIFICATIONS

Capacity (L)	8
Nominal Voltage & Frequency (V / Hz)	230 Vac / 50 Hz

TEST RESULTS

Heating Phase	Total Energy Consumption (Wh)	567.9
	Average Power Draw (W)	1193.8
	Thermal Efficiency (from 30-90°C)	77.7%
	Temperature: Max (°C)	116.0
	Time to Reach Pressure Cooking Phase (min:sec)	30:24
Pressure Cooking	Total Energy Consumption (for 30 min; Wh)	35.9
	Average Power Draw (W)	71.8
	Temperature: Max / Min / Ave (°C)	116 / 109.1 / 111.6
	Pressure: Max / Min / Ave (kPa)	89 / 53.4 / 65.5
Sauté Cooking	Calculated Total Energy Consumption (for 20 min; Wh)	233.1
	Average Power Draw (W)	466.1
	Temperature: Max / Min / Ave (°C)	159.2 / 124.3 / 150.5
	Temperature Stability (% time in ideal range)	94
	Time to Reach Sauté Temperature (min:sec)	07:24
Affordability	Unit Price ($-$$$$)	$
	Estimated Annual Operating Cost (at USD$0.20/kWh)	$61.09

burn™ life · saving · stoves

Affordability Prize Winner

Company	BURN Manufacturing
Sales Contact	Rebecca Wentworth
Phone	+ 254742642811
Email	rebecca.wentworth@burnmfg.com
Website	Burnstoves.com

2020 Buyer's Guide for Electric Pressure Cookers

17

Figure 19: Technical specifications of the Burn ecoa EPC tested in this set of pilots, as reported in the 2020 Global LEAP Awards for EPCs Buyer's Guide (CLASP 2020).

Burn Manufacturing is committed to the local manufacture of cooking devices. In Kenya, 400 people, of which 50% are women, are employed at the solar-powered manufacturing facility in Ruiru. Burn will soon open manufacturing hubs across the continent, with factories in Ghana and Nigeria set to begin production later this year. Although much of Burn's electric product suite is manufactured internationally, assembly of the electronic components is already taking place in their Kenyan facility (**figure 20**) and with time, more and more of the value chain will shift into their local manufacturing hubs.

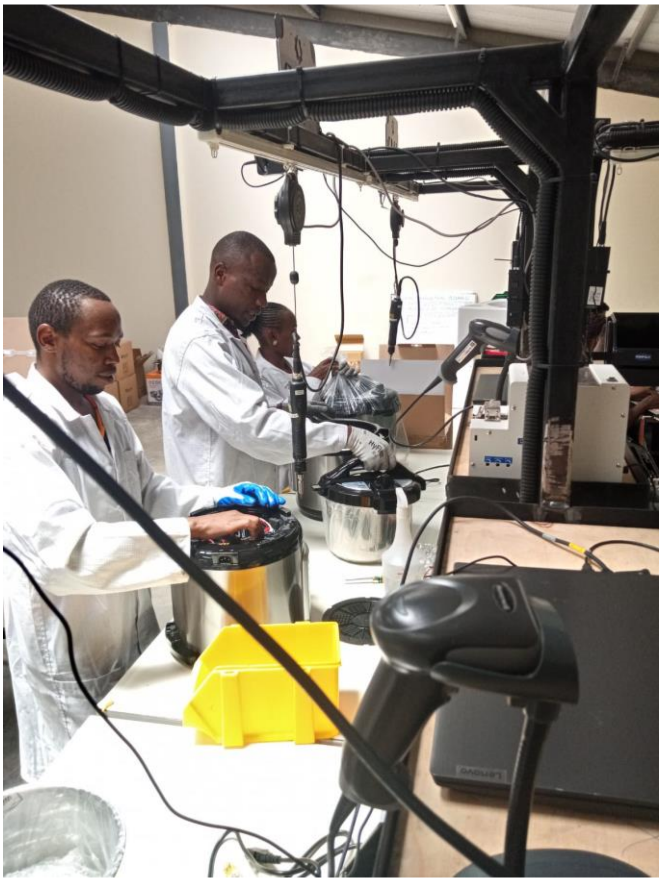

Figure 20: Assembly of electronic components in Burn's manufacturing facility in Kenya.

1.3 Impacts of EPC usage

1.3.1 Cost savings

The cost-saving dimension of EPCs has been well-documented in the extensive multi-county field trials carried out by the MECS programme and its partners (ESMAP 2020; (Sieff 2022); **figure 21** . The Kenya eCookBook (Leary and Fodio 2019) showed that the EPC is a cost-effective option for cooking dishes that require long boiling and can reduce the cost of cooking by an estimated 80 percent versus a standard hotplate.

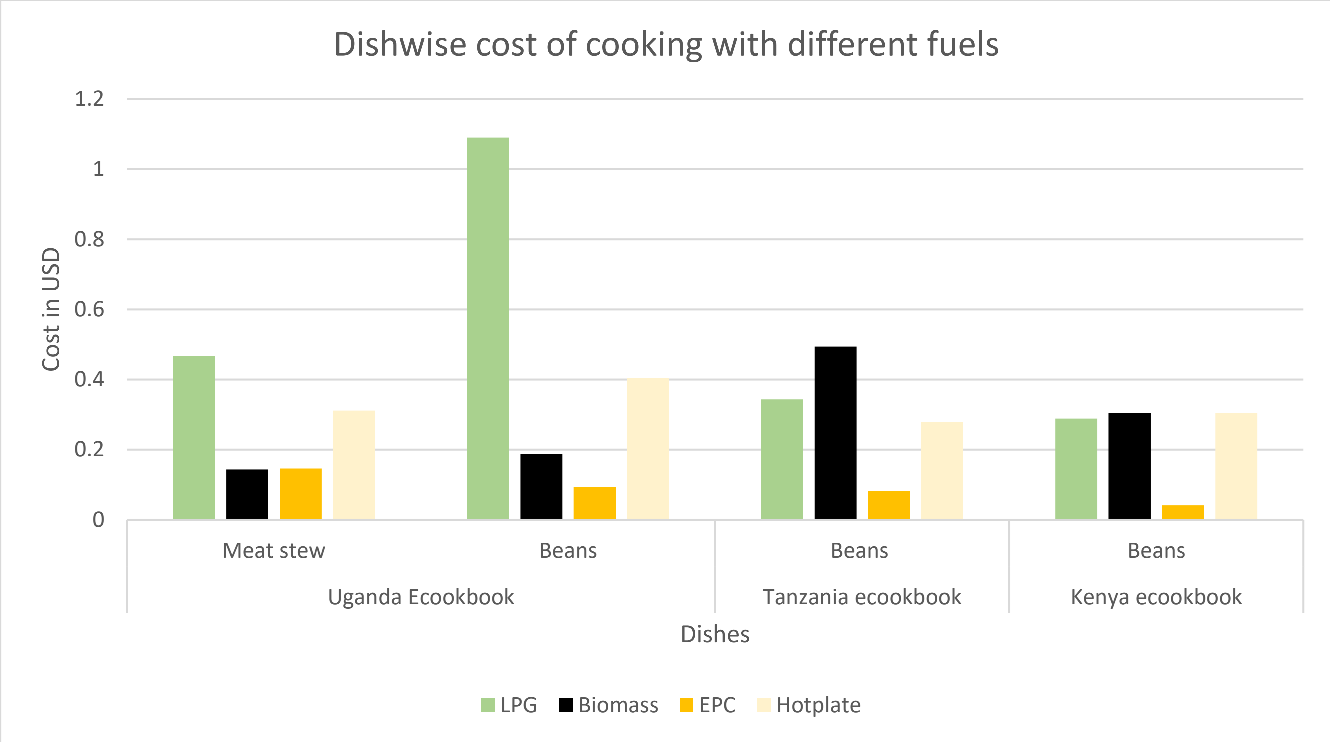

Figure 21: Comparison of the cost of cooking studies between some studies

The Kenya eCookBook (Leary and Fodio 2019) includes a comparison of the costs incurred by boiling yellow beans across multiple cooking fuels including charcoal, LPG, firewood, kerosene, and electricity using the EPC and electric hotplate. It is cheapest to cook beans using an EPC. Using a variety of dishes, the Uganda and Tanzania eCookBooks also report similar findings for at least some dishes, especially those that require boiling or steaming for long periods (CREEC 2020); (Naluwagga and Tesfamichael 2022).

Even within mini-grids, which typically have higher tariffs, it is still often cheaper to cook foods like rice and beans using an EPC than it is to use alternatives like charcoal and firewood, unless fuel is collected for free (Inston and Scott 2022). Estimates from a test with rice and beans (as separate dishes) show that charcoal requires approximately 40 times more energy than cooking using an EPC (Inston and Scott 2022). In a separate study involving KPTs with households that are grid-connected and those using solar eCooking systems, there was a significant reduction in the expenditure on cooking fuels, and households were able to save approximately 44 percent of their cooking costs by adopting a fuel stack of LPG and the solar DC or grid-connected AC EPC (Maina and Spencer 2021).

Some studies have compared EPCs with less-efficient eCooking appliances, which have demonstrated that appliances such as the electric hotplate are significantly more costly to cook with than an EPC (ESMAP 2020) (Leary and Fodio 2019). While the upfront cost of such appliances is lower than energy-efficient appliances, cost savings, and the long run, have been found to more than offset this cost difference (ESMAP 2020).

Consumer testimonials on the cost of using EPCs for cooking have largely been positive. A study by Efficiency for Access & 60_decibels (2021) highlights the experiences of 400 customers who purchased EPCs as part of a Results-Based Financing (RBF) programme supporting the sale of approximately 5,000

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EPCs in Kenya. 92% of customers said that their quality of life improved after acquiring their EPC and 31% saw a reduction in their expenses and a corresponding improvement in their savings. For those switching from charcoal to EPC use, find a significant reduction in the cost of cooking. For example, one of the male respondents noted that when using EPC, he now boils dry beans for a period of 45 minutes which costs him only 20 shillings(0.16 USD) and charcoal would have required 2kg which would cost 140 shillings (1.13 USD) (Efficiency for Access, & 60 Decibels 2021).

1.3.2 Time Savings

The EPC can offer a much quicker, more autonomous, and more modern cooking experience for many cooks. This can occur in multiple ways:

- First, for those using firewood, there is a reduction in the time spent collecting, specifically for women and children (Couture and Jacobs 2019) (Lambe, Nyambane and Bailis 2020) (Maina and Spencer 2021).
- Secondly is in the time spent doing the actual cooking due to the increased speed of cooking foods under pressure (see **figure 22**).
- Lastly, cooking with appliances like the EPC demands less in terms of time spent monitoring the food and open fire due to its automatic control of the cooking process (Naluwagga and Tesfamichael 2022) (Schreiber, Waceke and Blair 2020).

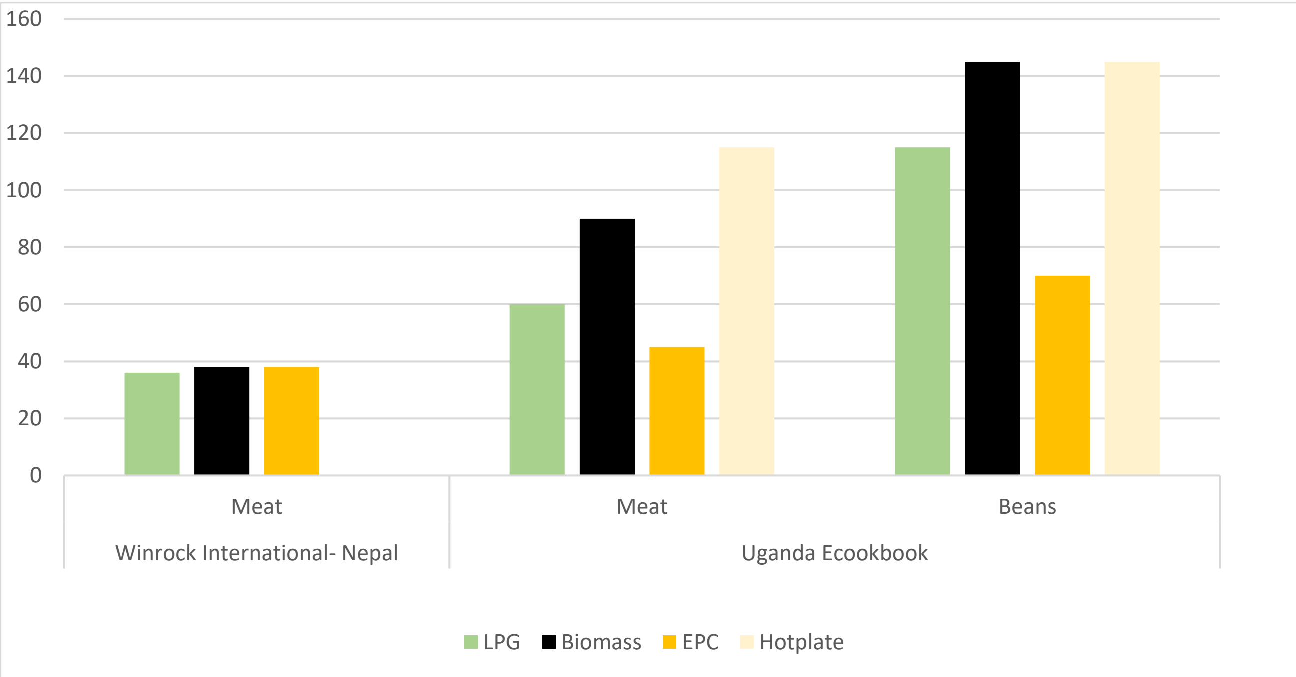


Figure 22: Comparison of time spent cooking with a range of fuels from a number of studies.

According to Naluwagga and Tesfamichael (2022) estimated EPC use to be up to two times faster than charcoal and a third quicker than LPG. The result is significant savings in the overall time spent cooking (Sawe and Aloyce 2020). These time savings are higher in the case of dishes that are boiled for a long time, for example, beans.

Efficiency for Access & 60_decibels (2021) reported that 31% of participants mentioned significant time-saving from using EPCs. Participants indicated benefits such as less time spent gathering firewood and time saved from the efficiency of the EPC. The ability to multitask has also been reported by women, who can, for example, watch the news while cooking, due to the fully automated nature of the EPC that allows it to be left unattended (Naluwagga and Tesfamichael 2022).

1.3.3 Carbon Savings

Several studies have sought to quantify the displacement effect of electricity on the use of charcoal in localized settings following the introduction of EPCs. Unsustainable firewood harvesting causes deforestation and forest degradation, as well as carbon emissions. The introduction of clean cooking fuels can deliver climate benefits due to the notable reduction in greenhouse gas emissions (Parikh, et al. 2019). While LPG is categorized as a clean cooking fuel and can be a climate-friendly option, (Parikh, et al. 2019) indicate that there is concern that it is a fossil fuel and that it still produces carbon dioxide on combustion, albeit in lower quantities than wood fuel.

Of particular note are the set of eCooking Market Assessments (Leary 2021), which used the WHO's BAR-HAP (WHO 2021) tool to model the potential carbon savings of a large-scale transition to electric cooking in specific countries. They noted 3 types of countries:

1. High impact across the board: Uganda, Rwanda, Kenya, Ethiopia and Mozambique all have substantial populations dependent upon charcoal, much of which is unsustainably sourced & inefficiently burned charcoal. Meanwhile, electricity generation is predominantly renewable and electricity tariffs are moderate/low. As a result, there are high potential impacts in all categories. For example, in the case of Rwanda, if 40% of grid-connected charcoal users (2.9m ppl, 0.7m HHs) switched to eCooking, BAR-HAP suggests that:
   • 669 DALYs/yr would be avoided
   • 0.54m tonnes/yr CO2eq emissions would be reduced
   • there would be a 0.21m tonnes/yr reduction in unsustainable wood harvest
   • 133m hrs/yr of women's time would be saved (191hrs/HH/yr)
   • there would be a 14-month payback for eCooking appliances ($80/HH upfront cost, $75/HH/yr savings on fuel energy costs)
   • 236 GWh demand for electricity would be stimulated.
2. In Nepal & Bangladesh, there is minimal use of commercialized polluting fuels, so grid-connected firewood users were targeted. In both countries, there is a high usage of unsustainably sourced and inefficiently burned firewood, as well as moderate/low electricity tariffs. In Nepal, electricity is generated almost exclusively from hydro, whilst in Bangladesh it is almost entirely fossil fuel based. However, both countries still showed high potential impacts across the board as Bangladesh uses gas to generate electricity, which a less carbon intensive fossil fuel than coal or oil.
3. In Benin charcoal is widely used, however deforestation/forest degradation is less of a challenge than the other countries studied, and charcoal prices are therefore lower. Meanwhile, electricity generation is dominated by imported fossil fuels (mostly oil) and the utility charges a higher electricity tariff than the other countries. As a result, the modelling suggested negative carbon impacts (i.e. an increase in emissions), no payback on appliances

(as there were no cost savings from switching to eCooking), a minimal impact on deforestation/forest degradation and only moderate impacts health and women's time.

1.3.4 Health impacts

Several studies have shown that respiratory complications such as wheezing, phlegm in the chest, chest cough, bronchitis, and asthma, among others are less prevalent in households cooking with electricity (Accinelli, López and Aguirre 2015); (Albers, et al. 2015) ; (Buthelezi, et al. 2019); (Capuno, Tan and Javier 2018). (Albers, et al. 2015) compared the respiratory outcomes in children from South African households where electricity was used as a primary cooking fuel and those that used other fuels. The authors report a higher prevalence of respiratory illness among those using non-electrical fuels for cooking and space heating. This is reinforced by the findings of (Accinelli, López and Aguirre 2015) in Peru, the authors find a protective factor against a cough in households that used electricity for cooking over those that used biomass and improved biomass stoves for cooking.

The study by (Efficiency for Access, & 60 Decibels 2021) records high consumer satisfaction among EPC users, with participants reporting a reduction in the smoke produced while cooking, cleaner pots with no soot, and, therefore, cleaner surfaces in the house (Maina and Spencer 2021)KPT also found that fuel stack of LPG and an EPC reduced the use of biomass to almost zero.

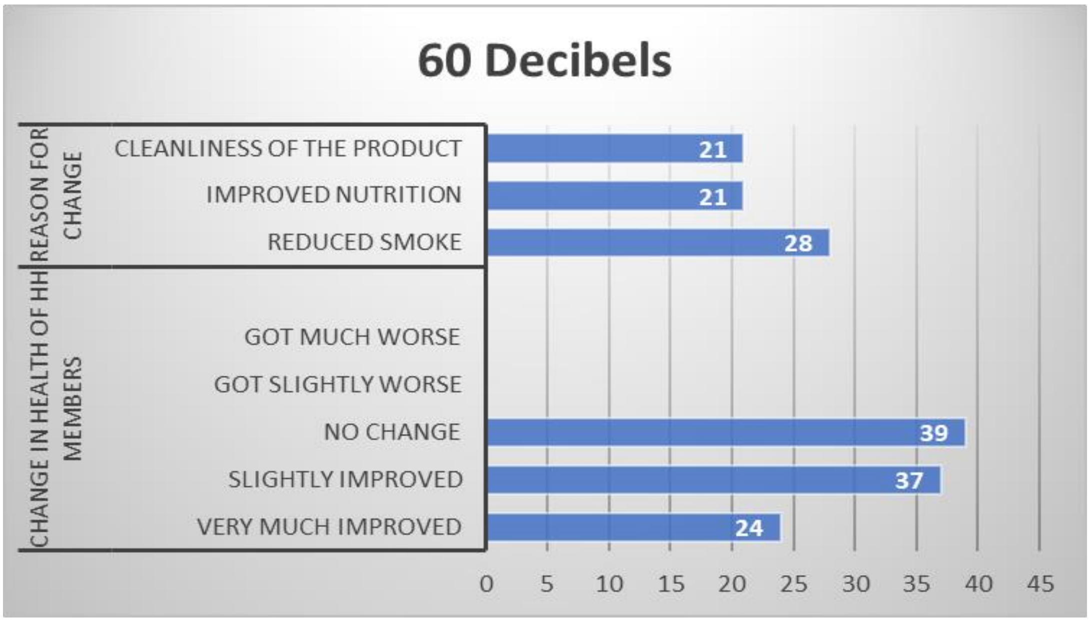


Figure 23:Feedback from customers purchasing EPCs through a Results-Based Financing (RBF) programme in Kenya (Efficiency for Access & 60 Decibels, 2021)

In a meta-analysis of a range of action research studies designed to understand the compatibility of modern energy-efficient appliances with different cooking cultures, (Sieff 2022) reports that the key motivating factors for using eCooking appliances amongst households participating in an action research study in Nepal were ease of use, time-saving, and fuel efficiency.

Figure 24: Factors influencing households to use eCooking appliances in Nepal (Seiff, 2022). In Myanmar, household participants specifically enjoyed eCooking because it saved time, freeing up time for other activities such as work, household tasks, prayers, and entertainment.

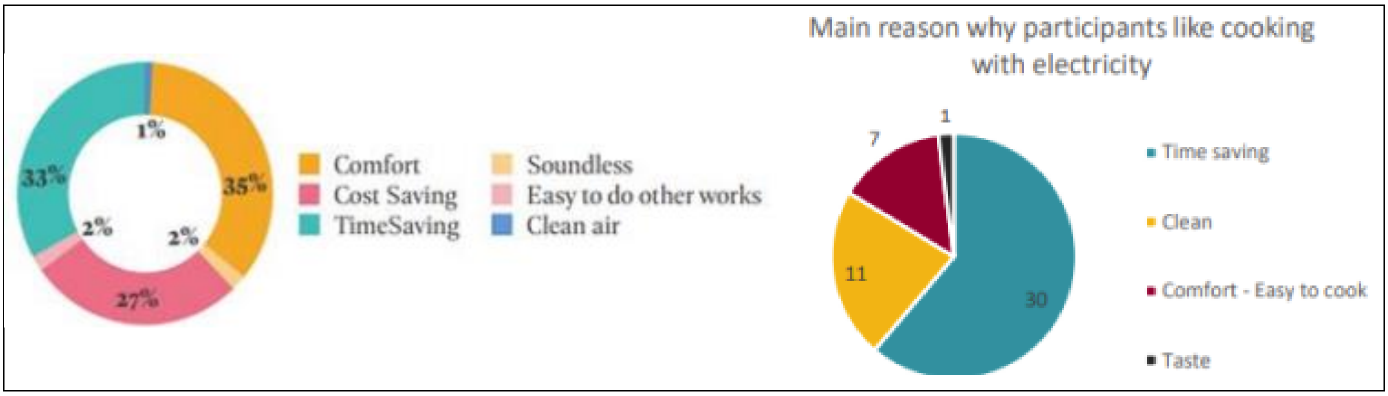


Figure 24: Factors influencing households to use eCooking appliances in Nepal (Seiff, 2022).

1.3.5 Change in cooking habits.

A growing body of research shows that a shift in eCooking is often accompanied by a shift in the cooking habits of households. This could be in terms of the dishes prepared by users, cooking times, or the frequency of cooking. In the cooking study by (SESCOM, Nexleaf, & TAFORI 2021), there was a general increase in the preparation of fresh meals and a move from partially precooked or reheated phases. This, they attributed to the fact that cooking using the EPC was faster and more affordable, eliminating the need for precooked foods for later use. It is no longer a requirement, in the case of dishes like beans, for households to cook in bulk and save in the refrigerator for later use (SESCOM, Nexleaf, & TAFORI 2021).

Several field trials highlighted the fact that a clean fuel stack of LPG and an EPC is much more likely to enable cooks to move completely away from biomass than either alone. (Naluwagga and Tesfamichael 2022) highlighted that some of the users participating in their field trial in Uganda shifted completely from using charcoal to cook and now use a fuel stack of the EPC and LPG. (Maina and Spencer 2021) Kitchen Performance Test (KPT) also found that a fuel stack of LPG and either grid or solar-powered EPC was able to reduce the use of biomass to almost zero for some participants in their field trial in Kenya.

Sieff (2022) synthesized the results from Winrock International and Practical Action's pilot studies in Nepal under the ECO (Electric Cooking Outreach) programme. **Figure 25** shows that Winrock International saw an increase in the use of eCookers from 0.7% during the 1st phase to 17.5% at the end line (6 months later). Practical Action also recorded a significant increase in the use of eCookers from 0% during the baseline phase to 35% after the endline. Usage was even higher, at 60%, during the transition phase of this trial, when the appliances were new and exciting, and the electricity cost was paid for.

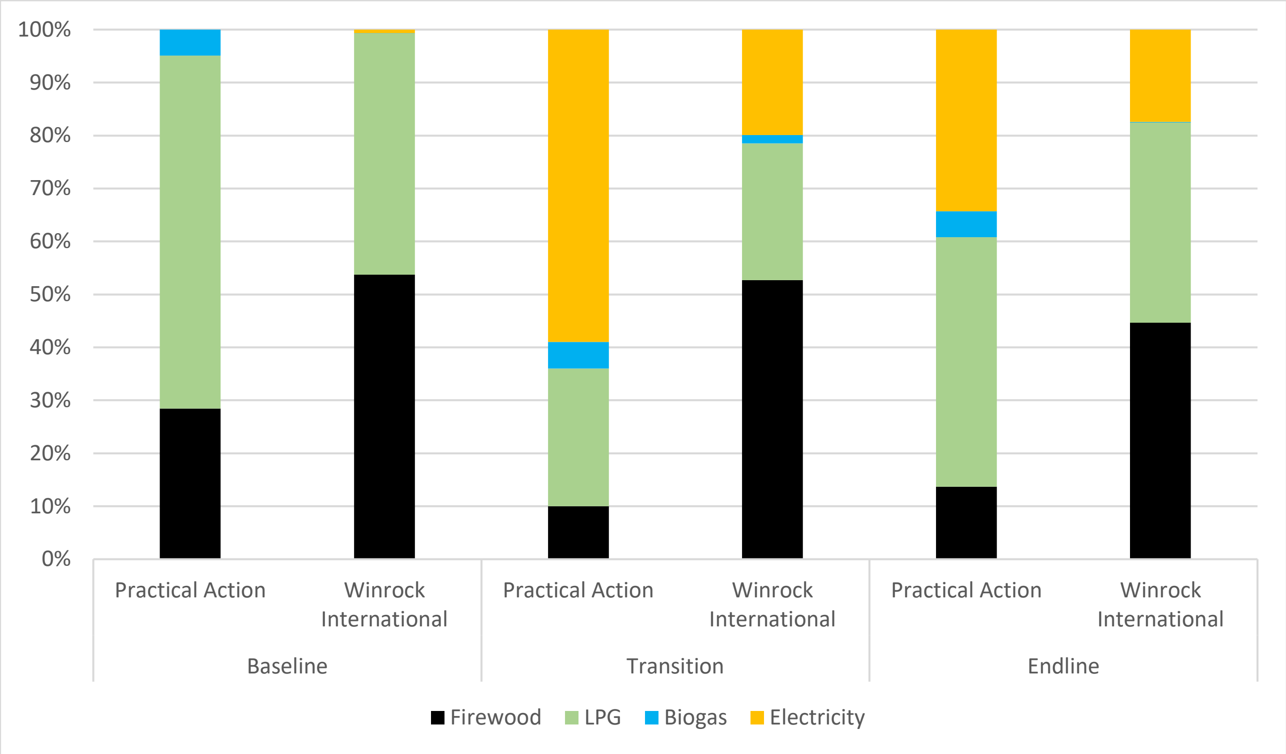


Figure 25: Fuel Types used by households participating in cooking diaries across different stages of le multiple studies in Nepal (Sieff, 2022).

Sieff's (2022) comparison of results from the ECO pilot studies conducted in Tanzania, Nepal, and Myanmar showed that the new electric appliances introduced during the studies were used for approximately one-third of cooking events on average. During the baseline phases of the study, biomass made up a significant proportion of the collective fuel stack, with households in Nepal recording 38% biomass use, Tanzania 75%, and Myanmar 62%. When the energy-efficient electric cooking appliances were introduced during phase 2 of the study, the use of biomass dropped significantly, with electricity displacing a large proportion of biomass use in the fuel stack in all three countries. In studies where single appliances were introduced, electricity was typically used for around one-third of cooking events. However, electricity was able to become the primary cooking fuel in studies where multiple appliances were introduced, or where other electric appliances were already used before the pilot began (such as Geres' pilot in Myanmar shown in **figure 28**.

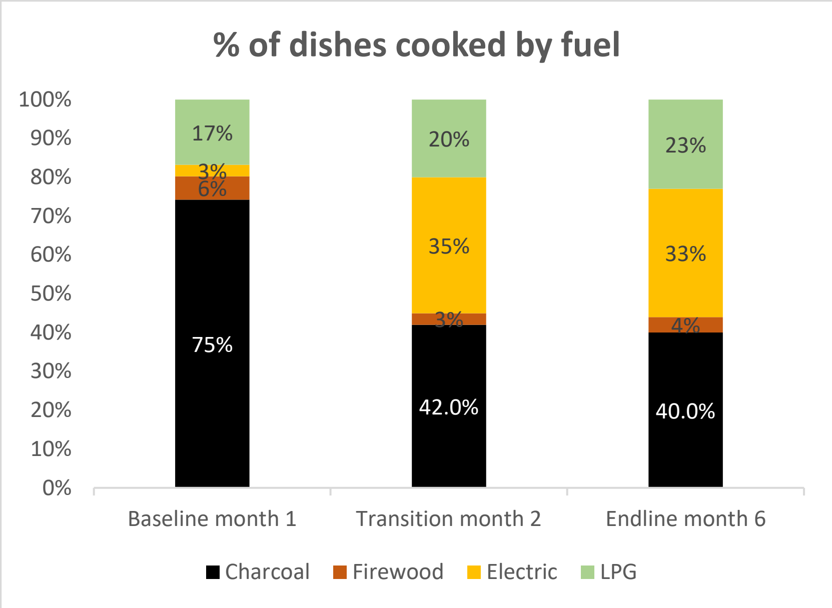


Figure 26:The percentage of dishes cooked per fuel in the ECO pilot study carried out by the Sustainable Energy Services Company (SESCOM) in Tanzania (Sieff, 2022).

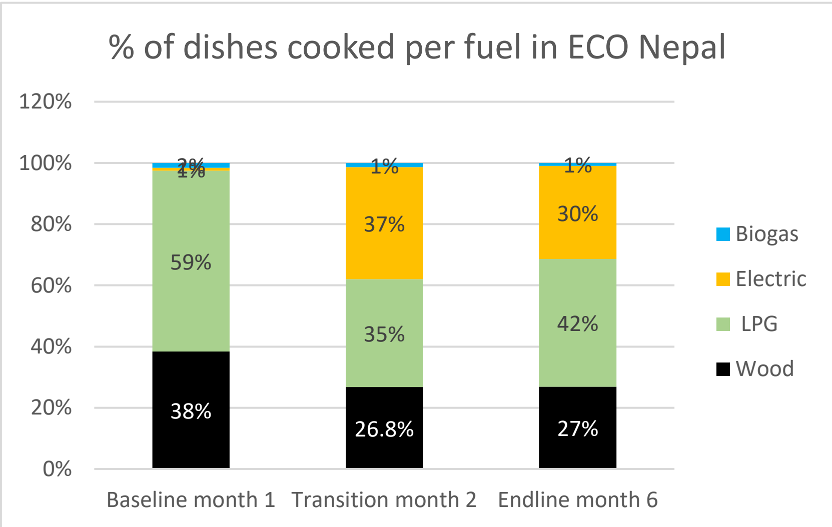


Figure 27: Percentage of dishes cooked per fuel across all ECO pilot projects carried out in Nepal (Sieff, 2022).

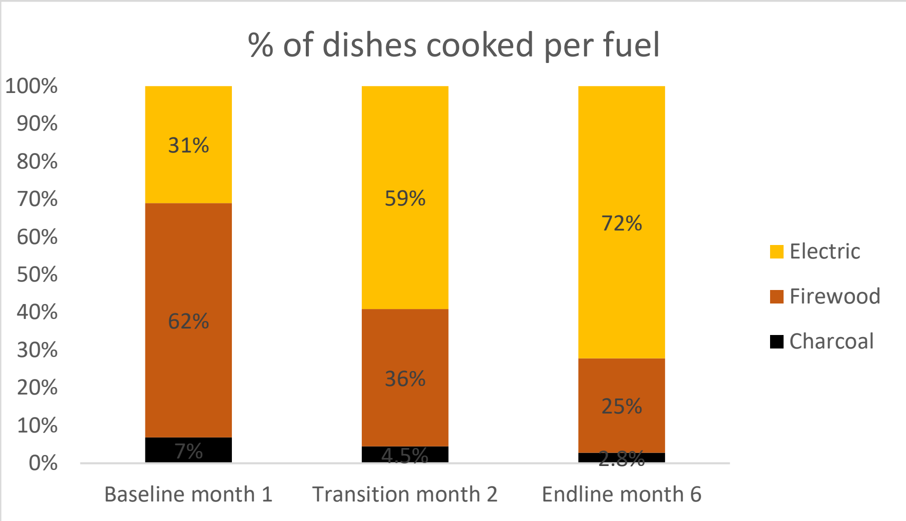


Figure 28: Cooking events by fuel per phase by villages in rural Thazi (Myanmar), the pilot by the French NGO, Geres (Sieff, 2022).

According to the study by (SESCOM, Nexleaf, & TAFORI 2021), it was observed that average cooking times declined after the introduction of the EPCs. The exit survey showed that households started cooking dinner later than their usual cooking times because the EPC cooks faster.

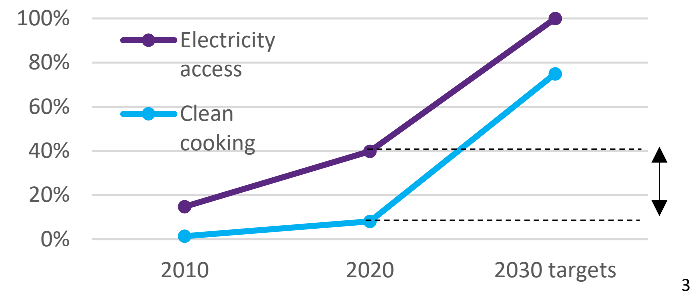
1.4 Overview of eCooking Appliance Markets in East Africa

This section offers a high-level overview of the state of the emerging eCooking market in the 3 East African nations where Burn's early piloting was carried out: Kenya, Uganda, and Tanzania. Each country was studied extensively as part of a series of eCooking Market Assessments carried out by EnDev/MECS in 2022. Further details on each market are available in the full eCooking Market Assessments (Kenya, Uganda, Tanzania).

1.4.1 Tanzania

Tanzania has recently made enormous progress on electrification with coverage more than doubling between 2010 and 2020 from 15% to 40% (World Bank, 2022a). The government has ambitious plans for electricity access expansion and increased generation capacity, aiming for nearly 6000MW of increased generation by 2026, 65% of which will be from renewable sources (Ministry of Finance and Planning, 2021). However, most of the population still relies on polluting fuels such as firewood and charcoal (35 approx. 90%). Only 3% of Tanzanians use electricity as their primary cooking fuel (National Bureau of Statistics (NBS) [Tanzania] and Rural Energy Agency, 2020). Research on eCooking in Tanzania started in 2018 and feasibility studies show it is cost-effective to cook with electricity compared to other paid-for fuels, compatible with the cuisine, and desirable and convenient for end users. There is a large untapped potential for electric cooking, particularly for key market segments such as urban charcoal users, who are connected to electricity but who do not cook with it, and eCooking will become an increasingly important strategy to stimulate electricity demand as electricity surplus grows. Since showing the feasibility, numerous pilots and activities in Tanzania have focused on strengthening the market system and establishing after-sales support services. The government of Tanzania and the private sector express interest in pursuing eCooking, particularly as neighbouring countries Uganda and Kenya pick up the pace of the transition with National eCooking Strategies under development.

Electricity and Clean Cooking Access

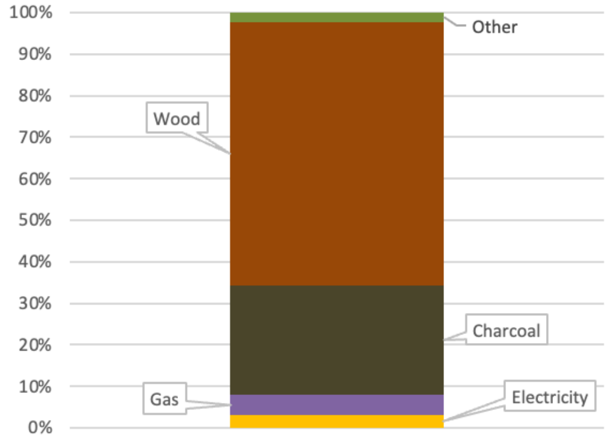


[3]

32% now connected to electricity, but still primarily cooking with polluting fuels

Cooking energy: Primary fuel use [4]

3% cook primarily with electricity

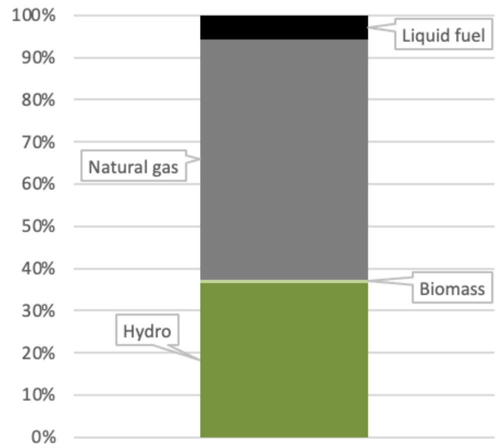


26% cook primarily with **commercialized** polluting fuels (charcoal)

90% cook primarily with polluting fuels

Electricity generation: On-grid [5]

37% renewable



30% surplus power generation (Ministry of Energy, 2020)

High reliability: 89% power availability (SAIDI*SAIFI=978hrs/yr) (Coley *et al.*, 2021)

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[3] 2030 cooking target (Ministry of Energy and Minerals, 2015b), 2030 electricity target (Ministry of Finance and Planning, 2021), 2010 and 2020 electricity data (World Bank, 2022a), 2020 clean cooking data (National Bureau of Statistics (NBS) [Tanzania] and Rural Energy Agency, 2020).
4 Source: (National Bureau of Statistics (NBS) [Tanzania] and Rural Energy Agency, 2020)
5 Source: (Ministry of Energy, 2020)

Off-grid (Coley et al., 2021):

Well-developed mini-grid & off-grid sectors: nearly 1m mini-grid customers, 94 mini-grid developers, 6.4m off-grid lighting/appliance customers

eCooking GMA viability scores/rankings for Tanzania

Overall: **37th/130**	On-grid eCooking: **0.42 – 104th/130**	Mini-grid eCooking: **0.47 – 23rd/130**	Off-grid eCooking: **0.47 – 23rd/130**

The MECS 2021 eCooking Global Market Assessment (GMA) draws on the experience of a range of stakeholders to identify the key factors which influence the viability of a scale-up of electric cooking and represents this as a weighted score constructed from 37 indicators covering 130 countries in the Global South (Coley *et al.*, 2021). As electric cooking relies on a supply of electricity that is provided in a variety of different ways, the GMA provides a score for the national grid, mini-grid, and off-grid (standalone) supported electric cooking as well as a combined overall score indicating the viability of a scale-up of electric cooking.

Tanzania's score is reflective of its strong mini-grid and off-grid infrastructure[6], although it is restricted by having low rates of access to electricity. It also has a high proportion of people using commercialized polluting fuels and biomass fuels, demonstrating a need to scale up its transition towards electric cooking as well as an ability to pay for modern fuels.

Key opportunities

- Access to electricity has more than doubled since 2010 (15% in 2010 to 40% in 2020) (World Bank, 2022a)
- EPCs highly compatible with popular long-cooking dishes such as beans and maize.
- Plans to significantly increase electricity generation capacity and a large proportion of this will be renewable energy generation.
- Cooking with EPC is affordable and cost-effective compared to LPG, charcoal, and paid firewood, even on mini-grids (Inston and Scott, 2022)
- Minister of Energy (Hon. January Makamba), appointed Sept 2021, is prioritizing clean cooking (Edward, 2022)
- The strong political will to regulate and decrease charcoal production and use.
- Solid track-record in government encouraging investment in the solar-home system and mini-grid sectors through the 2000s and 2010s.
- Instability in the mini-grid industry caused by low tariff directives in 2020 looks to be reversed in 2022.

[6] However, since 2020, regulatory tariff directives have affected the stability of this industry since this analysis was completed.

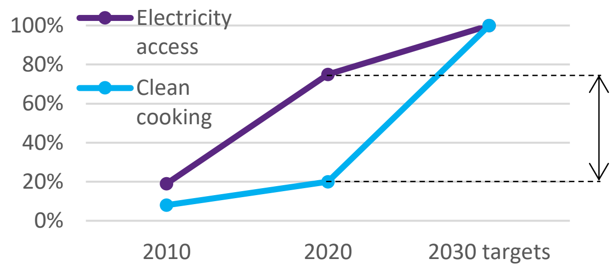
Key challenges

- LPG is perceived as the preferred ‘transitional’ clean cooking fuel by government and policy-makers, whereas there are key market segments that would benefit from switching straight to eCook.
- Lack of awareness among market actors, end users, and decision-makers, about the affordability and viability of cooking with EPCs
- The policy, therefore, focuses more on LPG for cooking futures, missing the opportunity to leverage electricity access gains and investment for clean cooking.
- Electricity is commonly perceived as ‘too expensive for cooking’, even though clean fuel stacks (LPG & EPC) are often the most cost-effective solution.
- No specific electric cooking strategy in the policy

1.4.2 Kenya

Kenya is the birthplace of mobile money and a hotbed for innovation in the development sector [1]. Many of the new electric cooking technologies and business models developed by MECS are being piloted in Kenya [2], where they can leverage the ecosystem of actors and the strong enabling environments in the converging clean cooking and electrification sectors [3]. Kenya has made enormous progress on electrification with coverage increasing from 19% to 75% in just 10 years, and the majority of its grid electricity is generated from renewable sources, mainly geothermal and hydro. However, most of the population still relies on polluting fuels such as firewood, charcoal, and kerosene for cooking [4]. Currently, 0% of Kenyans use electricity as their primary cooking fuel, meaning that there is an enormous untapped potential for electric cooking, which is increasingly drawing the interest of both the government and the private sector.

Kenya data snapshot from MECS eCooking Global Market Assessment:

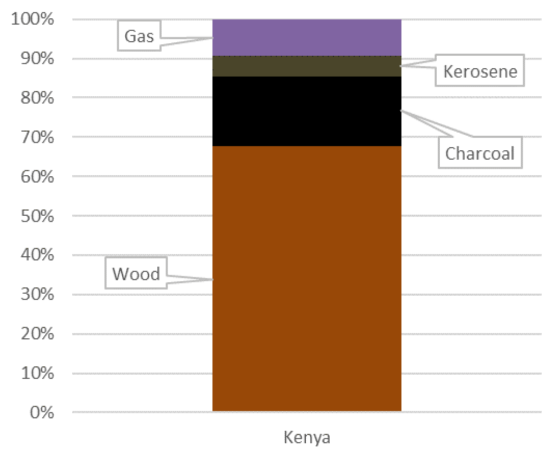


55% now connected to electricity, but still primarily cooking with polluting fuels

Cooking energy

Primary fuel use:

0% cook primarily with electricity

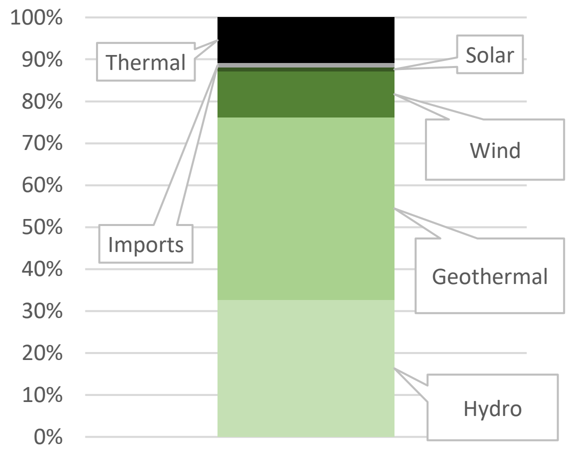


22% cook primarily with commercialized polluting fuels

Electricity generation

On-grid:

89% renewable



45% surplus power generation

High reliability: 99% power availability (SAIDI*SAIFI=83hrs/yr)

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Off-grid:

World-leading mini-grid & off-grid sectors: 0.1m mini-grid customers, 20 mini-grid developers, 13m off-grid lighting/appliance customers

eCooking GMA viability scores/rankings

Overall: **7th/130**	On-grid eCooking: **0.59 – 19th/130**	Mini-grid eCooking: **0.43 – 27th/130**	Off-grid eCooking: **0.55 – 2nd/130**

Key opportunities

- The rapid expansion of access to electricity in the last 10 years
- A diversified mix of renewable electricity generation both on- and off-grid
- Market leader for SHS sales in SSA
- National utility actively stimulating demand growth for surplus electricity.
- EPC is highly compatible with popular 'heavy foods'.
- Strong ecosystem for innovation and political will for change

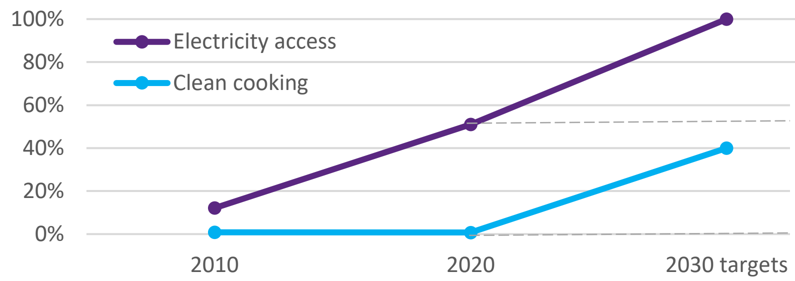
Key challenges

- LPG is already the aspirational fuel for many.
- Electricity is commonly perceived as 'too expensive for cooking', even though clean fuel stacks (LPG & EPC) are often the most cost-effective solution.
- Policy makers have identified the need for integrated planning, but the framework is not yet in place.

1.4.3 Uganda

Despite historically low electrification rates, cooking with electricity is now becoming a viable and scalable option for Uganda. According to the National Electrification Report conducted by (Ministry of Energy and Mineral Development 2020), 24% of households now have access to grid electricity and 27% are off-grid. The total installed generation capacity doubled from 600 MW to 1200 MW between 2010 and 2019. This investment has helped to mitigate the country's dependency on hydropower, which in 2005 led to significant, drought-induced load shedding and power outages. Uganda today produces an electricity surplus of almost double the current demand and is proactively stimulating demand for its predominantly renewable (92%) electricity. 21% of Ugandans use charcoal as their primary cooking fuel, however intensive charcoal production is depleting forests and the population is set to double by 2050. Charcoal users are an attractive market segment to target as they have a guaranteed existing expenditure on polluting fuel that could be repurposed into electricity units. As a result, the government of Uganda has put in place an array of policies and targets to facilitate the transition away from biomass, including the Draft Energy Policy (Ministry of Energy and Mineral Development 2019) which made specific mention of energy-efficient eCooking appliances.

Uganda data snapshot from MECS eCooking Global Market Assessment:

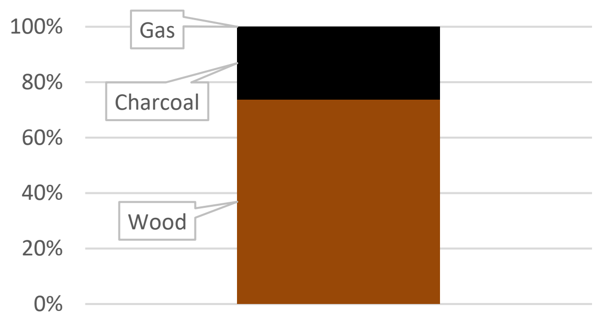


50% connected to electricity, but still primarily cooking with polluting fuels

Cooking energy

Primary fuel use:

0% cook primarily with electricity



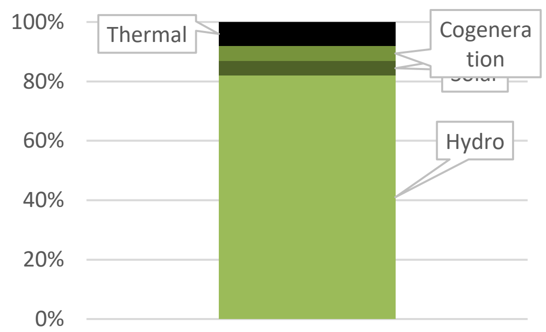
26% cook primarily with **commercialized** polluting fuels (charcoal)

100% cooked primarily with polluting fuels (charcoal & firewood)

Electricity generation

On-grid:

92% renewable



76% (520MW) surplus power generation

Increasing reliability: 65% power availability (SAIDI*SAIFI=3,072hrs/yr)

Off-grid:

Rapidly developing mini-grid & off-grid sectors: 0.1m mini-grid customers, 36 mini-grid developers, 5m off-grid lighting/appliance customers

eCooking GMA viability scores/rankings

Overall:	On-grid eCooking:	Mini-grid eCooking:	Off-grid eCooking:
32nd/130	**0.45 – 88th/130**	**0.38 – 39th/130**	**0.48 – 7th/130**

Key opportunities

- Uganda has a sizeable and well-financed SHS sector which may lay the foundations for a future profitable business model for off-grid eCooking solutions.

- Electricity utility Umeme is proactively looking at electric cooking as a way of boosting electricity demand.
- Uganda continues to accelerate rapidly with electrification as installed capacity is set to increase substantially from a variety of sources, however, this includes the country's first nuclear plants, which are planned to add 2,000 MW of power generation.
- The integration of electrification and eCooking in the NDPIII is a significant step forward for eCooking in Uganda.
- Energy-efficient appliances are highly compatible with Ugandan cuisine, in particular the EPC, which can drastically reduce energy consumption for the most energy-intensive dishes (heavy foods).
- Integration of the East African Community (EAC) has been increasing steadily, suggesting a common trade policy relating to the importation of electric cooking appliances.

Key Challenges

- The mini-grid sector is at a nascent stage.
- Duties on solar products and suitable electrical appliances constrain the off-grid energy market.
- Limited lifeline allowance causes affordability issues for some consumers.
- Military, state, and business elite involvement in charcoal production creates a disincentive for top-down strategies for clean fuel adoption.
- The perception that electricity is too expensive for cooking is deeply embedded in society.

2 Methodology and Datasets

Burn has used a wide variety of methods to collect data from its customers, including:

- KYC (**Know Your Customer**) surveys – basic demographic information & self-reported quantitative data on baseline cooking habits (asks retrospectively shortly after a customer acquires the new device), including cooking frequency and fuel choice for popular dishes. N.B. the baseline survey in Kenya was conducted before delivery of EPCs.
- **Baseline survey** – conducted in Kenya in place of the KYC survey
- **3-month satisfaction surveys** – qualitative data on customer experience with the new product and self-reported quantitative data on cooking habits, inc. cooking frequency and fuel choice for popular dishes.
- **Exit survey** – primarily qualitative data on customer experience.
- KPT (**Kitchen Performance Test**) – quantitative measurements of fuel/electricity consumption recorded in customers' homes before and after acquiring the new product.
- CCT (**Controlled Cooking Test**) – dish-level data on fuel/electricity consumption recorded in a controlled environment.
- EMU **(Energy Monitoring Unit**) – data on usage patterns, including electricity consumption, measured by a smart meter, either embedded within the appliance or connected externally.
- **Cooking diary** – detailed meal/dish level data on what is cooked and how accompanied by quantitative measurements of fuel/electricity consumption recorded in customers' homes before and after acquiring the new product.

- **Customer billing data** from KPLC (Gamos works closely with KPLC's Sales Growth team and it is our understanding that Burn has already shared the data from the Kenya pilots and each customer's meter numbers with KPLC intending to cross-reference with their customer billing dataset).

The data generated by Burn's pilots to date include:

Uganda (MECS):

- Sales period: May 2021 – February 2022
- Locations: Kampala, Entebbe, Mukono, and Nyenje
- Units sold: 200
- Valid KYC surveys (within 2 weeks after purchase): 178
- Valid exit surveys (3-6 months after purchase): 90
- NB: all interviews were conducted over the phone (because of covid)
- Cooking Diaries study data (4 phases): 172 respondents

In addition, MECS has access to cooking diary data and final reporting from the Uganda pilot with 200 households, however, the quality of this data, in particular the energy measurements, is questionable, as data was collected remotely during covid.

Tanzania:

- Sales period: June 2021
- Location: Dar es Salaam
- Units sold: 24
- Valid KYC surveys (within 2 weeks after purchase): 24
- Valid satisfaction surveys (3 months after purchase): 24
- PPT summarising key outcomes from the Tanzania pilot
- NB: all interviews conducted in person

Kenya:

- Sales period: November 2021 – February 2022
- Locations: Nairobi, Kiambu, and Machakos
- Units sold: 100 (plus 22 induction)
- Valid baseline surveys (before purchase): 99
- Valid satisfaction surveys (3 months after purchase): 65
- Valid baseline KPT (Kitchen Performance Test): 69
- Valid 3 months KPT (Kitchen Performance Test): 59
- NB: all interviews conducted in person
- KPLC monthly billing data covering a 16-month period to August 2022: 25 customers
- Cooking Diaries study data (2 phases): 72 (Baseline) and 82 (Transition) respondents
-

The data collected from these pilot customers has been shared with MECS for this analysis. This sub-set of Burn's broader eCooking piloting data includes the most reliable and directly comparable data currently available. It covers all of the piloting to date in Uganda and Tanzania, but for Kenya, only the most recent pilot of 100 EPCs is included, as previous pilots had a broader range of customers and a less comprehensive set of data.

Data from Burn's early piloting indicated that the utilization of the EPC depended heavily upon the target market segment and the training of sales agents. Much higher utilization rates were observed among low-income charcoal users and amongst customers who interacted with sales agents who were able to give comprehensive training on how to cook a wide range of popular local dishes. The early piloting also highlighted the challenges presented by informal connections and poor-quality household wiring, both in terms of safety and restricted utilization of the cooking device due to an unstable power supply. As a result, later pilots in Uganda, Tanzania, and Kenya deliberately targeted lower-income charcoal users in urban and peri-urban areas with safe access to electricity, which is the primary demographic represented in the subset of the data to be analyzed during this assignment.

The following section describes the research questions and approaches that were used to analyze the data shared by Burn. **Table 6** below shows how relevant the available data from each country is to answer each of these research questions.

Question 1: What is the feedback from customers about the cost, performance, and other benefits of using BURN's EPC? Does it meet their cooking needs and expectations?
Data available: baseline, KYC, satisfaction & exit surveys
Proposed analysis: Thematic analysis of customer survey data on benefits/drawbacks of EPC use, in particular cost & performance. Comparison of baseline/KYC survey data on expectations with exit/satisfaction surveys.

Question 2: What is the usage profile of the EPC for different segments of the market?
Proposed analysis: Disaggregate analysis below by country, income group, and primary fuel use before EPC. I expect to see low-income charcoal users using EPC more than high-income LPG users, but the latter segment may not be well represented in this dataset as this was a criterion for selecting which data to analyze.

- **What are typical energy consumptions per meal (and the calculated costs)?**
  - *Data available:* CCT (plus cooking diary data from the latest Kenya pilot if available)
  - *Proposed analysis:* Dish-level comparison of energy consumption & costs
- **When do those uses occur (time of day and frequency)?**
  - *Data available:* Time of day and frequency data from cooking diary data from Uganda (plus the latest Kenya pilot if available). Frequency data from satisfaction surveys.
  - *Proposed analysis:* Typical cooking times for each meal and typical EPC usage per meal. Frequency tables for popular foods, show average EPC usage. Map out typical cooking days for key market segments.
- **What was the baseline use of electricity in the household, and has the use of the EPC significantly increased the monthly cost?**
  - *Data available:*
    - Self-reported: KYC survey & exit survey

  - Measured:
    - KPT for the increase in electricity consumption
    - Energy Monituring Unit (if available)
    - Customer billing data from KPLC (if available)
  - *Proposed analysis:* Compare self-reported data on electricity bills before and after surveys. Cross-reference with electricity consumptions from KPT, EMU & KPLC customer billing data.
- **How does this compare with the monthly savings in their previous cooking fuel?**
  - *Data available:* self-reported from satisfaction/exit surveys, measured from KPT
  - *Proposed analysis:* Compare KPT and self-reported data from surveys on cooking fuel usage before and after.

Question 3: What does the data flow say about energy use and time-saving?

- **How can the BURN EPC best leverage the co-benefits of carbon saving and gendered time savings to strengthen the case for accessing carbon and results-based financing?**

Data available:

- Self-reported: KYC survey & exit survey
- Measured: KPT & CCT data on energy use (plus cooking diary data from the latest Kenya pilot if available)

Proposed analysis: Quantitative analysis of energy use (and cost) from KPT & CCT, quantitative analysis of cooking time from CCT, qualitative analysis of time savings and ability to multi-task from satisfaction and exit surveys, comparison of perceptions of time/cost savings before (KYC & baseline surveys) with after (satisfaction & exit surveys). Modeling of carbon savings given the baseline fuel usage, fuel stacking profile, and power generation mix in each country.

Table 6: Datasets and analysis techniques used to address each Research Question (RQ).

	Section		KE	TZ	UG
RQ1					
Cost, performance, benefits	3.2.1	KE and TZ surveys asked about perceptions on changes in fuel **costs**, and estimates of the amount.	L	l	X
Other benefits	3.2.2.2	Other benefits are reduced to simple statements on cooking **time, taste, and safety.** Uganda Exit asked for preference over other fuels – gives a range of benefits	l	i	l
Meet needs & expectations	3.3	The wording in surveys is different but tried to align similar issues from baseline expectations and 3-month experience (TZ). Did not align with UG	l	l	i
RQ2					
Energy consumption per meal (costs)	3.4.3	UG cooking diary data is difficult because 1 record can cover multiple meals – disaggregated analysis using filters (i.e. sub-sample of records). Calculated dish level energy consumption (charcoal and EPC)	l	x	l

Meal freq & time of day	3.4.1	KE asked for events done every day, which is slightly different from the frequency of meals. Can get meal types from UG Cooking diaries. Cooking start times from UG cooking diaries	i	x	l
Change in electricity use	3.5.1	Energy consumption: KPT and bills for KE only	l	x	x
Change in electricity cost	3.5.2	Perception on increase costs (3 months) UG only has cheap/affordable data	l	l	i
Savings in other fuels	3.6	Calculate total cooking costs per hold – no Exit data for UG	l	l	x
RQ3					
Energy use	3.6.3	Use Cooking Diaries to Calculate changes in the ratio of fuels used in Phases (1 & 4 in UG)	l	X	l
Time-saving	3.41., 3.4.2	Overall cooking times and times for individual dishes using different fuels.	L	x	l
	3.4.1	Meal preparation times	l	x	l
Carbon & RBF	4	BAR-HAP Impact Modelling			

l Good results

i not exactly addressing the question

X no data

3 Findings from cross-cutting analysis of EPC piloting datasets

3.1 Change in the cooking fuel mix

3.1.1 Kenya

After purchasing an EPC, respondents more frequently stacked fuels. At baseline no respondents used electricity, but three months after purchasing their EPC, they were all still using it (see **Figure 29**). This figure indicates that EPCs were mostly used to substitute charcoal in the cooking fuel mix.

Table 7: Number of cooking fuels used (Kenya)

Number of fuels used	Baseline	3 month
1	17%	
2	70%	37%
3	12%	51%
4	1%	12%

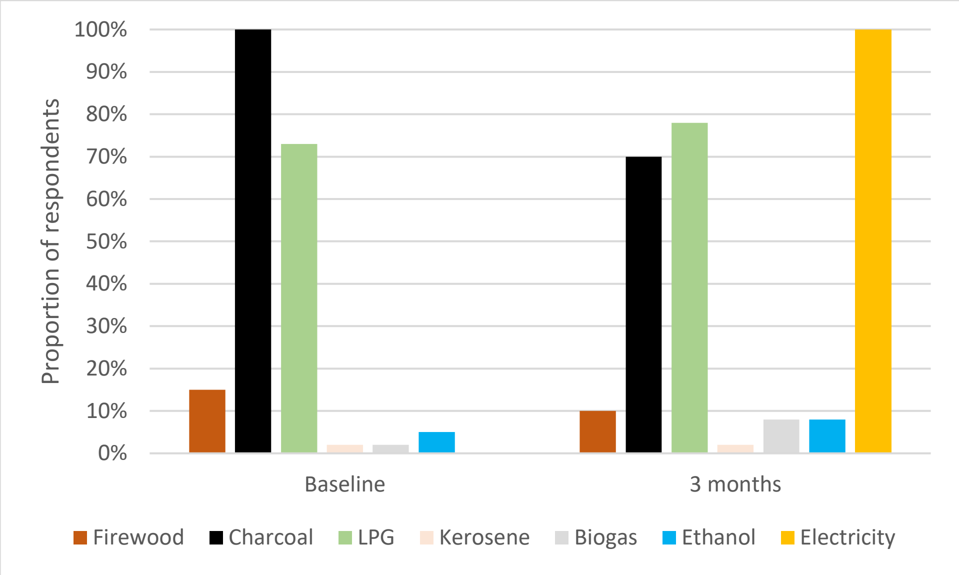


Figure 29: Change in fuel mix – to 3-month surveys (Kenya)

Data from the surveys presented above show that after receiving their EPC, all respondents started to cook with electricity. This finding can be nuanced by data from the cooking diaries study, which gathered data on the fuel used to cook individual dishes (at the one-month mark). This shows that electricity was the most commonly used fuel, closely followed by LPG. EPCs were used to cook 43% of dishes recorded.

Table 8:Fuels used to cook individual dishes (Kenya Cooking Diaries 1 month)

	Frequency	Percent
Electricity	3030	43.1
LPG	2755	39.2
Charcoal	1049	14.9
KOKO	136	1.9
Firewood	58	0.8
Kerosene	7	0.1
Other	2	0.0
Total	7037	100.0

In the baseline survey, respondents were asked an open question on the benefits of traditional fuels. The main issues have been coded and presented in **figure 30.** This shows that people chose charcoal because they feel it is cheap and readily accessible. On the other hand, LPG and firewood are chosen because they can cook quickly.

At the same time, they were also asked about challenges associated with traditional fuels. Results in **figure 31** show that biomass fuels face drawbacks associated with emissions (smoke and carbon monoxide), and cost (less so for firewood). LPG is regarded as an expensive option.

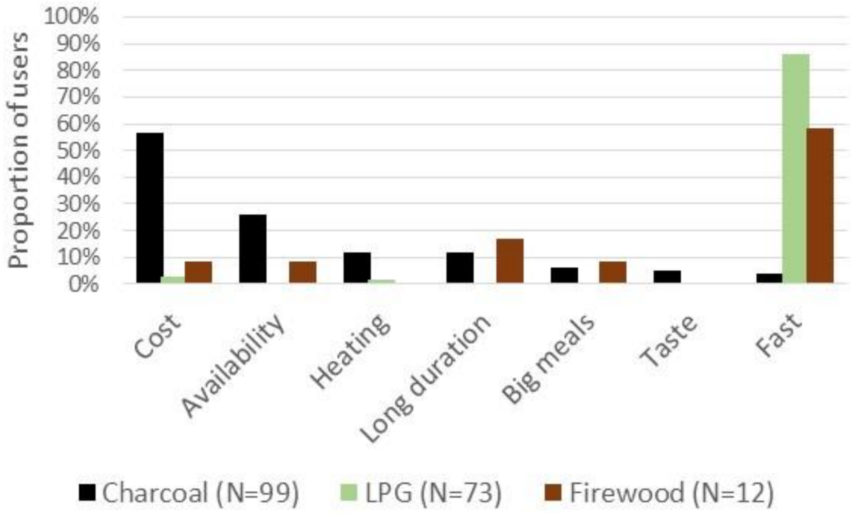


Figure 30:Main benefits of using traditional fuels (Kenya Baseline survey)

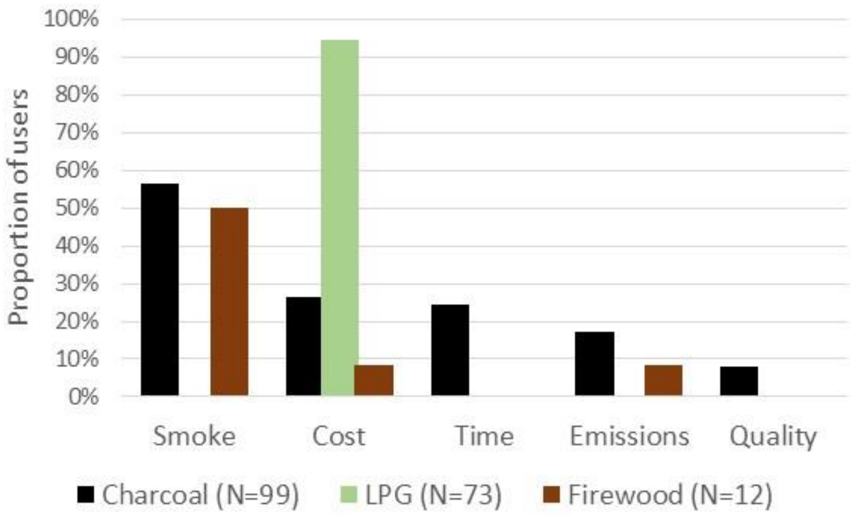


Figure 31: Main challenges of using traditional fuels (Kenya Baseline survey)

3.1.2 Tanzania

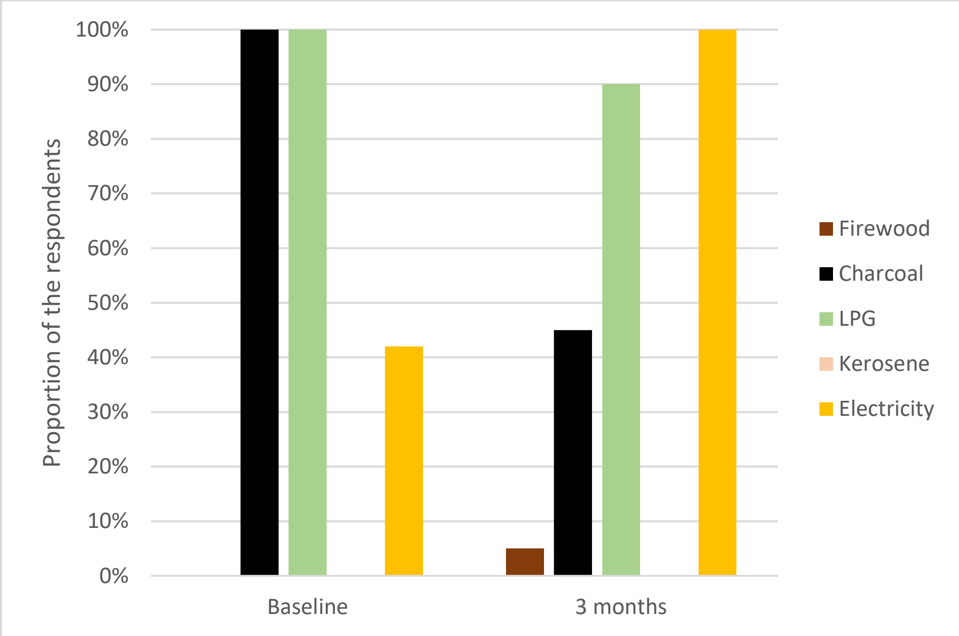


Figure 32:Change in fuel mix – to 3-month surveys (Tanzania)

3.1.3 Uganda

The Baseline survey in Uganda was conducted shortly after customers had taken delivery of their EPC, at which point most of them had used it at least once. This explains why there was only a modest increase in the use of electricity by the time of the Exit survey **(see figure 33**) and little change in fuel stacking behaviour (**table 9).** The figure indicates that an increase in EPC use was linked to a reduction in charcoal use.

Table 9: Number of cooking fuels used (Uganda)

Number of fuels used	Baseline	Exit
1	8%	7%
2	65%	63%
3	26%	30%
4	1%	

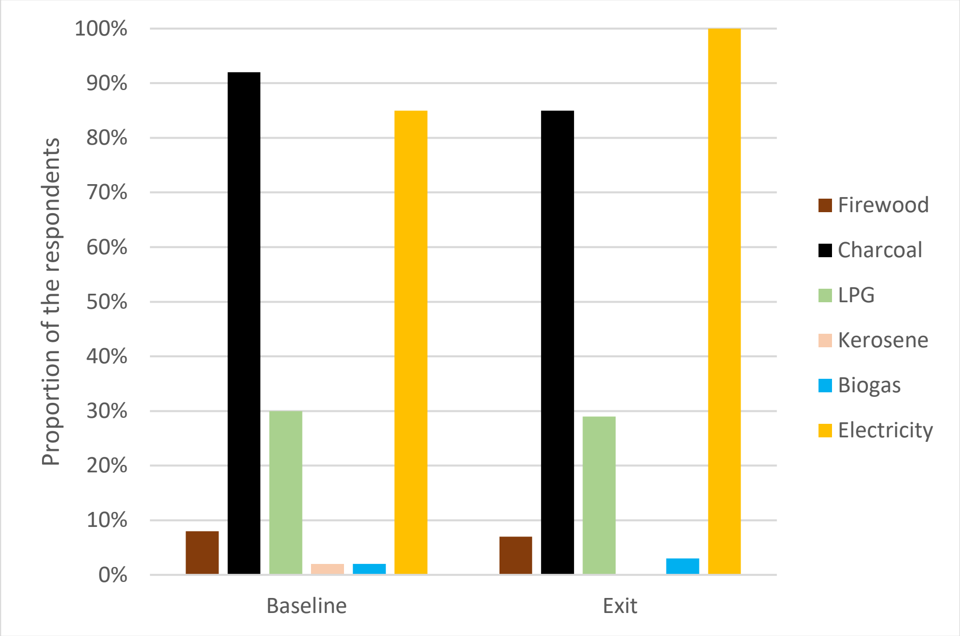


Figure 33:Change in fuel mix – to Exit survey (Uganda)

3.2 Benefits of cooking with an EPC

3.2.1 Cooking costs

3.2.1.1 Kenya

Overall, 77% of respondents to the 3-month surveys felt that their cooking fuel costs had decreased **(figure 34).** These respondents reported a drop in costs of 410 KES/week (median). This compares with a median total expenditure on charcoal, LPG and firewood of 3,400 KES/month reported at the baseline survey. Note that total expenditure on fuels at the 3-month survey, including electricity, dropped to a median of 2,400 KES/month, suggesting a reduction of 1,000 KES/month (see Section 3.6.4.1). These estimates are of the same order of magnitude, but suggest that responses to the question on overall savings (equivalent to 1,640 KES/month) tended to be overly generous.

There was almost unanimous agreement that cooking with an EPC was affordable (97%).

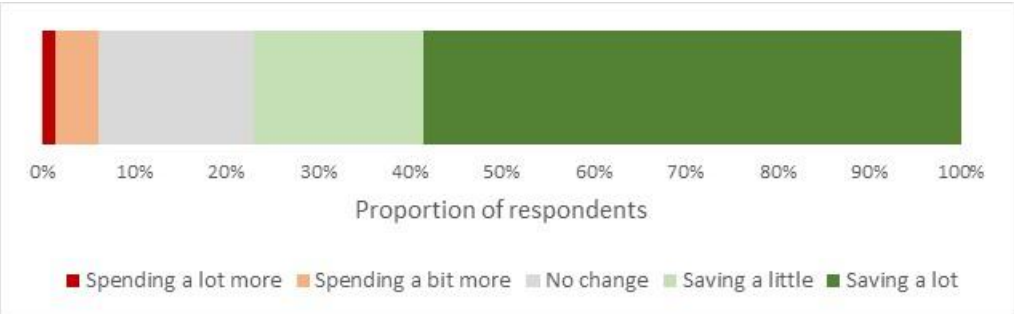


Figure 34:Perceived change in weekly fuel budget (3-month surveys)

3.2.1.2 Tanzania

Overall, 92% of respondents to the 3-month surveys felt that their cooking fuel costs had decreased (**figure 35**). These respondents reported a drop in costs of 6,000 TZS/week (median). An analysis of reported fuel costs (charcoal, LKPG, and electricity) gives a median of 36,500 TZS/month at baseline, falling to 19,500 TZS/month at the 3 month survey (see Section 3.6.4.2). When compared with savings based on fuel expenditure (17,000 TZS/month), responses to the question on overall savings (equivalent to 24,000 TZS/month) appear to be over stated, which is similar to the finding from Kenya.

42% of respondents felt that the ECOA represented good value for money, with the remainder saying it was the right price.

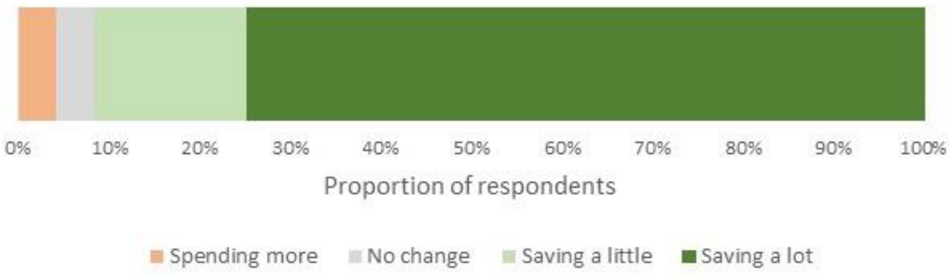


Figure 35:Perceived change in fuel budget (3-month surveys)

3.2.1.3 Uganda

The exit survey used in Uganda didn't include any questions on cooking fuel costs so it was not possible to make any comparisons with costs before using the *ecoa*.

3.2.2 Other benefits

3.2.2.1 Kenya

The 3-month surveys strongly highlighted time savings, taste, and safety as benefits of using the EPC:

- 88% of respondents said that they spend less time cooking after using an EPC.
- 97% of respondents said that food cooked in an EPC taste good or very good;
- 80% of respondents felt that cooking with electricity is safer than using other fuels.

In addition, they were asked about the differences between cooking with an EPC and cooking with charcoal (the dominant baseline fuel for all respondents). The results in **figure 36** show that saving time is the most widely appreciated feature of EPCs. The figure also confirms that EPCs are cheaper than using charcoal, which is consistent with the results shown above.

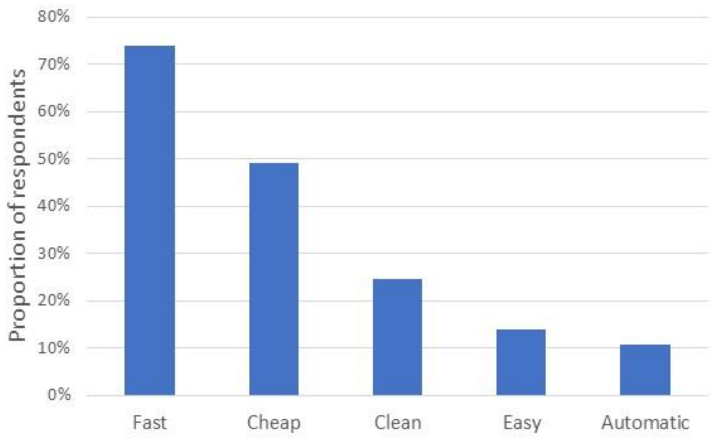


Figure 36:Differences between cooking with EPC and charcoal (presented as advantages of EPC) (Kenya 3-month survey)

When asked about challenges with adapting recipes for EPC, 72% of respondents said they experienced no problems, sometimes referring to the cookbook that was provided with the EPCs listing popular recipes with adaptations and tips for cooking in the Burn EPC. Aside from this, the most common issue was establishing the correct amount of water to use, especially for rice. Some respondents had difficulty cooking chapati and fried eggs, partly due to the shape of the pot. Only being able to cook in a single pot was also mentioned.

Some respondents had difficulty baking cakes, and trial and error to find the right amount of water for various recipes were common. Several respondents commented that they need to soak beans and cereals before cooking.

3.2.2.2 Tanzania

There was a unanimous view that the ECOA was safe, with 96% saying it was very safe. The taste was not given as a reason for not using the EPC more frequently, which can be interpreted as confirmation that the EPC does not impair taste.

3.2.2.3 Uganda

The majority of respondents felt that electricity was safe (80%), and a further 11% added that all fuels were safe (so no advantage of electricity). The reasons given for the safety of electricity mostly centred around no exposure to fire and heat (and reduced risk of burns), and no emissions with implications for pollution.

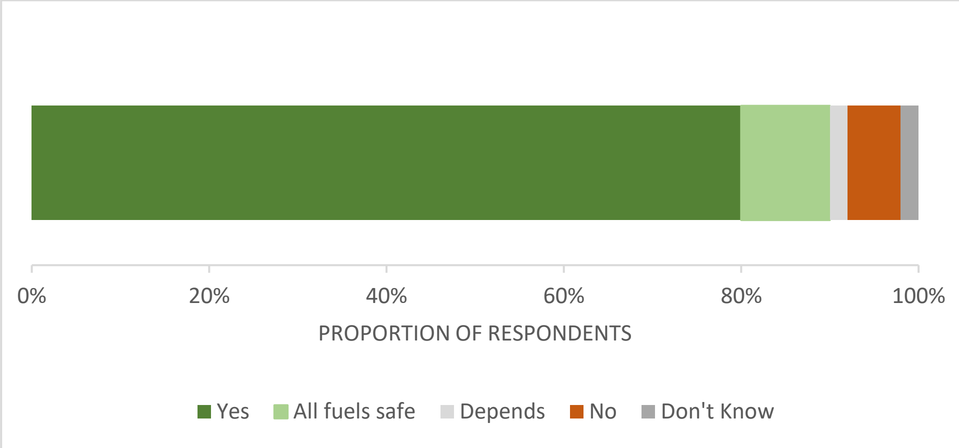


Figure 37:Do you think cooking with electricity is safer than other fuels? (Uganda Exit survey)

86% of respondents said that they had more time available once they started cooking with electricity. Some used the time to get on with other cooking tasks such as washing up and preparing other food; others were able to get on with other household chores such as collecting water, washing clothes, and ironing; others used the time for income-generating activities.

Respondents were asked if they preferred cooking with electricity over other fuels; 90% indicated a preference for cooking with electricity, and of, these, 68% gave one or more reasons for their preference. The first reasons given in these responses are illustrated in **figure 38** and show that EPCs are predominantly appreciated because of the reduced cooking time, and what users can do with that time. This approach further highlighted the importance of safety and raised the issue of cleanliness (which could also be regarded as related to convenience).

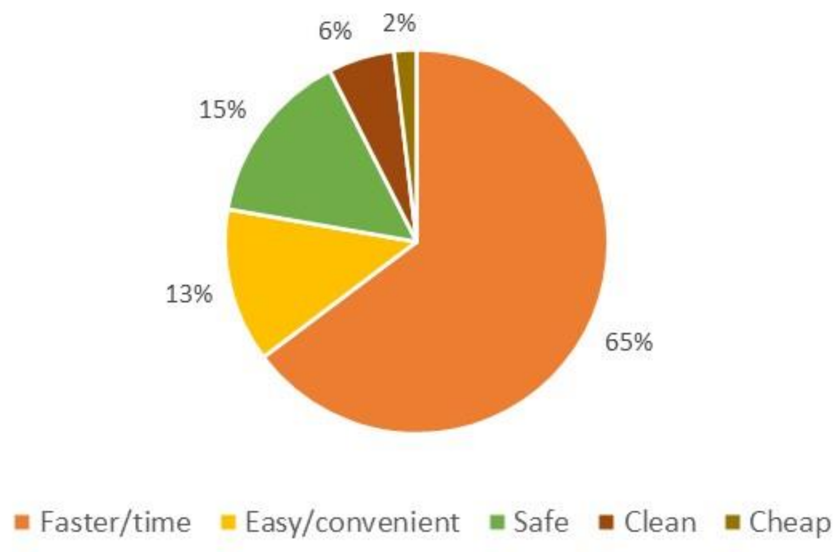


Figure 38:Figure : Reasons for preferring cooking with electricity over other fuels (Uganda Exit survey)

When it comes to taste, 42% of respondents said that food tasted better when cooked with electricity, and 20% said it tasted worse, mostly citing matoke. Matoke is prepared differently in Uganda vs Kenya. In Uganda, it is steamed, taking around 4 hours on charcoal, and can be difficult to prepare on an EPC for first-time users. However, the evidence from the Uganda eCookBook shows how to adapt the standard recipes for matoke to the EPC and offers testimonies from experienced users who have learned these new techniques and can make big savings on cooking time and cost without compromising on taste.

3.3 Meeting Expectations

3.3.1 Kenya

In the Baseline survey, respondents were asked to give reasons why they purchased the EPC, which are presented in **figure 39.** Time and financial benefits were most commonly mentioned; note that many people referred to the affordable payment plan, but this relates to the one-off capital cost, so has not been included in the cost-saving category. Many people said they bought the EPC because they had been advised it could cook many Kenyan dishes, with some respondents naming specific dishes. This advice came from both the marketing team and from friends and family who had recommended the product. People also referred to demonstrations, implying that their expectations had been informed by active marketing activities.

During the 3-month surveys, respondents were asked to describe the differences between cooking with the EPC and charcoal, which is useful given that charcoal was universally used as the primary cooking fuel at baseline. Results in **figure 39** show that the dominant expectations relating to time and cost savings were met. It also appears that after using the EPCs, people appreciated the clean cooking experience along with the convenience of automation, pre-programmed buttons, and not needing to light a fire.

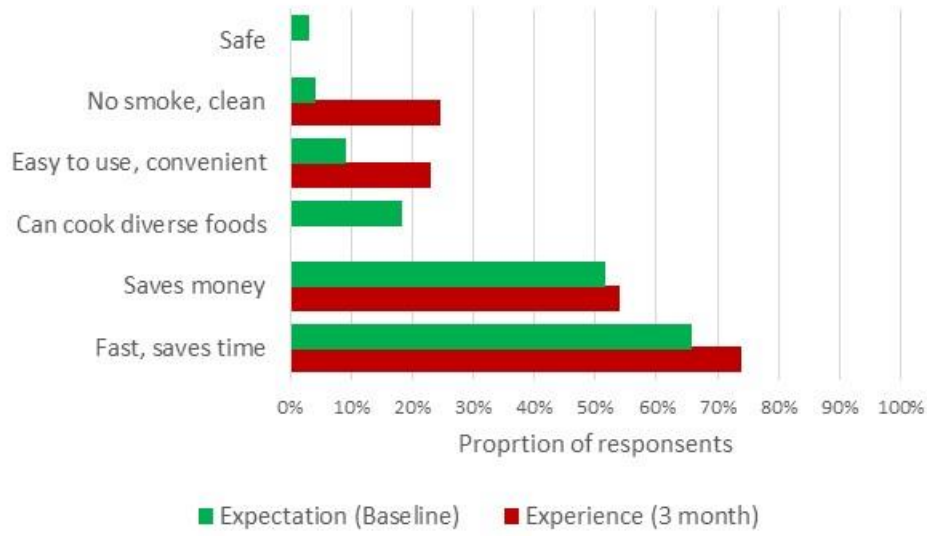


Figure 39:Comparing the experience of using EPC (3-month surveys) with expectations (Baseline) – Kenya

3.3.2 Tanzania

Customers' experience of using the EPC was overwhelmingly positive: 92% rated their experience as excellent, and none were negative. When asked to give the reason for these high scores, the dominant factors were speed of cooking, and cost savings (see **figure 40**). This figure suggests that customers did not find the EPC as easy to use as they had expected. However, it's important to note that the learning curve for EPC keeps rising past the first 3 months. Many users adapt slowly to the easiest dishes first before they start exploring more complex dishes like ugali. On the other hand, although few were motivated by safety issues, it appears that once they used the EPC, they appreciated that it was safe to use.

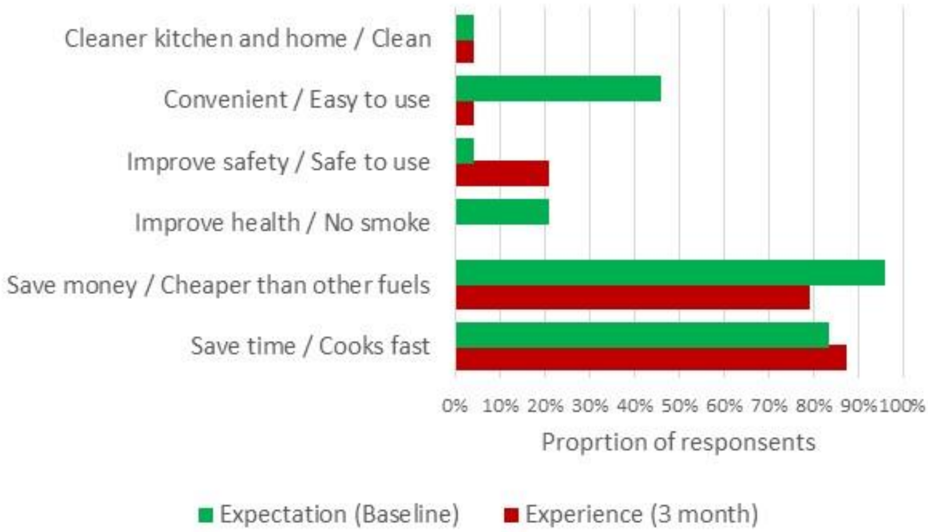


Figure 40: Comparing the experience of using EPC (3-month surveys) with expectations (Tanzania Baseline)

During the 3-month surveys, customers were asked to think retrospectively about what their expectations had been when buying the EPC. These factors (in **figure 40**) do not correspond closely with the expectations in **table 10** and neither do the results. They do confirm the dominance of saving time in expectations, but they also indicate that the aspiration to a modern lifestyle is important.

Table 10: What problems did you want to solve when you bought the ECOA?' (3 months Survey)

Does not require full-time attention	**96%**
It's modern	50%
Fuel too expensive	17%
Saves space	13%
Health problems	8%
Unsafe fuel	4%

In the Baseline survey, respondents were asked for reasons they had purchased the EPC (using multiple response options). Note that this is different from the question on expected benefits, and advantages presented above. The responses in **figure 41** highlight the importance of the payment plan in enabling customers to make a purchase. Top of the aspirational reasons was wanting to improve the home environment, which covers cleanliness (clean kitchen and pots), and emissions (smoke).

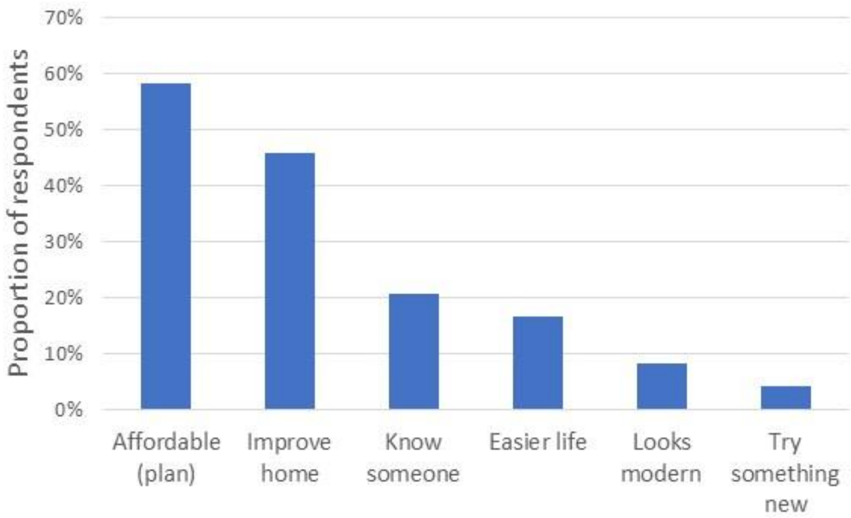


Figure 41:What made you purchase an EPC (Tanzania Baseline survey)

All respondents to the 3-month survey said that the EPC was fast (see **figure 42**). Although the question was phrased in terms of benefits not expected, the results closely match the results in Figure 42, which are based on the experience of using an EPC. This confirms the importance to customers of the speed of cooking, cost savings, and improved safety.

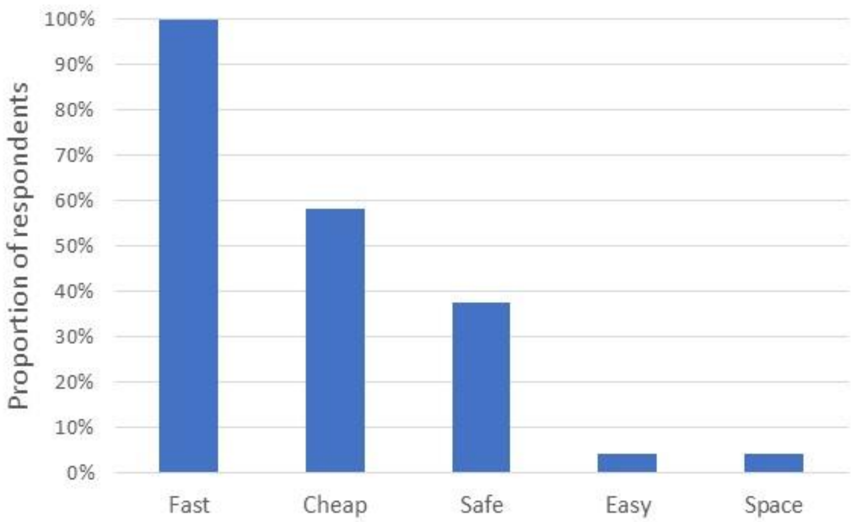


Figure 42:Benefits not expected at the time of purchase (Tanzania 3-month survey)

When it comes to features of the BURN product that are attractive to customers, the size is dominant (see **figure 43**). Nearly half of the customers felt that the BURN product offered greater safety than others; it would be interesting to explore what lies behind this thinking. Although the payment plans enabled customers to make a purchase (**figure 43**), this appears to be less important in choosing the BURN product, which implies that other manufacturers may also offer some kind of consumer financing.

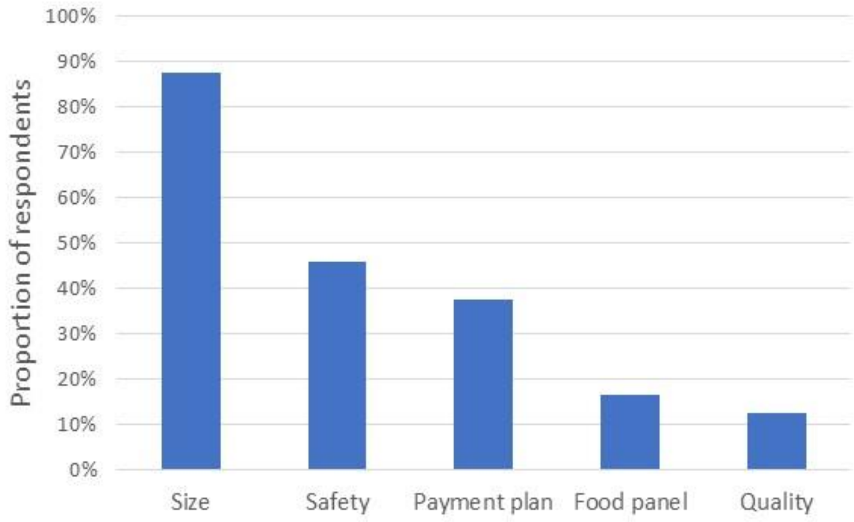


Figure 43:Reasons BURN EPC chosen over competitor products (Tanzania 3-month survey)

3.3.3 Uganda

When asked why they purchased the ECOA, the most common response was that the payment plan had enabled them to overcome the high capital cost barrier **(figure 44**). After that, the most important drivers were ease/convenience and home environment (cleanliness, smoke). When asked at the exit survey what they like most about cooking with electricity, the dominant factor was the speed of cooking and the time savings; this was followed by cleanliness/emissions, and ease/convenience. This indicates that the most important expectations were matched by their experience of using EPCs.

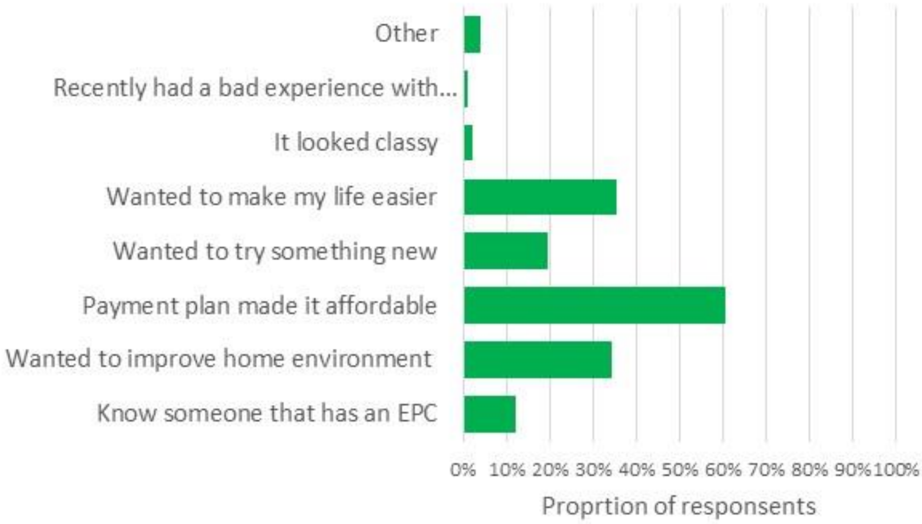


Figure 44: Expectations when buying EPC (Uganda Baseline)

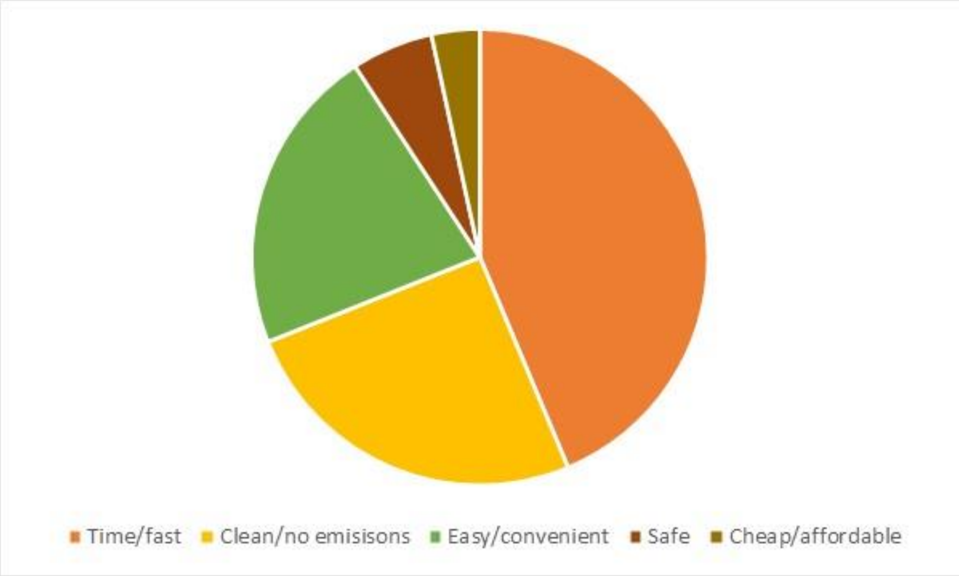


Figure 45: Experience of cooking with electricity (what people like most) – (Uganda Exit survey)

3.3.4 Net Promoter Scores

Customers

In the 3-month surveys in each country, customers were asked whether they would recommend the ECOA to others using slightly differently wording:

- Kenya: "On a scale from 0-10, how likely are you to recommend the BURN Ecoa to a friend or family member, where 0 is not at all likely and 10 is extremely likely?"
- Tanzania: "How likely are you to recommend the ECOA to friends and family?"
- Uganda: "Would you recommend others to use or buy the EPC?"

Note that Kenya was the only country to use the standard Net Promoter Score (NPS) methodology. This is an accepted measure of customer experience, which reflects customer satisfaction and the extent to which the product has met customers' expectations. The simple methodology asks customers how likely they are recommending the product to others using a scale of 0 – 10. Customers are then categorized according to their scores:

- 0 – 6 Detractors
- 7, 8 Passives
- 9,10 Promoters

The NPS score is then calculated as the number of Promoters – number of Detractors expresses as a percentage of all customers.

Results in **table 11** show an NPS score of 95 in Kenya. If the response categories used in the Uganda survey are mapped onto the NPS categories as in **table 11**, then this implies an NPS score of 97. Similarly, responses from Tanzania Indicate high levels of customer satisfaction. There is no clear definition of how to interpret NPS scores, but scores of over 90 can safely be regarded as excellent.

Table 11: Customer satisfaction results – all countries (3-month surveys)

	Kenya	Tanzania	Uganda
n	65	24	90
Detractors/No	0%		1%
Passives/Undecided	5%		1%
Promoters/very likely/yes	95%	100%	98%

3.4 Meals

3.4.1 Meals and preparation time

3.4.1.1 Kenya

Data from the Kenyan Customer Baseline and 3-month satisfaction surveys show that breakfasts and dinners were almost universally prepared every day (**figure 46**). The Cooking Diaries study went on to gather data on the time taken to cook each meal, and the median times for the main meals are presented in **table 12**. This indicates that introducing EPCs into the fuel mix resulted in an average of 25% reduction in meal preparation time for breakfasts and lunches. EPCs appear to make the most difference when preparing dinners, which are the most labour-intensive meal; the preparation time was reduced by over 50%. The Cooking Diaries study also recorded the day of the week that each cooking event took place; **figure 47** shows that fewer meals were prepared at weekends.

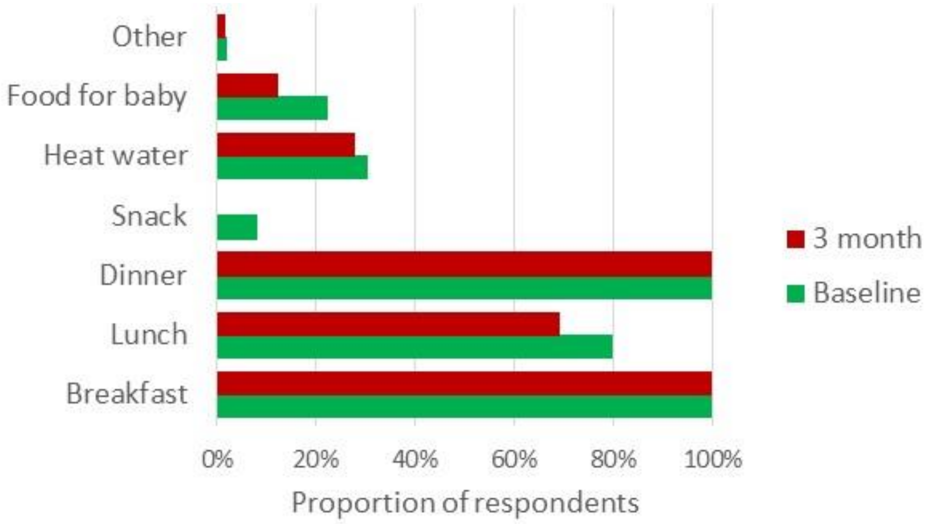


Figure 46:Heating events done every day – Kenya

Table 12: Time taken to cook meals (Kenya Cooking Diaries)

	Baseline		1 month	
	Time; median (minutes)	N	Time; median (minutes)	N
Breakfast	20	210	15	1758
Lunch	26	140	19	1267
Dinner	66	216	30	1905

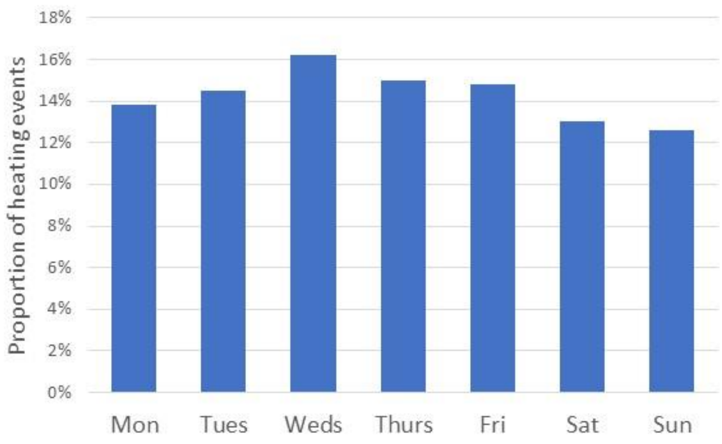


Figure 47:Weekly variation in cooking activity (Kenya 1 month cooking diaries)

3.4.1.2 Uganda

In Uganda, lunches were the type of heating event most commonly recorded in the Cooking Diaries. The frequency of other events, relative to the number of lunches recorded, is presented in **figure 48.**

The Cooking Diaries study gathered data on the time spent preparing a meal, but many of the records covered multiple meals, and the time duration between start time and stop time reflected this, e.g., a record covering breakfast, lunch, and dinner can cover over 12 hours. Therefore, for this analysis, only those records covering the preparation of a single meal have been used to calculate the median meal preparation times presented in **table 13.** This indicates that introducing EPCs into the fuel mix resulted in an average of 31% reduction in meal preparation time for lunches, and a 48% reduction for dinners.

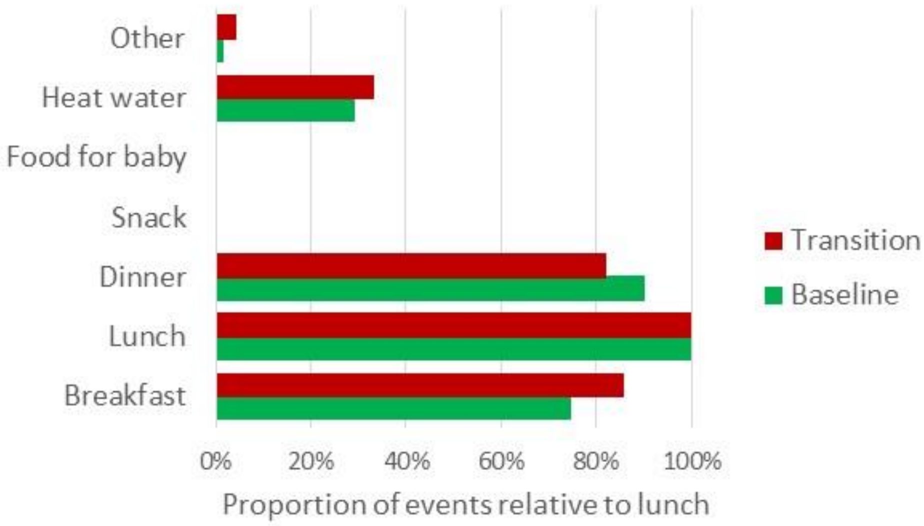


Figure 48: Relative occurrence of heating events (relative to lunch) – Uganda

Table 13: Time taken to cook meals (Uganda Cooking Diaries) (N>=5)

	Phase 1		Phase 4	
	Time; median (minutes)	N	Time; median (minutes)	N
Breakfast	21	29		
Lunch	180	180	125	153
Dinner	110	132	90	63

The Cooking Diaries study in Uganda gathered data on the start time for cooking each dish. It is proposed that the start time may vary with the cooking device (rather than the study phase), so the following figures present time of day profiles for each of the main cooking devices used throughout the study.

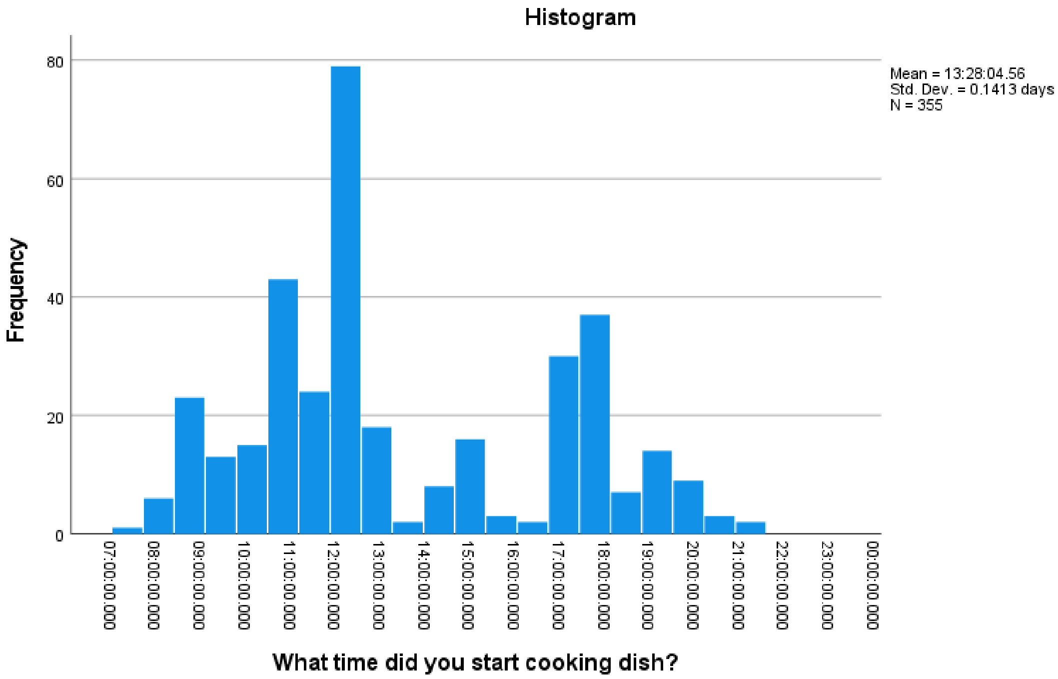


Figure 49: Distribution of cooking start times – dishes cooked with firewood (UG)

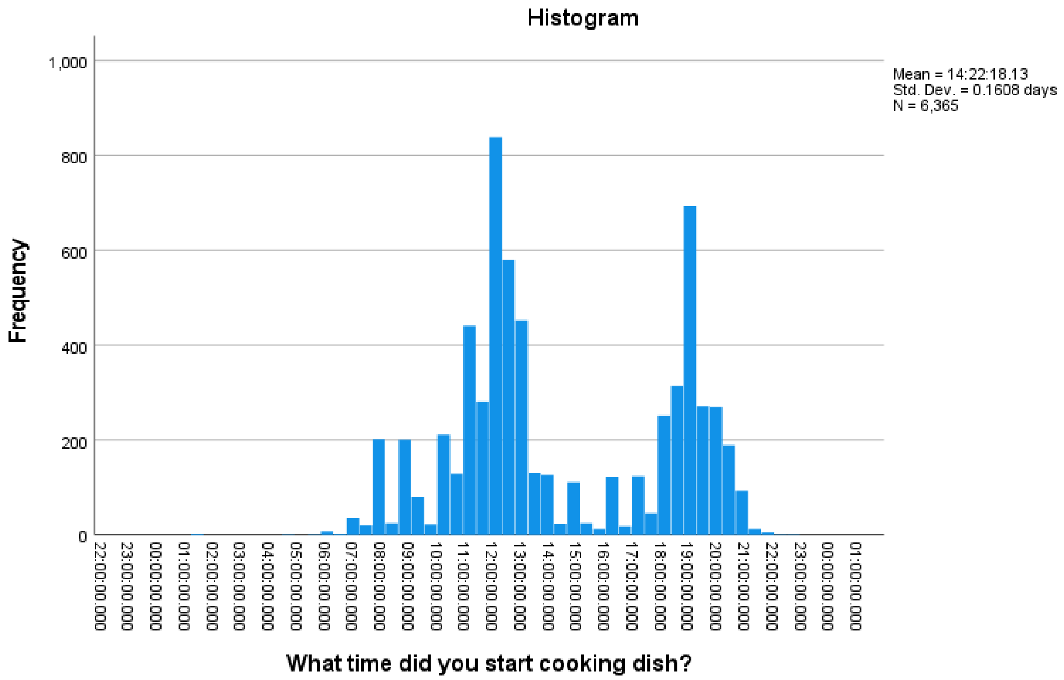


Figure 50: Distribution of cooking start times – dishes cooked with charcoal (UG)

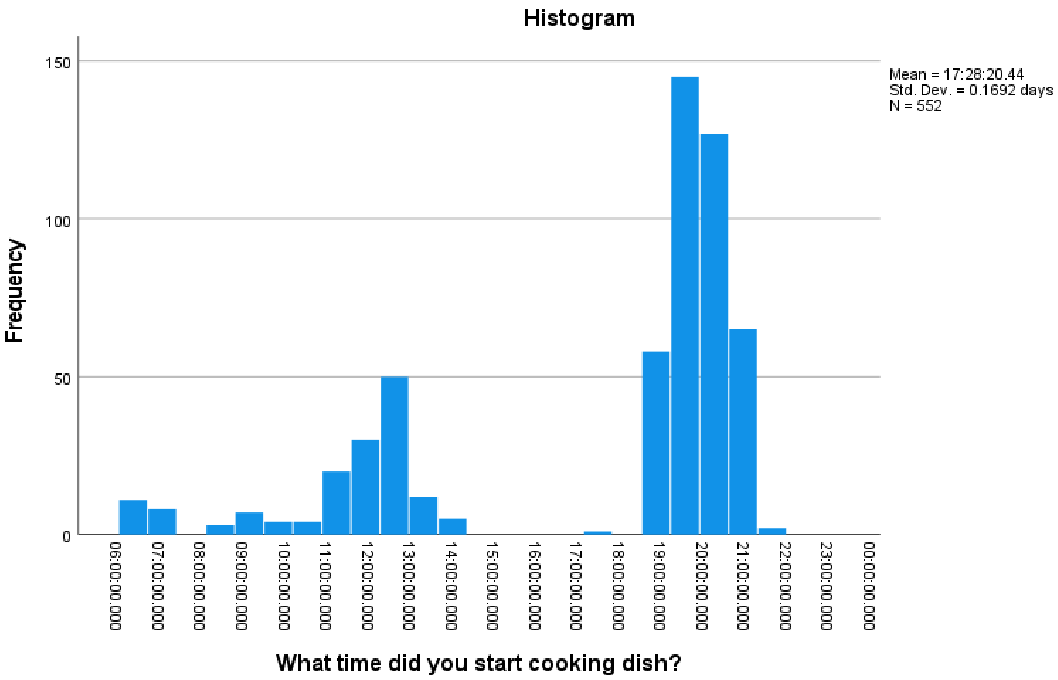


Figure 51:Distribution of cooking start times – dishes cooked with gas (UG)

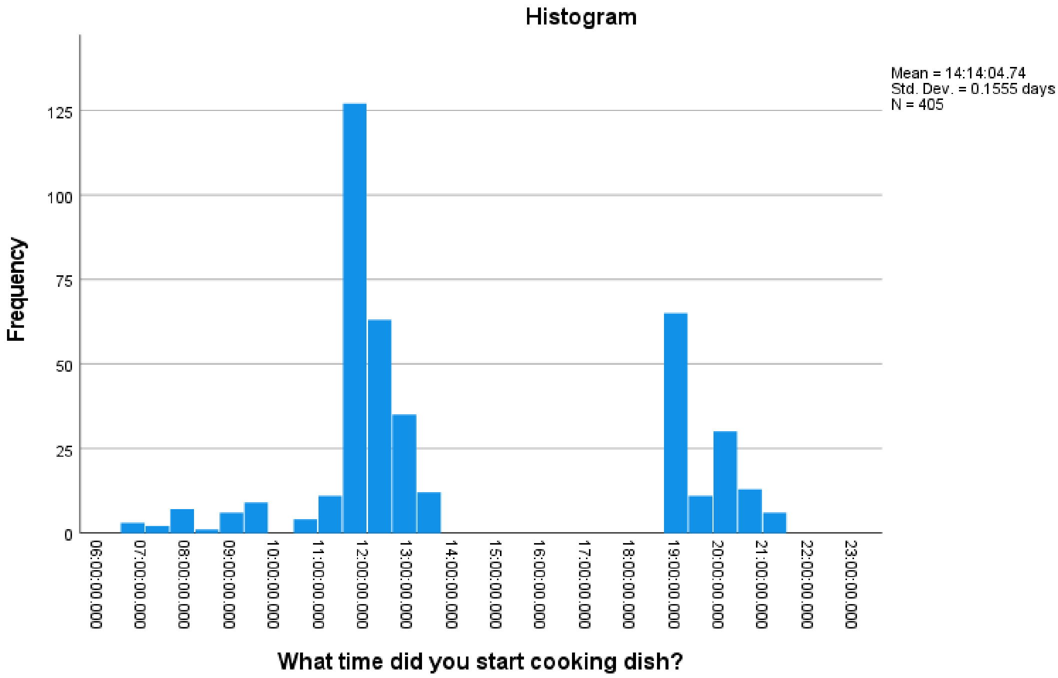


Figure 52: Distribution of cooking start times – dishes cooked with EPC (UG)

All of these charts exhibit two main cooking periods. Cooking start times for EPC and LPG show similar trends (see **table 14**), whereas cooking with charcoal starts one hour earlier, and cooking firewood starts two hours earlier.

Device	Peak 1	Peak 2
Firewood	9.00 – 13.00	17.00 – 20.00
Charcoal	10.00 – 14.00	18.00 – 21.00
LPG	11.00 – 13.00	19.00 – 21.00
EPC	11.00 – 13.00	19.00 – 21.00

Table 14: Approximate summary of cooking periods (by start time) – UG

3.4.2 Time to cook individual dishes

3.4.2.1 Uganda

Across all of the dishes cooked in the Uganda Cooking Diaries study, median dish cooking times indicate that overall, dishes are cooked in approximately half the time when using LPG or EPCs (see **table 15**).

A dish-by-dish analysis of the cooking time using different fuels is given in **table 16**. This shows that cooking some dishes on LPG or the EPC, such as matoke, can save a lot of time compared to cooking on charcoal, whereas the time saving is more modest when cooking other foods such as soup and rice. Across all dishes where a comparison can be made, the average time saving when cooking with LPG is 35% (compared to charcoal), but the average saving is 68% when cooking with an EPC.

Table 15: Dish cooking time (Cooking Diaries) – UG

Device	Number of dishes (N)	Cooking time (median)
Firewood	352	1:00
Charcoal	6330	1:18
LPG	540	0:45
EPC	404	0:35

	Firewood		Charcoal		LPG		EPC	
	Median	N	Median	N	Median	N	Median	N
Beans	17:30.0	70	03:00.0	664	10:00.0	23	40:00.0	179
Beef/Goat	15:00.0	11	56:00.0	395	20:00.0	6	30:00.0	47
Boiled potatoes	40:00.0	5	30:00.0	9				
Fish stew (boiled)	20:00.0	13	00:00.0	122	35:00.0	7		
Fried fish			00:00.0	133	30:00.0	14		
Fried potatoes			15:00.0	69			30:00.0	13
Leafy veg	20:00.0	9	30:00.0	319	25:00.0	42		
Matoke	15:00.0	83	15:00.0	1172	00:00.0	31	30:00.0	13
Porridge	00:00.0	6	18:00.0	54	30:00.0	15	20:00.0	9
Rice	50:00.0	23	00:00.0	984	50:00.0	136	30:00.0	61
Soup (goat, beef, fish)	40:00.0	8	50:00.0	196	50:00.0	39	25:00.0	5
Sweet potatoes/cassava/taro root	45:00.0	38	30:00.0	235			12:00.0	17
Ugali	15:00.0	25	30:00.0	473	20:00.0	8		

Table 16:Time to cook specific dishes using different fuels (Uganda) (N>=5)

3.4.2.2 Kenya

Across all of the dishes cooked in the Baseline and 1-month surveys of the Kenya Cooking Diaries study, median dish cooking times indicate that overall, dishes are cooked in approximately half the time when using LPG or EPCs as opposed to biomass fuels (see **table 17)**. Note that this is weighted by the frequency with which specific dishes were recorded. A dish-by-dish analysis of the cooking time using different fuels is given in **table 18**. This shows that cooking some dishes on LPG or the EPC, such as cereals, can save a lot of time compared to cooking on charcoal, whereas the time saving is more modest when cooking other foods such as porridge and meat stew. The table indicates that cooking with ethanol is quicker than cooking with firewood or charcoal, but not as quick as cooking with LPG or EPC. Across all dishes where a comparison can be made, the average time saving when cooking with LPG is 32% (compared to charcoal), but the average saving is 44% when cooking with an EPC.

Table 17: Dish cooking time (Cooking Diaries) – Kenya

Device	Number of dishes (N)	Cooking time (median)
Firewood	70	25
Charcoal	1896	25
LPG	2975	11
Ethanol	143	15
EPC	2985	12

Table 18: Time to cook specific dishes using different fuels (minutes) (Kenya Cooking Diaries) (N>=5)

	Firewood		Charcoal		LPG		Ethanol		EPC	
	Median	N	Median	N	Median	N	Median	N	Median	N
Rice	22.5	6	25	184	15	143	15	19	12	594
Tea	20	23	15	238	10	1230	12.5	42	10	359
Ugali	21	8	25	300	15	280	15	15	15	426
Water/milk	40	10	20	137	10	55	5	5	10	116
Cereals			45	106	20	29	25	5	20	315
Matoke	30	9	30	75	20	50			15	161
Meat stew			25	62	23	88	30	14	20	227
Reheat			10	51	5	366	10.5	18	5	113
Sukuma			15	208	10	175	15	6	7	178
Chapati			45	129	30	81			30	14
Eggs			10	41	6	127			5	29
Githeri			75	73	15	24			45	214
Pasta			15	19	13.5	26			10	23
Porridge			20	45	20	189			15	37
Potato			30	93	20	23			10	100
Soup			25	19	30	11			15	21
Veg			15	37	10	52			7	48
Mandazi			40	20	30	7				

3.4.3 Energy consumption by meal and dish

3.4.3.1 Uganda

The Uganda Cooking Diaries data were filtered for those records that covered the preparation of only a single event (breakfast, lunch, or dinner). The median values of each fuel energy used are presented in **figure 53** – note that this includes meals that may have been cooked using multiple fuels. This shows the energy consumed to cook a meal when using each of the fuels, irrespective of the phase of the study.

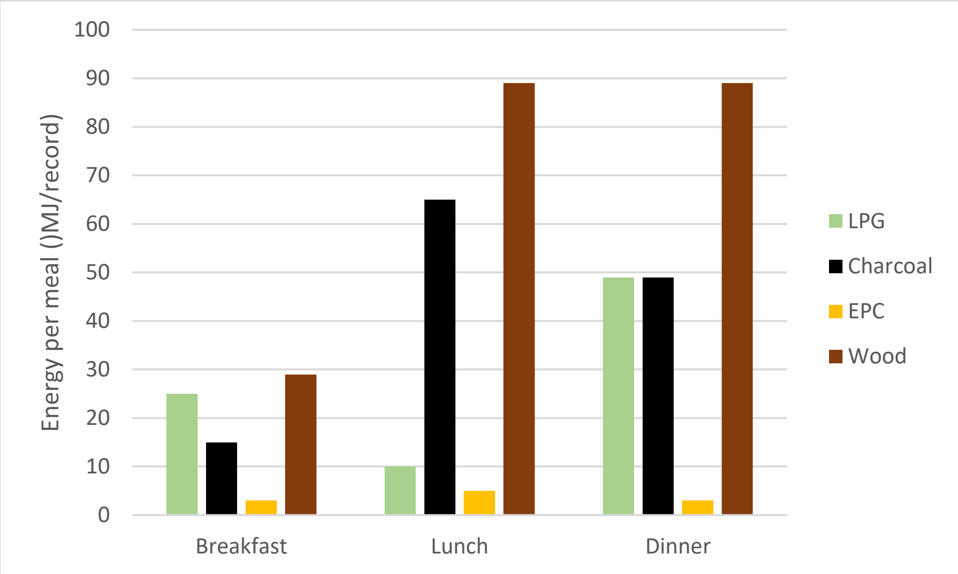


Figure 53: Energy consumption by meal type (single reason records) – UG (number of records above the bar)

The dishes most commonly cooked are presented in **table 19**.

Table 19: Top ten dishes prepared (all phases) – Uganda Cooking Diaries

Dish	Frequency	Percent	Cumulative (%)
Matoke	1315	17	17
Rice	1222	15.8	32.8
Beans	944	12.2	45
Ugali	515	6.7	51.7
Beef/Goat	463	6	57.7
Leafy veg	376	4.9	62.6
Sweet potatoes/cassava/taro root	296	3.8	66.4
Soup (goat, beef, fish)	249	3.2	69.6
Fried fish	150	1.9	71.5
Fish stew (boiled)	148	1.9	73.4

3.4.3.2 Kenya

In the Kenya Cooking Diaries studies, no data was gathered on the energy consumption of traditional fuels, but EPC electricity consumption readings were taken at a dish level. Per capita, energy consumption figures for individual dishes are presented in **table 20** and **figure 54**. The average consumption across all 11 dishes is 0.07 kWh/person. Unfortunately, it is not possible to show how the energy consumption when cooking with an EPC compares with cooking with charcoal.

Table 20: Dish level per capita electricity energy consumption (Kenya Cooking Diaries) (N>=5)

	Per capita energy consumption (median)		N
	MJ/person/event	kWh/person/event	
Rice	0.22	0.062	55
Ugali	0.28	0.079	50
Meat stew	0.25	0.070	27
Tea	0.21	0.058	59
Sukuma	0.17	0.048	19
Githeri	0.44	0.121	33
Porridge	0.21	0.058	7
Cereals	0.28	0.079	41
Matoke	0.21	0.058	26
Water/milk	0.47	0.132	20
Eggs	0.13	0.037	5

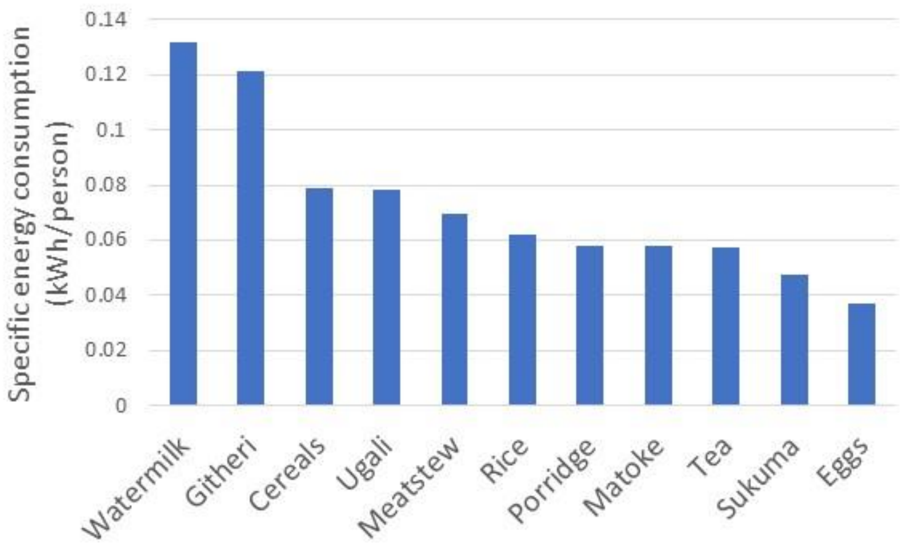


Figure 54: Dish level per capita electricity energy consumption (Kenya Cooking Diaries) (N>=5)

3.5 Changes in household consumption and costs

3.5.1 Electricity consumption

3.5.1.1 Kenya

KPLC has supplied meter readings for 25 customers who participated in the pilot in Kenya covering 16 months from May 2021 to August 2022. A year-on-year comparison of electricity consumption can be calculated for four months from May to August. The mean electricity consumption among households with valid billing data over these four months increased by 44% from 2021 to 2022 (from 44.6 kWh/household/month to 64.1 kWh/household/month). This is equivalent to a monthly increase of 19.5 kWh/household, or $3.6 (390 KSh) at 0.183 $/kWh (20 KSh/kWh). The trend of increased electricity consumption represented by a three-month rolling average consumption across customers with valid billing data, is illustrated in **figure 55**.

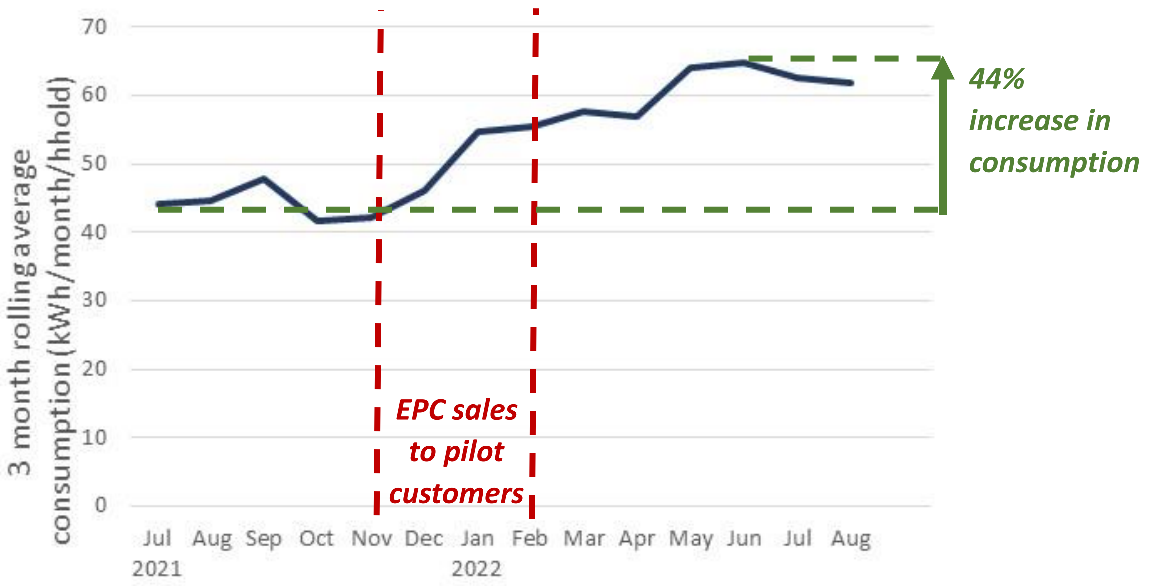


Figure 55:Trends in electricity consumption – 3-month rolling average (average across all 25 pilot customers where customer billing data was available, Kenya)

A sample of three customers has been highlighted in **figure 56** to illustrate differences in individual household trends. Three-month rolling averages indicate there is a seasonal trend of high consumption -mid-year, and low consumption towards the year's end. Nevertheless, these trends indicate that for these example households, rolling average consumption in July and August 2022 was substantially higher than in the same period in 2021: 30% higher for Customer X, 170% higher for Customer Y, and a ten-fold increase for Customer Z, who appeared to have minimal use of electricity before purchasing an EPC.

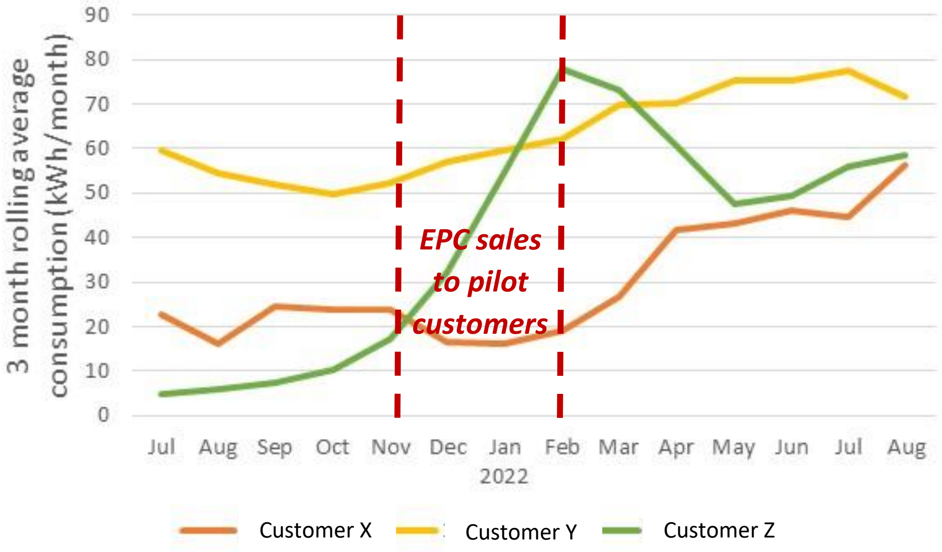


Figure 56:Trends in electricity consumption – 3-month rolling average (3 example households in Kenya)

KPT data collected over three days (at the time of the 3-month surveys), gives an average electricity consumption of 1.16 kWh/day, equivalent to approximately 35 kWh/month; this is the same order of magnitude as the example households given in **figure 56**. At 0.183 $/kWh (20KSh/kWh), this is equivalent to 0.21 $/day or 6.5 $/month. During the recent public engagement for the tariff review process, KPLC reported that the average monthly consumption from households across their entire customer base is just 35kWh, with 60% consuming less than 15kWh per month. As a result, this pilot data suggests that EPCs could make a valuable contribution to demand stimulation by increasing consumption for a typical customer by 50-100%. Importantly though, as many customers will be starting from very low levels of consumption, the resulting increase in expenditure is still likely to be lower than savings on cooking fuel for most customers who are already paying for their cooking fuel.

3.5.1.2 Tanzania & Uganda

No energy data was collected in the baseline, 3-a month, or exit surveys in Tanzania or Uganda, and the Uganda cooking diaries data did not include dates.

3.5.2 Electricity expenditure

3.5.2.1 Kenya

In Kenya, all Baseline respondents used charcoal as their primary cooking fuel. The median expenditure on electricity was 800 KES/month (mean = 971 KES/month). Note that this is consistent with billing data, which indicates a mean cost of 890 KES/month based on 44.6 kWh at 20 KES/kWh (see Section 3.5.1.1). At the 3-month surveys, **figure 57** shows that expenditure had risen to a median of 850 KES/month (mean = 1,095 KES/month), indicating an increase of 6%.

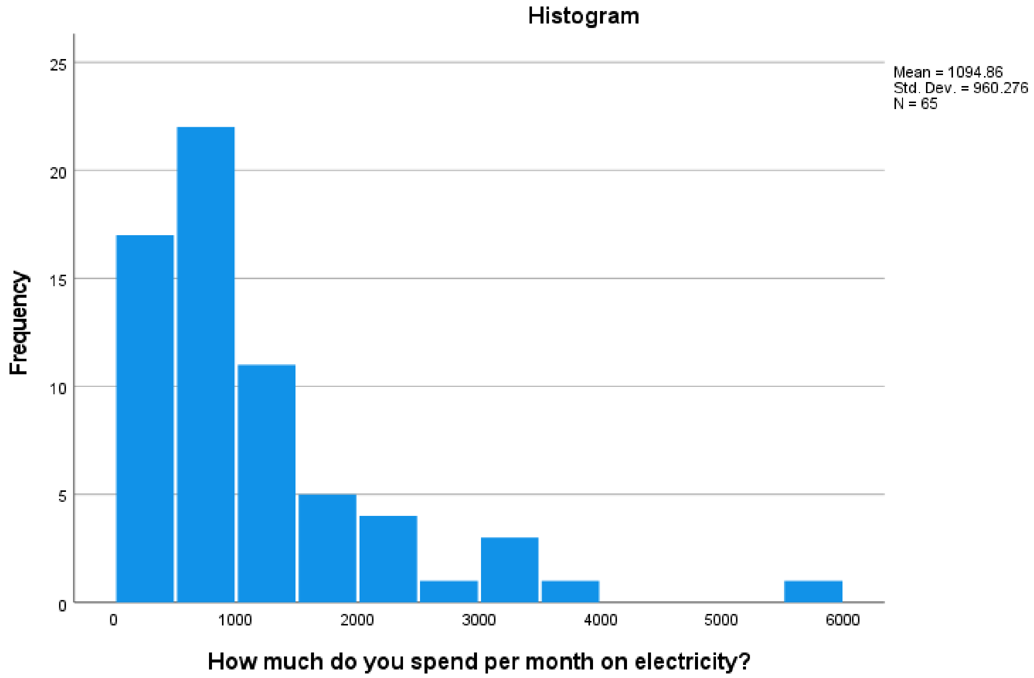


Figure 57: Distribution of expenditure on electricity (KES/month) – Kenya (3-month surveys)

Even after adopting electric cooking with an EPC, less than half of the respondents felt that their electricity bills had increased (**figure 58**). Those who felt that bills had increased (either a little or a lot) reported a 58% increase compared with before using the EPC (**table 21**)

Figure 58:Perceived change in electricity costs (3-month surveys)

Table 21: Magnitude of increases in electricity costs (3-month surveys)

Medians (KES/month)	Increased a little/lot	No change
N	26	38
Current expenditure	950	800
Increase	350	-
Estimated Baseline expenditure	600	-
Percentage increase	58%	-

Respondents to the 3-month survey were divided into two groups: those using their EPC up to once a day (occasional users), and those using it more than once a day (intensive users). This classification was then applied to respondents to the Baseline survey**. Table 22** shows that intensive users spent more on electricity during the 3-month surveys, as might be expected. However, it also shows that expenditure among occasional users dropped by the time of the 3-month surveys. Further research is needed to determine why this is so; for example, it could be that customers became more aware of electricity expenditure after using their EPC so estimates at the 3-month survey was more accurate, or other devices were used less often after 3 months (e.g. fridges are used less often as shorter cooking times mean beans are cooked more frequently rather than needing refrigerating).

Table 22: Change in spending on electricity by the intensity of EPC use (Kenya)

KES/month	Baseline	3 month
Occasional (<= once/day)		
Median	1000	600
Mean	1218	893
N	11	21
Intensive (> once/day)		
Median	750	850
Mean	857	1191
N	14	44

3.5.2.2 Tanzania

At the baseline survey, the mean[7] spend on electricity was approximately 16,700 TZS/month (based on estimates using the mid-point of expenditure bins). Breaking this figure down, the mean expenditure of respondents who cooked with electricity (not EPC) was 21,300 TZS/month, substantially higher than among those who did not cook with electricity (13,500 TZS/month). By the

[7] Means have been used because any median figure would simply represent the midpoint of the median bin; it is proposed that in this case means are more meaningful, given that using bins eliminate outliers.

time of the 3-month survey, spending appeared to have dropped to a mean of 9,000 TZS/month. However, these figures should be treated with caution as enumerators reported that customers had poor knowledge of expenditure on electricity.

After adopting electric cooking with an EPC, only 13% of respondents felt that their electricity bills had increased (**figure 59**). Note that 42% of respondents at baseline used electricity for cooking, but not with EPCs; the 37% of respondents to the 3-month surveys who reported a drop in electricity bills is probably a result of these customers replacing inefficient electric cooking devices with the EPC. Those who felt that bills had increased reported a 34% increase compared with before using the EPC (**table 23**).

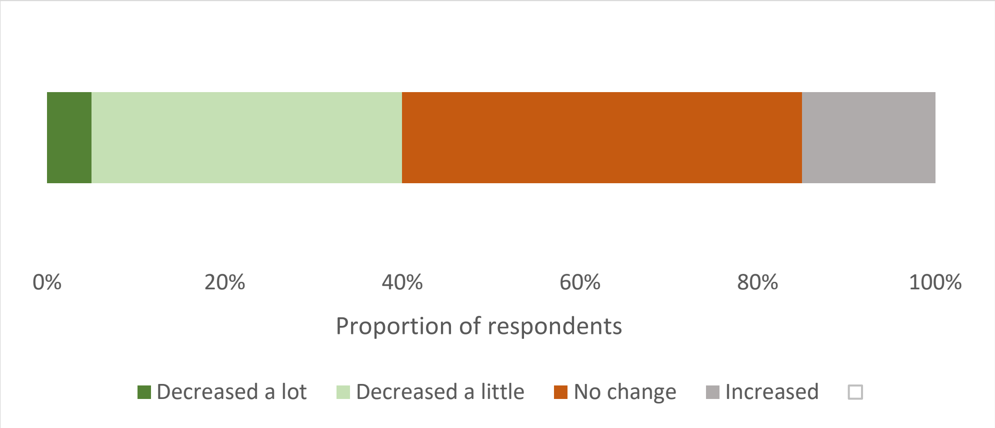


Figure 59:Perceived change in electricity costs (3-month surveys, TZ)

Table 23: Magnitude of changes in electricity costs (respondents reporting an increase in expenditure) (3-month surveys, TZ)

	Means (TZS/month)
Current expenditure	9000
Increase	2300
Estimated Baseline expenditure	6700
Percentage increase	34%

3.5.2.3 Uganda

At the baseline survey, the mean[8] spend on electricity was approximately 20,500 UGS/month (based on estimates using the mid-point of expenditure bins). However, there was no data on expenditure at the exit survey and the cooking diaries did not have data on overall electricity bills.

The majority of respondents felt that it was cheaper to cook with electricity than their normal cooking fuel (**figure 60**), and an additional 32% said it depends on how the electricity is used – it is cheaper if using the EPC, but not using it too much. However, the vast majority (91%) agreed that cooking with electricity is affordable (**figure 61**).

[8] Means have been used because any median figure would simply represent the midpoint of the median bin; it is proposed that in this case means are more meaningful, given that using bins eliminate outliers.

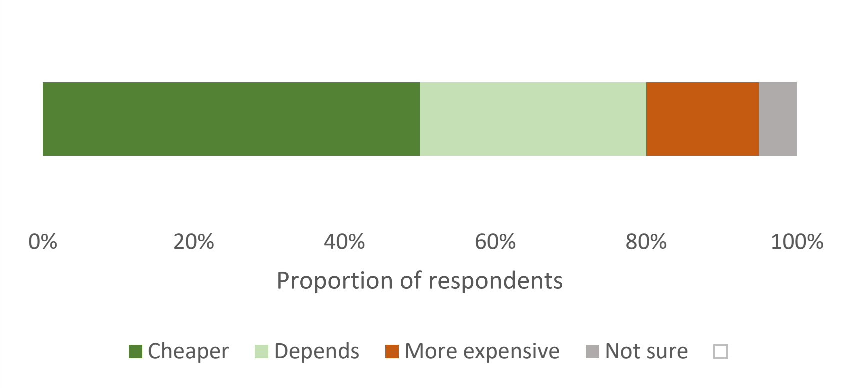


Figure 60: Is cooking with electricity cheaper or more expensive than using your normal fuel? (Uganda Exit survey)

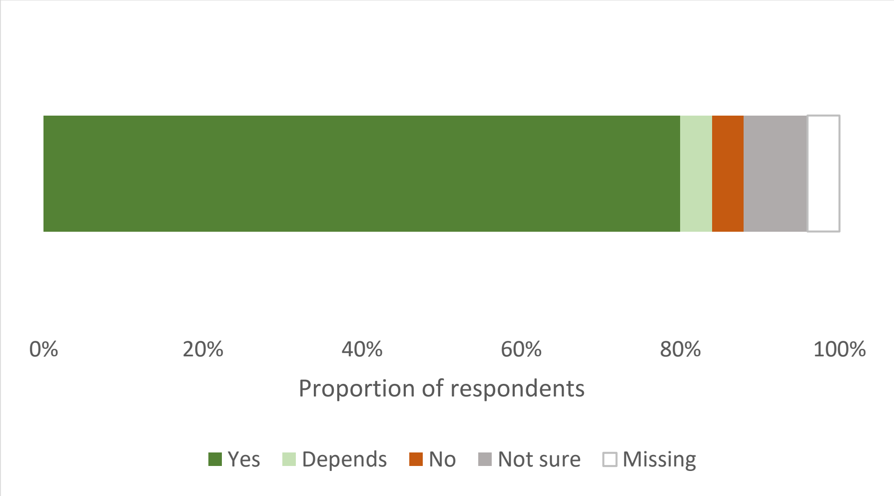


Figure 61: Do you think electric cooking is affordable? (Uganda Exit survey)

3.6 Fuel/energy consumption

3.6.1 Kenya

The KPT results give fuel consumption data for each household along with overall figures averaged across all households (irrespective of whether they used the fuel or not). The ratios of energy use at the 3-month survey to the energy use at the baseline survey indicate that the adoption of EPCs reduced charcoal use by over 90% (**see table 24**).

Table 24: Change in energy consumption and costs (Kenya KPT)

3-month data as a proportion of baseline data	Charcoal	LPG	Firewood
Relative consumption	9%	139%	44%
Relative cost	16%	114%	27%

The figures presented in **figure 62** relate to the overall use of fuels, over an unspecified period, and do not necessarily reflect the intensity of use of each fuel. A better measure of this can be gleaned from the Kenya Cooking Diaries data, which asked which fuel was used to cook each dish. Note that this does not tell us about energy consumption, but **figure 62** shows that by the time of the 1-month survey, participants had substituted charcoal with both electricity and LPG. The use of charcoal dropped from 75% of all dishes to 15%. The energy consumption will not be directly proportional to the number of dishes cooked, but it will be closely linked, and these figures suggest an 80% reduction in charcoal use, which is the same order of magnitude as the savings evident from the Kitchen Performance Tests data.

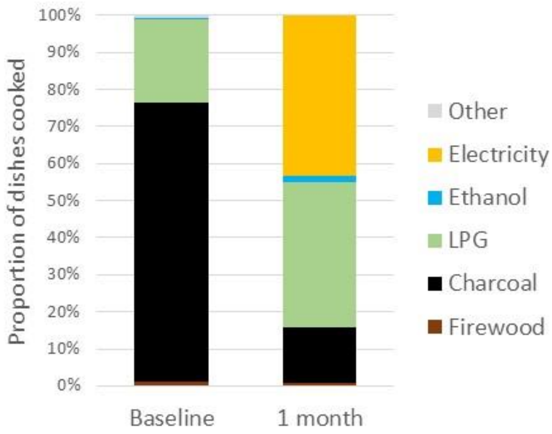


Figure 62: Fuels used to cook individual dishes (Kenya Cooking Diaries)

3.6.2 Tanzania

Respondents in Tanzania were asked at both baseline and 3-month surveys how often they cooked using each fuel. These responses have been used to estimate the total number of cooking events in a week (assuming each time a fuel is used represents some kind of cooking event i.e., no account is taken of fuel stacking within a single cooking event. The proportions of each fuel used in all cooking events have been estimated for both phases – see **figure 63**. This shows how EPCs have primarily displaced charcoal in the cooking energy mix.

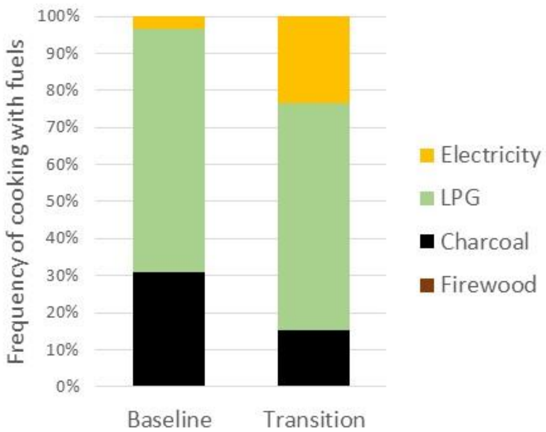


Figure 63: Proportions of fuels used for cooking events (estimated) (Tanzania 3 month Survey)

3.6.3 Uganda

Figure 64 shows that in Phase 4 of the Uganda cooking diaries, EPCs had been used mostly to substitute wood. While EPCs were used to cook 5% of Phase 1 dishes, this increased to 11% in Phase 4; this exactly matches the drop in firewood use from 6% to 0% of all dishes cooked. There was only a marginal reduction in the proportion of dishes cooked using charcoal.

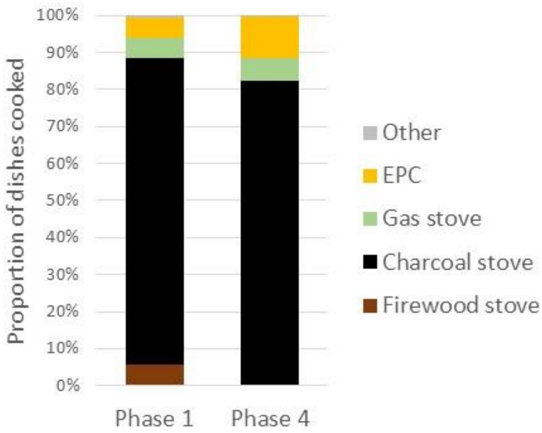


Figure 64:Fuels used to cook individual dishes (Uganda Cooking Diaries)

The Uganda Cooking Diaries data also includes dish-level energy consumption data for all fuels, although this data should be treated with caution as it was collected independently by participants during COVID-19 lockdown. Among all records in the Cooking Diaries dataset (n=3,600), 81% contain an energy consumption measurement for at least one fuel. These records cover the cooking of a total of 6,925 individual dishes. Of those dishes cooked in Phase 1 of the study (Baseline), 6% were cooked using an EPC; the highest use of EPCs took place in Phase 4 (11%).

The specific energy figures illustrated in **figure 65** represent the overall contribution of each fuel to the total energy used to cook all of the dishes in each phase. They have been calculated by summing the total fuel consumption for each fuel recorded in each phase and dividing by the total number of dishes prepared in the phase (across all devices). Comparing the contributions of fuels to the total energy consumption in each phase shows that a six-fold increase in electricity consumption (from a very low base in Phase 1) corresponded with a 21% drop in charcoal consumption. The use of wood was all but eliminated, with an 85% reduction.

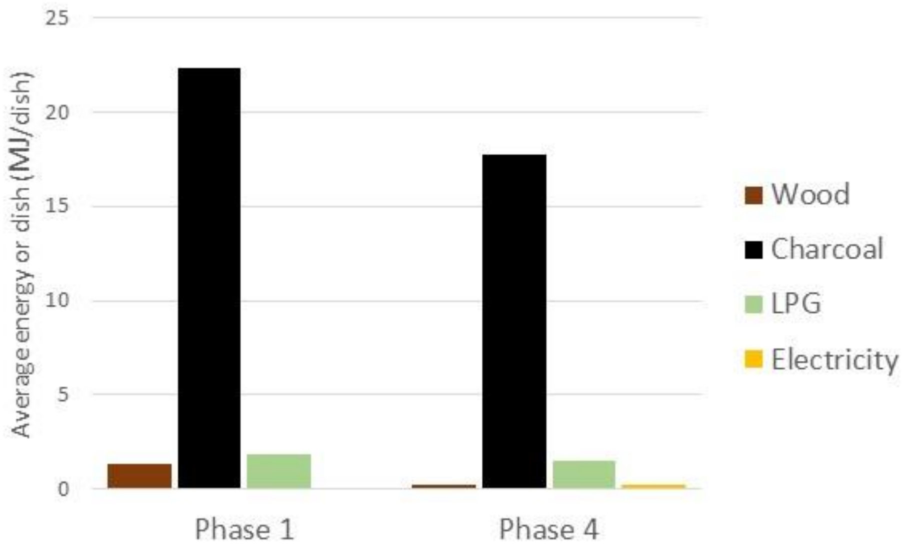


Figure 65: Changes in specific energy consumption (UG cooking diaries)

The energy analysis in **figure 64** confirms the substitution of firewood evident in **figure 65.** Even though EPCs were used to cook 11% of dishes in Phase 4, the amount of energy used is minuscule compared to the other fuels. Although there was little change in the proportion of dishes cooked using charcoal (**figure 64**), there was a substantial reduction in the amount of energy; this may reflect the greater use of EPCs in Phase 4 for cooking energy-intensive dishes such as beans, which were the most frequently cooked dish with the EPC in Uganda.

3.6.4 Costs of all Cooking Fuels

3.6.4.1 Kenya

Figure 66 shows that when the total expenditure across all fuels is divided by the total number of respondents, the average household expenditure on cooking fuels at baseline was 3,400 KES/month, and 1,850 KES/month at the 3 months survey, representing an overall cost saving of 1,550 KES/month (45%).

At the baseline, all respondents were using charcoal (as their primary fuel); at the 3-month surveys, only 71% were using charcoal but they were using less of it (and paying less). The overall reduction in fuel costs across the two surveys is illustrated in **figure 66.** In this figure, the total expenditure on each fuel summed across all who used it is divided by the total number of respondents in the survey. Participants reported that their expenditures on electricity increased by an average of 556 KES/month.

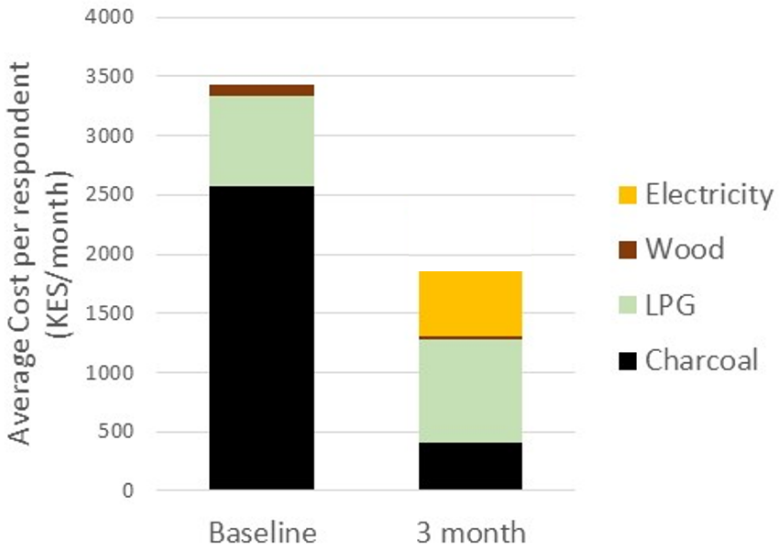


Figure 66:Average costs of cooking fuels and electricity used for cooking - Kenya

The KPT results give fuel consumption data for each household along with overall figures averaged across all households (irrespective of whether they used the fuel or not). Changes between the baseline and the 3-month surveys would not be expected to mirror the changes illustrated in **figure 66** because they do not take into account the different prices that people will pay (e.g., seasonal, size of measure purchased). Nevertheless, they demonstrate the same trends and indicate that the adoption of EPCs reduced charcoal use by over 90%.

3.6.4.2 Tanzania

At baseline, all respondents were using both charcoal and LPG (**see figure 67**). The overall reduction in fuel costs across the two surveys is illustrated in **figure 67.** The average total expenditures per household on cooking fuel and electricity for all domestic applications at baseline was 36,500 TZS/month, which drops to 19,500 TZS/month at the 3-month surveys. As mentioned earlier, the reduction in electricity costs could be partially explained by a switch from inefficient electric cooking appliances to EPCs by some participants, but it could also be due to inaccuracies in estimates made by customers in the self-reported data.

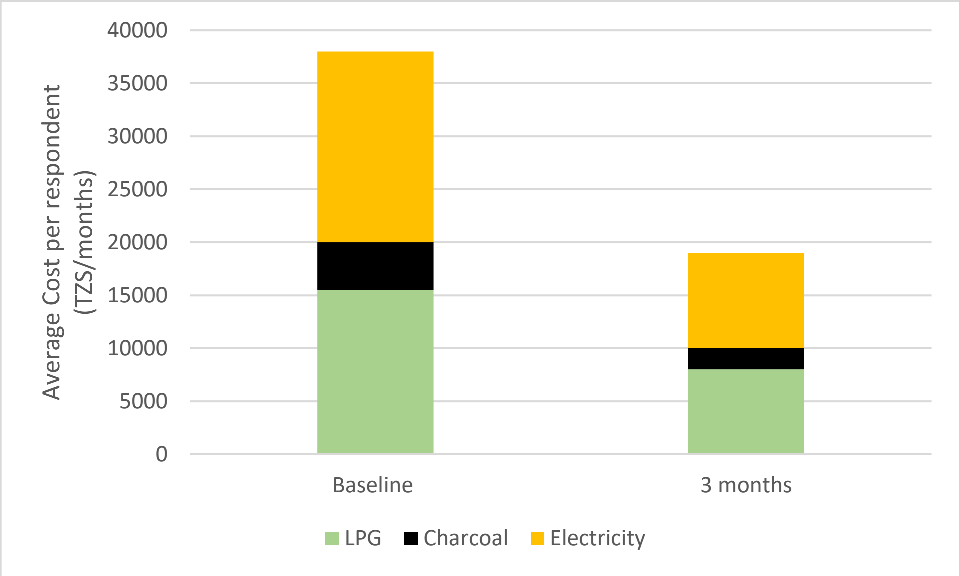


Figure 67: Average costs of cooking fuels and electricity for all domestic applications – Tanzania.

3.6.4.3 Uganda

The average total cost per household at baseline was 128,000 UGZ/month, which already included some EPC use. Unfortunately, there were no cost data in the exit survey to compare to.

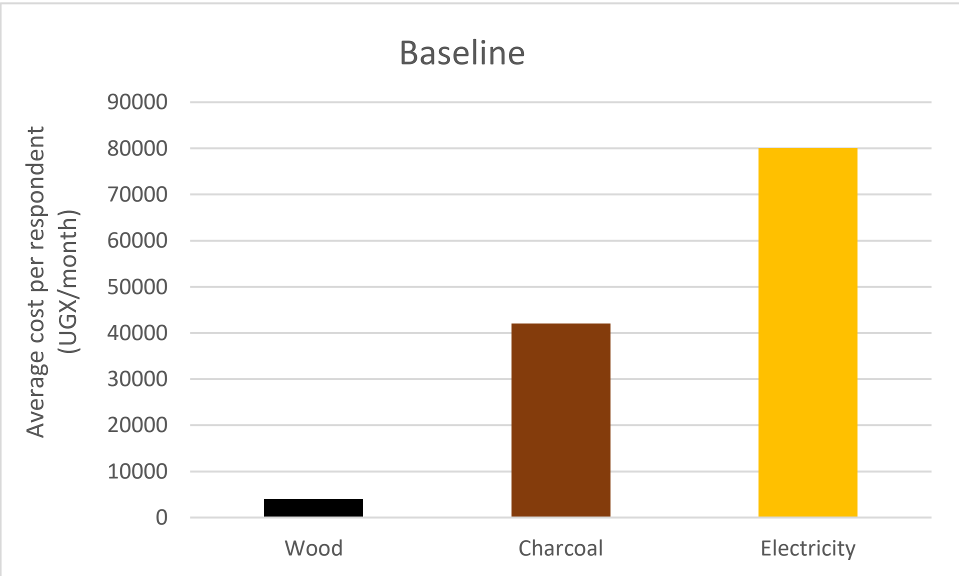


Figure 68:Average costs of cooking fuels and electricity for all domestic applications – Uganda (Baseline survey)

3.6.5 Prevailing fuel prices

3.6.5.1 Kenya

In the 1 monthly follow-up for the cooking diaries study in Kenya, participants were asked to recall the amount of each fuel they had purchased and how much they paid for it. Many of the measures used to buy charcoal do not specify the weight e.g. 1 sack. Unit prices have been calculated from those records with valid details of the weight purchased and the amount paid. The plot of the median price in **figure 69** shows that people buying charcoal in small amounts pay a substantial premium of 100% or more. It should be noted that the reported weights do not necessarily align with the actual weight of charcoal sold, for example, a "2kg tin" of charcoal often contains closer to 1kg of charcoal.

For LPG, most participants refilled 6kg (N = 20) and 13 kg (N = 5) cylinders. Median prices were 217 and 185 KES/kg respectively, indicating that households buying the smaller cylinders paid a relatively modest 15% premium. The price paid for electricity was mostly constant, (i.e., independent of the number of units purchased) apart from when only one or two units were purchased, in which case the reported price nearly doubled (see **figure 70**). However, this may be due to outliers in the data, as electricity units are sold to domestic customers at fixed lifeline and regular tariffs. These tariffs do fluctuate due to the addition of variable tariffs and levies, but not up to this level during the period of study.

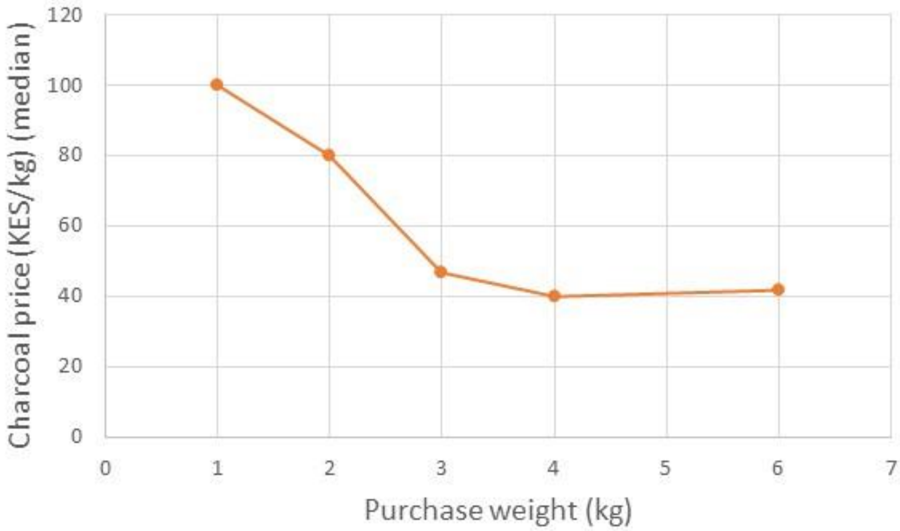


Figure 69: Variation of charcoal price with measure purchased (median) (Kenya Cooking Diaries 1 month)

Figure 70: Variation of electricity price with number of units purchased (median) (Kenya Cooking Diaries 1 month)

3.6.5.2 Tanzania

LPG. Most participants who refilled their cylinders paid 15,100 – 21,000 TZS (this was the range option given). If we assume they were filling 6 kg cylinders, that would give a price of approximately 3,000 TZS/kg.

Electricity: Although customers were asked how much they pay for tokens (range 3500 – 16000) and how often they buy tokens, they were not asked how many units they received each time.

3.6.5.3 Uganda

LPG. Most participants who refilled their cylinders paid 49,000 – 99,999 UGX (this was the range option given). If we assume they were filling 6 kg cylinders, that would give a price of approximately 12,000 UGX/kg.

Uganda surveys had no data on electricity consumption and Uganda Cooking diaries had no price or cost data.

3.7 Challenges

When asked what challenges they encountered when using EPCs, having a single pot was the greatest source of frustration among Kenyan customers (see **figure 71**). This required users to wash the pot in between cooking multiple dishes. Issues with the electricity supply have been divided into two categories in **figure 71**: quality of supply (power outages and low voltage) and payment control (EPC locked out and/or run out of electricity units). Relatively few respondents spontaneously mentioned difficulties with cooking foods as a challenge; issues included overcooking quick-cook dishes, getting the right amount of water, and difficulty baking cakes. In addition, respondents were specifically asked about how the EPC cooked food and if they had difficulties adapting recipes to cooking in an EPC. While most reported no challenges, often referring to the recipe book, issues again centred around gaining experience of correct amounts of water (especially rice), and a need to pre-soak beans and cereals. People had difficulties cooking certain foods, especially cakes, but also chapati and fried eggs.

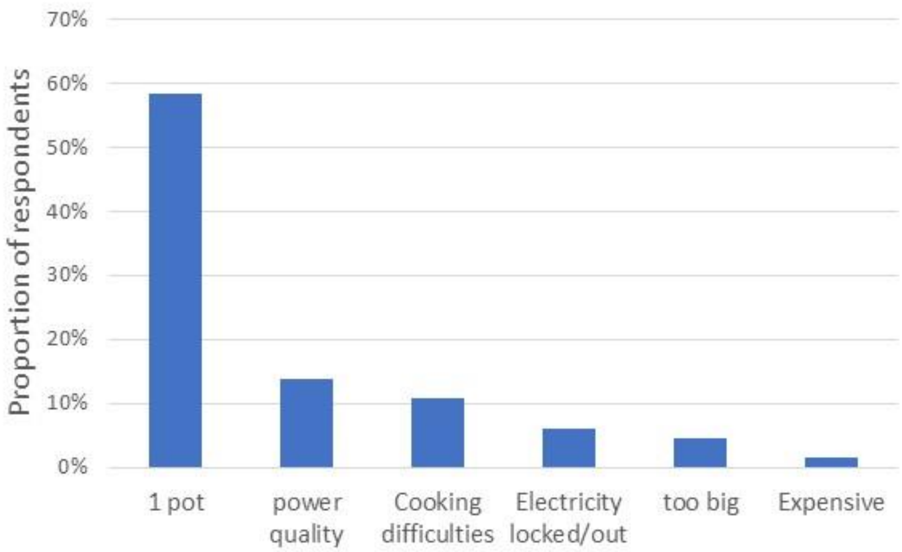


Figure 71: Challenges when using EPC (Kenya 3 months survey)

The quality of the electricity supply is a constraint in Kenya. 75% of respondents had experienced power outages in the 3 months since acquiring their EPC. Although most of these customers only experienced outages a few times per month or less (**table 25**), most felt that these had affected their use of the EPC (71% of the 75%).

Table 25: How often do you experience power outages? (Kenya 3-month survey)

	Frequency (N)	Percent
Less frequent	35	71.4%
A few times per month	10	20.4%
A few times per week	4	8.2%
Total	49	100%

Tanzanian respondents to the 3-month survey were less forthcoming with challenges they had experienced although a few respondents admitted they did not know how to bake cakes and cook ugali. When asked specifically about power issues, all respondents said they experienced power outages 1-3 times a month and running out of units occurred with similar frequency.

When asked what they disliked about cooking with electricity, the two most common issues among Ugandan respondents have perceived expense and safety concerns, most notably the fear of electric shocks. Two said that they would be reluctant to allow children to help with cooking because of a fear of shock. Responses do not specifically tie the risk of shocks to the EPC, so concerns may likely lie with poor-quality household wiring and damaged sockets and switches. **Figure 72**, shows that 80% of respondents felt that electricity was safer than other cooking fuels, but **table 26** shows that most of those with a fear of shocks still felt that electricity was safer than other cooking fuels. This suggests that, even though safety concerns may be valid, they may not present a barrier to purchasing EPCs, if they are still regarded as safer than traditional fuels.

The high priority of cost among Ugandan compared to Kenyan customers may illustrate the importance of domestic economics. Baseline electricity costs were similar for both sets of customers:

the median figure of 800 KES/month (6.7 USD[9]) is similar to the figure of 20,500 UGX/month (5.5 USD[10]) (see Section 3.5.2). This difference almost perfectly matches differences in electricity tariffs: 0.21 USD/kWh and 0.18 USD/kWh in Kenya and Uganda respectively (2021)[11]. However, per capita figures indicate that Kenyans are better off than Ugandans, given per capita GDP figures of 2,010 USD and 860 USD respectively[12].

The proportions of Ugandan respondents mentioning power outages (power quality) and cooking difficulties were similar to Kenya, although burning food was the most commonly reported cooking difficulty in Uganda. When specifically asked, half of Ugandan respondents said there were certain dishes they could not cook in the EPC, such as matoke, cassava, sweet potato, and groundnut. However, other participants reported regularly cooking these dishes, indicating that it is possible, but that there are likely specific adaptations that need to be made to recipes that are not necessarily apparent to new users. 20% of respondents said that certain foods tasted worse when cooked in an EPC, and this was almost entirely matoke, indicating that these recipe adaptations also play a critical role in attaining the desired flavour/texture of the final dish.

Most Ugandan respondents felt that customers needed training on how to operate the device (82%); those who felt customers could work it out for themselves referred to the manual.

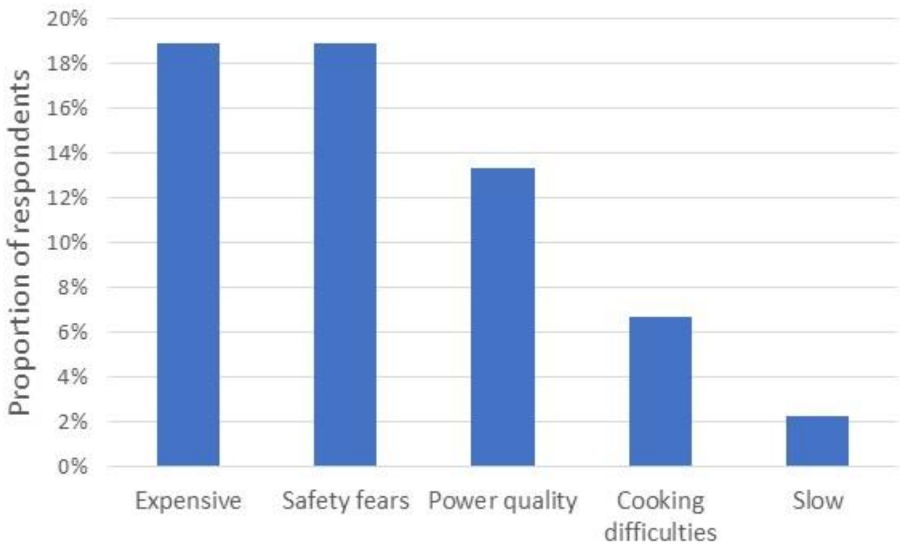


Figure 72: What do you dislike about cooking with electricity (Uganda Exit survey)

Table 26: Relationship between different indicators of the safety of electric cooking

	Fear of shock (Dislike electricity)		
Electricity is safer than other fuels	No	Yes	Total
Yes	58	14	72
All fuels safely	10	0	10

[9] Exchange rate 120 KES/USD.
[10] Exchange rate 3,700 UGX/USD
[11] https://www.statista.com/statistics/1277594/household-electricity-prices-in-africa-by-country/
[12] https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=UG

Depends	1	0	1
No	3	3	6
Don't know	1	0	1
Total	73	17	90

As in Kenya, the quality of the electricity supply is a constraint in Uganda. 67% of respondents had experienced power outages since acquiring their EPC. Most of these customers experienced outages roughly weekly **(table 27**), and most felt that these had affected their use of the EPC (73% of the 67%).

Table 27: How often do you experience power outages? (Uganda Exit survey)

	Frequency	Percent
Never	30	33.3
Once every 2-3 months	6	6.7
1-3 times a month	29	32.2
1-2 times a week	15	16.7
3-5 times a week	2	2.2
Once a day	7	7.8
More than once a day	1	1.1
Total	90	100.0

3.7.1 Summary of challenges

Although the EPC is well suited to African cuisine and many dishes can be cooked using an EPC, the customer feedback highlights a couple of notable constraints:

- Firstly, having only a **single pot** makes it difficult to cook meals comprising more than one dish. Secondly, certain dishes are not well suited to cooking in an EPC, such as chapati. It is suggested that most of the other complaints relate to a lack of experience and understanding of how to cook using an EPC, e.g. getting the right amount of water, overcooking, and burning food; it is likely that users will learn how to adapt the cooking practices to overcome these difficulties in time. However, this process can be accelerated with carefully designed training materials for new users, including cooking demonstrations at the point of sale, recipe books, and video recipes.
- **The quality of the power supply** does not stop people from cooking with electricity, but it does limit the intensity of eCooking. Even though the proportion of customers affected by outages was similar in Kenya and Uganda, the quality of supply appears to be poorer in Uganda, given that outages were more frequent. Approximately half of the customers in both Kenya and Uganda felt that power outages had affected their use of EPCs; mostly by reverting to traditional fuels. It is not clear what 'reputational damage' this does for eCooking among potential customers, and this would merit further study.
- **Electrical safety** concerns were a priority among Ugandan customers (but this issue was not raised in Kenya). It is likely that these concerns relate to poor quality household wiring and

damaged sockets and switches rather than EPCs themselves. Despite these concerns, electricity was still regarded as safer than other cooking fuels.

4 Potential Impacts of Scaled Uptake

This section explores the likely costs and benefits for one simple illustrative scenario of scale-up of eCooking, drawing on and calibrating using the data from the BURN pilots. The Kenya pilot is used as the basis for this analysis, as this is where the best quality data was available.

4.1 Approach

The World Health Organisation (WHO) revised “Benefits of Action to Reduce Household Air Pollution” (BAR-HAP) tool[13] has been applied to quantify the expected financial costs, and health and environmental benefits of the scale-up.

The scenario modelled is that all households connected to the grid in Kenya in 2020 but using charcoal as their primary cooking fuel transitioned to using an EPC by 2030. This amounts to some 1.8 million households or 6.6 million people[14]. A ramp-up of transitioning households takes place over the first 5 years and then a further 5 years of operation is modelled.

The scenarios represent a programme of eCooking appliance investment, with the capital costs paid by the programme (this could be donor, investor or government funded) and any savings in fuel costs, and avoidance of buying replacement traditional stoves, benefiting the households. The model calculates the changes in those capital and operating costs, but also estimates a much wider set of economic, social and environmental cost and benefits of the transition, such that the overall ‘social net-benefit’ to the region of the transition can be shown.

BAR-HAP has been implemented here using its policy option of a ban on charcoal use, whose effect is assumed to come in gradually over the initial transition period, and with a 100% subsidy for the capital cost of the EPCs, from the stove programme. This is clearly not a realistic policy and is simply used here to effect the transition wanted for this illustration, and to provide clarity about the impacts and where costs fall; it can be regarded as a proxy for other specific actions used to mobilize a major transition from charcoal to eCooking. Other policy options that could have been modelled would see a different distribution of stove and fuel costs and savings between parties.

4.2 Assumptions and parameter values

Households transition to the use of an EPC for a proportion of their cooking, fuel stacking for the rest. The earlier analysis of the pilots demonstrated that for all three countries EPCs mainly displace charcoal, with the balance of cooking taken by a mix of charcoal and LPG. Based on the Kenyan pilot, the EPC is modelled as meeting 43% of the daily cooking requirement, but it is substituting for some 80% of the baseline charcoal use. The contribution of LPG to the remaining 57% of cooking is not modelled: BAR-HAP is not well configured to represent the use of multiple improved devices/fuels. **Figure 66** shows that the use of LPG did not change significantly, so the modelling here can focus on the substitution of the EPC for charcoal.

[13] https://www.who.int/tools/benefits-of-action-to-reduce-household-air-pollution-tool
[14] Based on Leary et al (2022)

The EPC is assumed to cost $70 and to have a useful life of 5 years (after which it is replaced, requiring a further investment). BURN has retailed EPCs in Kenya at around $77; $70 is chosen to reflect some expected cost reduction through scaling for this sort of large-scale transition.

The baseline energy use data from the pilots is incomplete and so BAR-HAP's assumption for charcoal cooking efficiency of 14.4% is adopted. The EPC energy use is difficult to quantify from the pilots since for most meals and some dishes multiple devices and fuels were used and device-specific energy data are not available. The EPC energy performance was therefore modelled using the specific energy consumption ratio for charcoal to EPC use in Africa given by (Scott and Leach 2022) a value of 15. A review of the pilot data suggests that this figure derived statistically from a wide range of kitchen performance tests and controlled cooking tests in -sub-Saharan Africa, is a reasonable approximation.

The pilot data shows that for Kenya the EPC saves 44% of food preparation time on a per-dish basis: this is adopted and acts to reduce the BAR-HAP default cooking time of 2.6 hours per day. So approximately 1 hour is saved per household per day.

Kenya's grid electricity generation capacity mix is dominated by geothermal (41%) with most of the balance from hydro (30%) and wind (16%), with 10% of thermal generation[15]. At times the generation itself is more than 90% renewable and Kenya has long-held policy ambitions for 100% renewable electricity by 2030. The July 2022 Whitepaper offers a bold roadmap to 2040 with a rapid increase in power supply, with most of it green. As such, the scenario includes GHG emission factors to represent the likely future of increasing decarbonization of power. To implement this, Kenya is assumed to achieve a similar position of almost 100% renewable generation as Iceland (which has 73% coming from hydropower and 27% from geothermal power), with very low GHG emissions, and an emission factor of just 0.21 gCO2/kWh.

The charcoal price comes from the pilot data analysis: with a median price paid of 80 KES/kg, translating to $0.73 (with an average exchange rate in 2021 of 109 KES/$). The majority of participants in the pilot were paying 16.6 KES/kWh, which is the lifeline tariff. For this analysis, a rate of 20 KES/kWh ($0.183/kWh) is used, which is a value commonly used in energy planning that cut across the lifeline and regular domestic tariffs.

4.3 Results

Table 28 shows the outputs of BAR-HAP for the modelled scenario. The financial costs of equipment, fuel, and programme costs are in the top half, and then the health and environmental impacts are in the lower half (in both physical units and then monetized).

Table 28: Summary of key input and output parameters from BAR-HAP modelling.

[15] https://www.trade.gov/country-commercial-guides/kenya-energy-electrical-power-systems

	Population (million)	Housholds (million)
National population, 2020	53.60	14.73
Grid connections, 2020	38.80	10.66
Of which, using charcoal as main fuel	6.60	1.81
Households transitioning to EPC		1.81

(costs are -ve, benefits are +ve)				Monetised Costs & benefits, $/yr
Total present value (ie net social benefits of the transition)				167,560,257
Total costs of transition, government+private				61,381,742
Private cost to housholds: total				81,504,041
Stove				727,073
Fuel				83,422,134
Maintenance				-2,645,166
Costs to government: total				-20,122,299
Stove				-15,904,715
Fuel				0
Admin+Programme				-4,217,584
Health, Time, and Environmental Benefits: total		**Physical: change/yr**	**Physical: % of national cooking total**	106,178,515
Health impacts total: DALYs avoided	DALYs	2,931		43,456,904
Mortality reduction	*YLL*	1,515	0.2%	38,894,416
Mortality reduction	*Lives*	130	0.5%	
Morbidity reduction	*YLD*	1,415	0.8%	4,562,488
Morbidity reduction	*Cases*	7,246	0.8%	
Time savings	Hours	566,272,156	7.3%	44,275,766
Time savings per adopting household	*Hours/HH*	313		
Electricity use	*MWh*	285,796		
CO2-eq reduction (CO_2,CH_4,N_2O)	Tonnes	1,104,186	4.0%	16,859,460
Unsustainable wood harvest reduction	Tonnes	191,486	1.4%	1,586,385

Note: costs are discounted across programme period.
Totals are Net Present values; costs/year are NPV divided by the ten years of the programme

4.3.1 Physical and financial impacts

The table shows that while this transition would cost the stove programme some $110 per household for equipment and programme costs ($20 mill/year for ten years, across 1.8 mill households), it would save households roughly four times that over the period, due to reduced energy bills each year. These numbers are all on an annualized basis from the full ten-year periods modelled and are thus not easy to relate to specific investments: payback times are set out below. Electricity tariffs are relatively high, but the EPC is highly efficient and charcoal prices are also high. Furthermore, health benefits would include more than 130 lives saved per year and more than 7,000 cases of debilitating illness avoided per year. Some 1.4% of current unsustainable wood harvesting would be avoided. Some of these impacts may seem modest but this scenario is targeting only 12% of the national population.

The transition from charcoal to electric cooking would make a significant reduction in greenhouse gas emissions. Further attention though is needed to better understand the appropriate emissions factors for Kenya now and in the future: the UNFCCC-approved standardized baseline emissions factor for

Kenya[16] is currently at 317 gCO2/kWh and whilst this is still valid for use under UNFCCC rules, it seems in practice to be out of date. The modelling here has instead assumed low emission factors, reflecting a highly decarbonized electricity supply system.

From KPLC's perspective, the transition would bring a considerable increase in electricity demand, of some 285 GWh/year. The model does not look at power flows and thus the effect on loads is not known.

4.3.2 Economic impacts

The charts display the monetized costs and benefits from the right-hand side of the table, and how these stacks up to a net social outcome. The overall position is one of a large net social benefit for the transition to EPCs, offering more than $1,700 net social benefit per household over the ten-year periods considered.

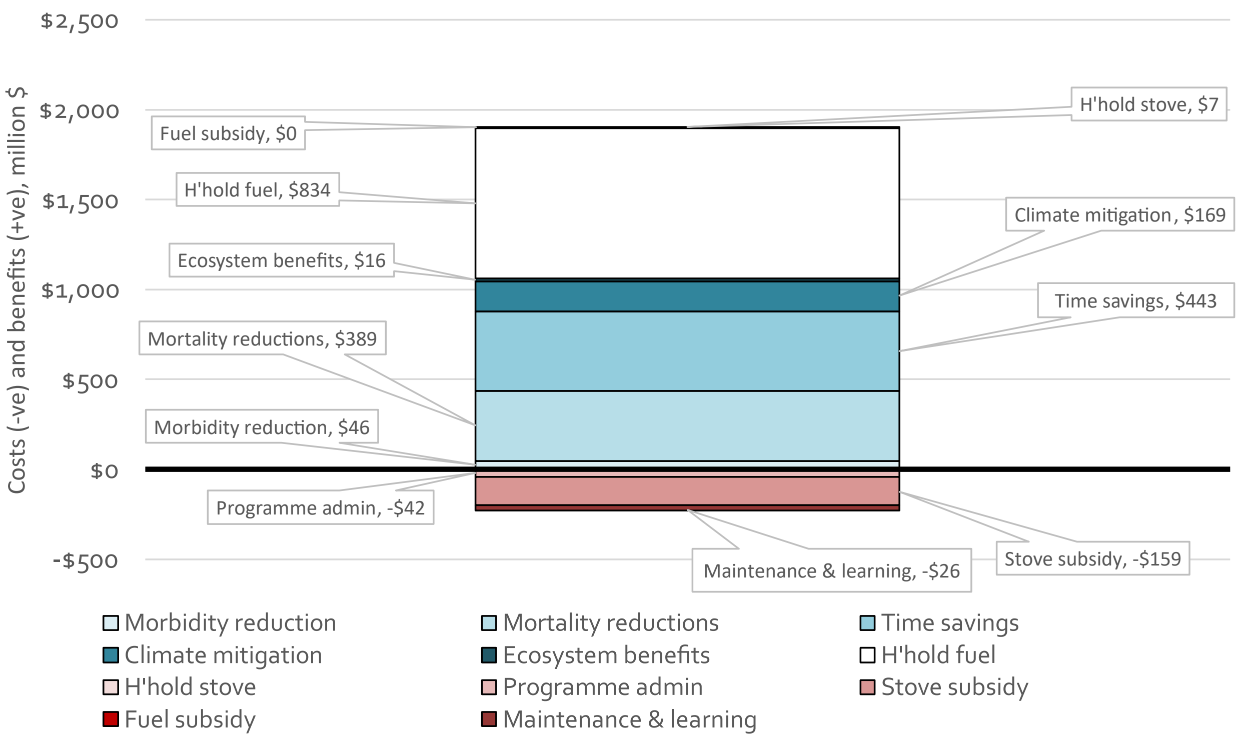


Figure 73: Breakdown of net costs and benefits from the modelled charcoal to electric transition

The social benefits from avoided time spent cooking are significant, reflecting time savings using an EPC, and the opportunity cost for peoples' time, as used in BAR-HAP. The climate mitigation benefits are also large: BAR-HAP monetizes GHG emission reductions using a social cost of carbon which they assume to be around $18/tCO2. This is higher than typically achieved in the voluntary carbon market (where $8 would be more usual), but there is a significant opportunity to monetise the carbon savings to support the EPC transition using carbon credits. The health benefits are also large, driven mainly by the valuation of reduction in mortality attributed to indoor air pollution from charcoal cooking.

[16] https://cdm.unfccc.int/methodologies/standard_base/2015/sb148.html

By far the largest benefit though comes from reduced fuel costs to households. Charcoal prices in urban areas were assumed to be $0.73/kg, and even with electricity tariffs at $0.18/kWh, combined with cooking energy savings from the use of more efficient electric devices, this leads households to save around $10 per month (on an average spend on charcoal in the baseline of KES2500/month, $23/month –**figure 73**). The largest element of cost is from the purchase of modern stoves, represented here as a 'stove subsidy', due to the way BAR-HAP's transition policies have been applied. In practice, the EPCs would more likely be bought by households using some form of consumer finance. Therefore, the payback period for the investment is of particular interest.

4.3.3 Payback times

The BAR-HAP tool has been applied here using the crude assumption that a stove subsidy programme pays the full cost of the initial investment in eCooking equipment; hence the capital costs (shown as 'Stove subsidy') and the benefits in reduced running costs (captured as 'Household fuel') are separated. In practice, the initial capital cost of the EPC could be paid for in a number of ways. Further exploration of that is beyond the scope of this work. However, the clearest way to compare the investment costs to the change in operating costs is the payback time. The above tables involve discounting to give a sense of the overall costs and benefits of a long project where the time value of money is important. Here the simple (or undiscounted) payback is calculated.

Table 29 shows the expenditure on charcoal in the baseline, and then on the EPC and the remaining stacked charcoal, for one of the modelled households. The investment in an EPC would pay back in less than eight months. The figures in the table are very similar to those in the preceding analysis of the BURN pilot data for Kenya, with small differences just owing to how cooking is modelled in the BAR-HAP tool.

Table 29 : Shows the expenditure on charcoal in the baseline, and then on the EPC and the remaining stacked charcoal, for one of the modelled households

	Baseline		**Post transition**		**Saving**	
	KES/month	**$/month**	**KES/month**	**$/month**	**KES/month**	**$/month**
Charcoal spend	2510	23.0	502	5	2008	18.4
Electric cooking spend			948	9	-948	-8.7
Total cooking spend	2510	23.0	1450	13	1060	9.7
Capital cost					**KES**	**$**
					7630	70.0
Payback period					**Years**	**Months**
					0.60	7.2

4.4 Cross-country comparison

In Kenya the impacts are strongly positive. While the data from the pilot did not support similarly detailed modelling with BAR-HAP, the conditions in Uganda and Tanzania are broadly similar.

In Uganda, firewood and charcoal are the most widely used cooking fuels, with pressure on forests from intensive charcoal production. There has been limited use of LPG to date and electricity access rates have been historically low, but are growing steadily. The power supply is majority hydro, and there have been issues with load shedding in drought periods, but there has been considerable investment and a more diverse energy mix is in the pipeline.

In Tanzania, prospects are similarly positive. In particular, the lifeline tariff for electricity is very low, making eCooking financially attractive. Around 70% of urban households rely on charcoal and a presidential task force has recently been established to facilitate the adoption of alternative cooking fuels and technologies. LPG is seen by many as the most attractive alternative, in particular by high-level decision makers, and hence significant efforts would be needed to promote the transition to electricity as a viable and complementary strategy. Natural gas makes up the largest share of electricity generation, however, it is one of the cleanest fossil fuels and the Julius Nyerere hydropower station is due to double the national generation capacity in 2023.

Detailed market assessments for eCooking in Uganda, Kenya, and Tanzania including impact modelling (but using other national data, not specific to the BURN pilot). Further discussion of the conditions affecting electric cooking potential, based on a wider set of market assessments in Sub-Saharan Africa and South Asia is available here.

5 Conclusion

The results of the analysis show that there are considerable cost and time savings for households acquiring an EPC, in particular for households who are currently using charcoal as their primary fuel. There is a learning curve that needs to be overcome to maximise the benefits of the new appliance, however, Burn's sales and marketing team have refined their approach throughout this early piloting and are now able to offer comprehensive training and after-sales support to new customers, which can enable them to make the most of their new appliance. Once new customers overcome this initial hurdle, the modern cooking experience combined with the substantial cost and time savings creates a strong driver for sustained use. This is evidenced by the high levels of sustained use seen in the Kenya pilot (almost 50% of the menu was cooked with the EPC 3 months after purchase) and much more moderate levels of use in both Tanzania and Uganda (where new teams who had not worked with EPCs before were responsible for setting up and supporting the EPC pilot). This was further exasperated in Uganda, where training and after-sales service were severely disrupted by covid lockdowns.

As a result, a key learning point from this study is that investment in training both end users and sales teams is critical for unlocking the social, economic, and environmental impacts that can be obtained from the adoption and sustained use of EPCs. Without this, EPCs tend to be used for a relatively limited set of dishes and therefore have minimal impact on the use of biomass. Currently, EPCs are a niche technology in East Africa, so general awareness of how to cook popular local dishes is low. As they become more common, awareness will inevitably grow organically, however, concerted efforts will need to be made at this early stage to ensure that consumers are fully aware of the range of dishes that they can cook in an EPC and the specific adaptations that they need to make to their familiar recipes to achieve the same familiar taste. Only when customers are empowered with this knowledge can EPCs start to make a substantial contribution to reducing the use of biomass in kitchens across East Africa.

This impact analysis described above describes just one simple scenario of uptake at scale of EPC cooking in Kenya, for one particular market segment (grid-connected charcoal users). The transition from charcoal to electric cooking offers considerable financial benefits for the user, although for many households some form of consumer finance or other support would be needed to break down the high initial investment. The modelling also shows that the transition at scale would bring very significant net social benefits for Kenya overall, based on the WHO's physical impact and impact monetization methodologies.

Charcoal was the dominant traditional fuel of choice in both the Kenya and Uganda pilots, while in Tanzania most respondents used LPG (noting that none of the samples are in any way representative of populations as a whole). Evidence shows that when customers acquired EPCs, they tended to use them to substitute for charcoal and wood rather than LPG. In terms of social costs, if EPCs were to be used to substitute for LPG rather than charcoal, then the impacts on time savings and mortality highlighted in the BAR-HAP analysis would be greatly reduced. These findings simply confirm the intuitive view that EPCs will yield greater benefits to charcoal users.

The variety of impacts and their level in any one country or region of course depends on many local conditions. Key factors that drive positive impacts for the transition to electric cooking include:

- Reliance on unsustainably sourced polluting fuels (notably firewood or charcoal) for large segments of the population.
- For use of an EPC, traditional and popular foods need to be suited to this device; e. g. beans and other long-boil dishes, such as stews.
- For grid eCooking: wide access to reliable grid electricity. However, it is possible to add a household battery to support cooking on less reliable grids and off-grid cooking with PV and battery (i.e., a large solar home system) is also becoming an increasingly viable option.
- The electricity supply (whether grid or mini-grid) should ideally be relatively low carbon. A high share of renewables is desirable, but even eCooking with electricity generated from natural gas can lead to lower emissions than cooking with charcoal.
- The relative price to households of electricity and traditional fuel is key. High electricity tariffs can still support eCooking if energy-efficient appliances are used and traditional fuel prices are also high.
- The price of EPCs (or other eCooking devices) is also important, underpinning payback times and overall economic benefit. The supply chains into countries, and border controls and tax policies vary widely and can significantly increase retail prices and create bottlenecks in the supply chain.

6 References

Accinelli, R A, L M López, and J C Aguirre. 2015. "Rural electrification and respiratory health: An empirical approach in Peru." *American Journal of Respiratory and Critical Care Medicine* 191 (8): 957–958. https://doi.org/10.1164/rccm.201411-2086LE.

Albers, P N, C Y Wright, K V Voyi, and A Mathee. 2015. "Household fuel use and child respiratory ill health in two towns in Mpumalanga, South Africa." *South African Medical Journal* 105 (7): 573–577. doi:https://doi.org/10.7196/SAMJnew.7934.

Buthelezi, S A, T Kapwata, B Wernecke, C Webster, A Mathee, and C Y Wright. 2019. "Household fuel use for heating and cooking and respiratory health in a low-income, South African coastal community." *International Journal of Environmental Research and Public Health* 16 (4). doi:https://doi.org/10.3390/ijerph16040550.

Capuno, J J, CAR Jr Tan, and X Javier. 2018. "Cooking and coughing: Estimating the effects of clean fuel for cooking on the respiratory health of children in the Philippines." *Global Public Health* 13 (1): 20-34. doi:https://doi.org/10.1080/17441692.2016.

CLASP. 2020. "Global LEAP Awards 2020 Buyer's Guide for Electric Pressure Cookers."

Couture, D T, and D Jacobs. 2019. *Beyond Fire: How to achieve electric cooking.* World Future Council and Hivos.

CREEC. 2020. "Cooking with Electricity in Uganda: Barriers and Opportunities." https://mecs.org.uk/wp-content/uploads/2020/10/Uganda-CCT-Report-.pdf.

Efficiency for Access, & 60 Decibels. 2021. "USES & IMPACTS OF ELECTRIC PRESSURE COOKERS Insights from Kenya."

ESMAP. 2020. *Cooking Electricity With a Cost Perspective.* World Bank.

Inston, R, and N Scott. 2022. "Costs of cooking with different fuels: a case study from mini-grids in Tanzania. ." www.mecs.org.uk.

Lambe, F, A Nyambane, and R Bailis. 2020. *Beyond Fire Backcasting a Pathway To Fully Electric Cooking in Rural Kenya By 2030.* Stockholm Environment Institute and Hivos. https://www.sei.org/publications/beyond-fire-backcasting/.

Leary. 2021. *Exploring the market for eCooking: insights from sub-Saharan Africa and South Asia.* https://mecs.org.uk/blog/exploring-the-market-for-ecooking-insights-from-sub-saharan-africa-and-south-asia/.

Leary, J, and J Todd Fodio . 2019. *The Kenya eCookBook: Beans & Cereals Edition.*

Leary, Jon. 2022. "Kenya eCooking Market Assessment." https://mecs.org.uk/wp-content/uploads/2022/02/MECS-EnDev-Kenya-eCooking-Market-Assessment.pdf.

Maina, J, and J Spencer. 2021. "Development and evaluation of a direct current solar electric pressure cooker unit (DSEPC)."

Ministry of Energy and Mineral Development . 2020. *Sector Perfoormance Report: Utilising Energy and Mineral Resources for Economic.* Kampala ,Uganda: Ministry of Energy and Mineral Development .

Ministry of Energy and Mineral Development. 2019. *Draft National Energy Policy.* Kampala, Uganda: Ministry of Energy and Mineral Development.

Naluwagga, A, and M Tesfamichael. 2022. "Uganda eCookbook."

Parikh, J, J Cloke, E Puzzolo, D Pope, and C Singh. 2019. "Electric Cooking: Needs, Challenges, And Way Forward." https://irade.org/website/wp-content/uploads/2021/03/Electric-Cooking_p4.pdf.

Sawe, E, and K Aloyce. 2020. *The Tanzania eCookbook.* https://mecs.org.uk/wp-content/uploads/2020/07/Tanzania-Ecook-Book-text-web.pdf.

Schreiber, K, M Waceke, and H Blair. 2020. *Electric pressure cooking: accelerating microgrid e-cooking through business & delivery model innovations.* Efficiency for Access.

Scott, N, and M Leach. 2022. "Comparing energy consumption and costs – from cooking across the MECS programme. ." MECS working paper.

SESCOM, Nexleaf, & TAFORI. 2021. *Piloting Innovative Business Models for Accelerating Uptake of Efficient Electric Cooking Appliances in Morogoro, Tanzania. .* MECS.

Sieff, Richard. 2022. *Analysis of the Key Findings from the Electric Cooking Outreach (ECO) Challenge Fund Projects Author:.* UK: MECS. https://mecs.org.uk/wp-content/uploads/2022/10/ECO-Final-Report.pdf.

WHO. 2021. *Benefits of Action to Reduce Household Air Pollution (BAR-HAP) Tool (Version 2, July 2021).* https://www.who.int/publications/m/item/benefits-of-action-to-reduce-household-air-pollution-(bar-hap)-tool-(version-2-july-2021).