



MECS
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In-depth exploration of cooking entirely with electricity

Qualitative Summary Paper - Working Paper for Comment

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Executive Summary

In summer 2022, MECS (Modern Energy Cooking Services) established a challenge fund to investigate the implications of cooking entirely with electricity in select countries in Asia and Africa. This produced 21 reports from 18 partners in 12 countries outlining the energy and time costs and savings; barriers and difficulties of cooking with ecook (electric cooking) appliances; and participant preferences and experiences. Our partners followed a modified 'Cooking Diaries 3.0' protocol to produce meal-resolution data to explore these areas of enquiry.

This report offers a summary of the qualitative data generated by this challenge fund in relation to research questions 5, 6, 7 and 8:

5. Which dishes do people prefer to cook using different electric devices?
6. What is the user experience of cooking entirely with electricity?
7. What barriers prevent people from cooking entirely with electricity?
8. What difficulties do people encounter when cooking entirely with electricity and how do they overcome these?

In the 'Cooking Diaries 3.0' protocol, participants first completed a baseline survey, then partners monitored the households as they continued to cook as normal. After a consultation with participants, partners selected ecook technology to introduce to the households. These appliances frequently involved EPCs (electric pressure cookers) and induction stoves but also included infrared and hotplate stoves, rice cookers, kettles and more. In the next phase called 'transition', households were asked to cook exclusively with the ecook appliances where possible. After this, they completed the endline survey, which covered topics such as difficulties, barriers and experience with cooking entirely with ecook devices.

During the transition phase, rice was most often cooked using rice cookers and EPCs, yet EPCs were also used for lentils, beans and pulses in addition to vegetables, stews and soups and meat. Meat and vegetable dishes had the most variation in which device was chosen to cook them with. Meat was found to be cooked with induction, infrared or hotplate stoves (NAMHUS, CEEEZ), EPC (EED, CEEEZ), airfryers (CEEEZ). Vegetables, on the other hand, were cooked in EPCs (CEEEZ), induction and infrared stoves (NAMHUS, WACN, KAPEG), hotplates (Jahangirnagar) as well as in a rice cooker (CIRCODU). Like in the baseline, microwaves were often used for reheating events (Kijani, EED) and electric kettles used for water heating events (CEEEZ, WACN).

Whereas in the baseline phase participants had used pre-existing ecook devices for task-specific actions, during the transition phase, participants demonstrated themselves becoming more confident and comfortable with these devices, as appliances were not always used in task-specific ways, with vegetables being steamed in a rice cooker (CIRCODU) and tea being made in the microwave (CEEEZ).

According to the endline surveys, the majority of households had a positive experience, as they were able to produce tasty dishes, whilst saving time and effort. Participants in the NAMHUS and ABF studies were particularly pleased by the texture of rice prepared in an EPC, with the majority of Kijani and TaTEDO participants stating that overall food tastes better. In contrast, KAPEG and Kijani's participants saw little change in the taste of food, which is promising for ecook as it is able to create

21 reports
18 partners
12 countries

Baseline
Select ecook
technology
Transition
Endline

Innovative ways of
using task specific
appliances.

an entire menu without forfeiting traditional tastes. However, 6 out of 10 households in the NAMHUS study stated that the food prepared with electricity tasted worse, yet NAMHUS believed this could be remedied with more training.

.....the majority of Kijani and TaTEDO participants stating that overall food tastes better.

In 11 studies, participants discussed how ecook technology saved them time, with participants in Kijani and Microenergy Bangladesh and Tanzania studies able to multi-task due to ecook needing less monitoring. Alongside ecook being more autonomous, it also reduced the need to travel to find and fetch fuel which was a positive point noted by the participants of the TaTEDO study. On the other hand, CIRCODU and EED found that the hotplate was slower to prepare food than at baseline, leading to it being unpopular. Little effort also had to be expended when using the device itself, with devices being easy to use according to participants in the Microenergy Bangladesh and Tanzania studies. It was also easy to learn how to use according to 75% of WACN participants and 10/13 CIRCODU households. It was found that older users struggled to learn, with the oldest participant in IISD's study being the only participant to say that it would not have been possible to learn how to use the ecook appliance without the training they received. Older participants in PEEDA's and ABF's study were found to be the most reluctant to use the technology.

..... able to multi-task due to ecook needing less monitoring.

Participants in the IISD and Microenergy Cambodia studies praised the good heat capacity of the devices which allowed faster cooking (albeit this leading to initial issues around burning food in the ARIN study). Concerns over safety of devices often lay in the exposed heating element of the hotplates (EED), the hot EPC cover and depressurising EPCs. These concerns over overheating were realised in the Finovista study, where overheating wiring led to the induction cookstove body melting in two low-income households. However, the majority of participants in the CIRCODU, Jahangirnagar study said that ecook was safe and in five studies, the health benefits of ecook were linked to ecook not producing smoke, with the kitchen becoming a child-safe area.

However, there were also significant barriers and difficulties to using ecook. Initial preconceptions of ecook (such as having high running costs and being unsafe) led to reluctance to take it up. Six studies raised concerns about the high upfront cost of ecook appliances. Alternatively, only 3 out of 10 households in NAMHUS' study were concerned about the cost of ecook appliances, however this may be because participants did not realise how expensive the devices were. This was the case in the IISD study, 53% of participants believed that the devices cost half or less than the actual price when asked to guess how expensive they were. The financial barrier to ecook is illustrated by participants being reliant on our partners financing their devices for the study, and often also for additional items such as induction-compatible pans. The local market for ecook devices was also limited, with quality, quantity, efficiency and affordability lacking for the large part. Device aftercare was also largely absent, and spare parts being unavailable locally, adding significance to the preconception held by some study participants that electrical appliances are less reliable and needing frequent repair work.

Six studies raised concerns about the high upfront cost of ecook appliances.

The lack of cheap electricity (Bahir) and lack of money to pay for electricity in low- and mid-income households (CEEEZ) was also a concern and barrier to households in the study. For participants in the CIRCODU study, when more electricity units had to be purchased more frequently, their assumptions that ecook was expensive felt validated despite energy and cost savings relative to their baseline fuels. However, as no households considered electricity expenditure a detrimental factor in the

endline survey of IISD's study, the perceived barrier of running cost is not universal, yet occasionally the actual cost of using ecook can be more expensive than baseline fuels as found in EED's study where 50% of households found electric cooking to be slightly more expensive than their baseline LPG fuel source.

the perceived barrier of running cost is not universal.

Once using ecook in the study, participants often had issues with the capacity of the devices, struggling with the reduced volumes of food that they could cook in one event, and frustrated by sequential cooking and its additional time and effort burden. This led to households reverting to baseline fuels and avoiding bulky foods such as pumpkin and yam (S Divin). As a result, both EED and CIRCODU recommended that cooking capacity should be increased in relation to both device size and device number. Moreover, some participants were not able to cook their desired foods with the devices provided. PEEDA, TaTEDO, NAMHUS and ABF all reported participants struggling to prepare chapati (the most frequently named food unsuitable for ecook devices). Finovista did provide participants with an electric roti maker, however participants reported that they were too stiff when produced this way, and so resorted to baseline fuels. This may also reflect insufficient tailoring of ecook device combination to the household's diet during the participant consultation phase.

...participants often had issues with the capacity of the devices, struggling with the reduced volumes of food that they could cook in one event...

However, the most significant barrier to complete adoption of ecook and its consistent use was unreliable electricity supply and poor domestic electrical infrastructure. Domestic infrastructure was called 'obsolete' (pg21) by ABF with NAMHUS and PEEDA having to replace or upgrade areas of the domestic electrical wiring, sockets or micro-circuit breakers in order for households to participate. These precautions were necessary, as both the Finovista and Kijani studies found that ecook devices had melted or burnt due to poor wiring. In several studies, electricity meters were shared amongst households, such as in the TaTEDO study where the neighbours would rotate who would pay for the shared meter, often leading to blackouts before the next neighbour would pay. Electrical bandwidth was also an issue, with 60% of IISD households as well as several ABF households unable to support ecook and other electrical devices at the same time.

.... significant barrier... unreliable electricity supply and poor domestic electrical infrastructure.

Fluctuating voltages and blackouts were a common feature of 20 studies. Power fluctuations and failures for CIRCODU and Kijani participants often coincided with when they wanted to cook. Brownouts increased the labour required to cook as cooking time increased. Outages were fairly regular, with WACN finding that 75% of participants had 1-2 outages per week which lasted for a minimum of 13 minutes. Longer power cuts were also experienced, particularly in Tanzania which was experiencing a period of electricity rationing during the study period, leading to an average of 4-12 hours of power rationing per day (Microenergy Tanzania). During these outages, participants tended to revert to their baseline fuel, demonstrating that cooking entirely with ecook is not plausible during periods of power outages or reductions.

Overall, our partners' reports have shown that cooking with electricity as a primary fuel is currently more feasible than cooking entirely with electricity. Significant barriers to use such as electricity stability, capacity, cost and market availability introduce difficulties to consistent ecook, however the positive experiences participants had with ecook suggests that with additional support, cooking an increasing proportion of diets with electricity is possible. Moreover, having identified these barriers, as well as interest from governments increasing, it is plausible that cooking entirely with electricity can be worked towards and will be possible in the future.

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Contents

Executive Summary.....	1
Contents.....	5
1. Introduction	6
1.1 Methodology.....	6
2. Which dishes do people prefer to cook using different electric devices?.....	8
2.1 Rice.....	8
2.2 Beans, lentils and pulses	9
2.3 Vegetables.....	9
2.4 Meat and fish	9
2.5 Stews and soups.....	9
2.6 Water heating and tea	9
2.7 Reheating	10
3. What is the experience of cooking entirely with electricity?	10
3.1 Sensory.....	10
3.2 Heating experience	11
3.3 Time-related.....	11
3.4 Effort	12
3.5 Safety and hygiene.....	13
4. What barriers prevent people from cooking entirely with electricity?.....	13
4.1 Electrical infrastructure.....	13
4.2 Cost	15
4.3 Markets	15
4.4 Awareness and learning.....	16
5. What difficulties do people encounter when cooking entirely with electricity and how do they overcome these?.....	16
5.1 Lack of reliable energy supply.....	16
5.2 Cooking capacity	16
5.3 Inability to cook certain foods with ecook appliances.....	17
5.4 Demographic modifiers.....	17
6. Conclusions	18

1. Introduction

MECS (Modern Energy Cooking Services) is a research programme funded by UK Aid (FCDO) which works with partners in 16 countries. Seeking to accelerate and support the transition of low-income economies to clean and electric cooking, MECS established a challenge fund in summer 2022 to investigate the implications of households cooking entirely with electricity in select countries in Africa and Asia.

Partners were asked to use the 'Cooking Diaries 3.0' protocol¹ with a small number of households (median number of households among the partners was 13) in order to generate meal-resolution data on electric cooking devices and whether they can be used to successfully meet all household cooking needs. This data was required to answer 8 research questions:

1. How much energy is required to cook entirely with electricity?
2. How much traditional energy can be saved by transitioning to cooking entirely with electricity?
3. What are the cost implications of transitioning to cooking entirely with electricity?
4. How much energy is required to cook individual dishes using a range of electric cooking devices?
5. Which dishes do people prefer to cook using different electric devices?
6. What is the user experience of cooking entirely with electricity?
7. What barriers prevent people from cooking entirely with electricity?
8. What difficulties do people encounter when cooking entirely with electricity and how do they overcome these?

1.1 Methodology

The challenge fund generated 21 research papers from 12 countries with 18 partners across Asia and Africa. Partners utilised the 'Cooking Diary 3.0' protocol to produce data which describes 'how' people cook and the energy and time used.



Figure 1.1: map showing the location of the studies at national resolution.

¹ <https://meecs.org.uk/wp-content/uploads/2020/12/Cooking-Diaries-3.0-Protocols-JL-9-9-19-LOW-RES.pdf>

These studies used the first two out of three phases of the cooking diary protocol: the baseline and transition phase.

- The baseline phase: participants continue to cook as normal. Which dishes are being cooked, cooking methods, batch cooking or reheating, appliances and utensils as well as time and fuel used were recorded at the dish-level. At the meal-level, the name and gender of the cook of each event, cooking purpose, catering number and time used were again recorded.
- The transition phase: participants switch to using electric appliances as much as possible. The same data is recorded again.

Bookending the two phases were two surveys (baseline and endline surveys) which collected data on demographics and other quantitative data (such as prices paid for fuels) and qualitative data on cooking experience. Between the two phases was a participant consultation which aimed to agree on which combination of eCook (electric cooking) devices would best enable the participant to cook entirely with electricity based on the baseline survey. Some partners tailored the devices given to each household more specifically than others, as where some designated a range of eCook devices on a household-by-household basis, others gave each household the same suite of eCook devices.

This paper is part of the culmination of this challenge fund, summarising our partners' qualitative findings, consequently focusing particularly on research questions 5, 6, 7 and 8.

Partner	Country	Appliances Provided										HH Number	
		EPC	Rice cooker	Induction Cooker	Infrared Cooker	Holzgarte	Air fryer	Electric Kettle	Microwave	Oven	Other		
ABP	Nepal											Teapot	20
KAMEO	Nepal												20
NUMBERS	Nepal												10
PEBA	Nepal											Teapot, grinder, juicer	10
WACH	Nepal											Roti maker	20
ARIN	Nepal												15
EEP	Nepal												10
Kjara	Nepal	*including KI introduced DC EPC										Teapot, Sandwich maker, Coffee maker	13
oake	Ethiopia												13
CEEZ	Zambia											Pre-existing, electric frying pan and slow cooker; introduced, introduced, electric frying Pan.	10
CHODU	Uganda												13
CHIC	Uganda												10
Finavate	India											Roti maker	14
ISD	Indonesia												15
Jahangmagr	Bangladesh												20
Mikroenergy	Bangladesh												10
Mikroenergy	Cambodia												10
Mikroenergy	Tanzania											Coffee maker	10
TUTED	Tanzania												10
NSEI	Nigeria												16
S DIAN	Sierra Leone												19

Figure 1.2: an overview table of the partner studies, location of study, households involved and eCook devices used in the study.

Key
Pre-existing eCook Device
Introduced eCook Device
Introduced to some households and pre-existing in others

2. Which dishes do people prefer to cook using different electric devices?

Cooking is a deeply cultural experience, with both practicality and preference dictating which appliances are selected to cook with. During the baseline of the study, few participants used ecook appliances. Those who did tended to use task-specific ecook appliances, such as rice cookers, electric kettles and microwaves. IISD found that all households used rice cookers to cook rice in the baseline phase, excepting one who used an LPG stove for medical reasons. Similarly, TaTEDO found that a few participants already had rice cookers at the baseline phase. Microwaves were seen as specific to reheating food for participants in EED’s study in Kenya. Electric kettles were frequently already owned, with CREEC finding that 90% of water boiling was achieved using electricity in the baseline, and 16 out of 20 households in ABF’s study also finding this. Studies in Tanzania (TaTEDO), Uganda (CIRCODU) and Rwanda (S Divin) also found households possessed electric kettles at the baseline stage.

The next section will outline the ecook appliances chosen to cook certain classes of food during the transition phase. However, it should be noted that the availability of ecook appliances and therefore range of choice available to the study households is strongly related to the appliances provided to participants by our partners (see Figure 1.2).

Appliance	EPC	Induction	Hotplate	Microwave
Positive Responses	<ul style="list-style-type: none"> Faster-cooking Cheaper Automated control systems Keeps food hotter for longer Energy efficient Cost efficient Can cook irrespective of wind and outdoor conditions 	<ul style="list-style-type: none"> Boiled, sauteed or fried dishes tasted better than traditional fuels Faster cooking time Safer Easier Cleaner No need to get refills Can cook irrespective of wind and outdoor conditions 	<ul style="list-style-type: none"> Liked absence of smoke Can cook irrespective of wind and outdoor conditions 	<ul style="list-style-type: none"> Saves time when reheating food Can cook irrespective of wind and outdoor conditions
Negative Responses	<ul style="list-style-type: none"> Pre-programmed cooking timer may not save time when cooking fresh dishes 	<ul style="list-style-type: none"> Fried, meat or dishes which took longer to prepare tasted worse than traditional fuels or were considered too difficult 	<ul style="list-style-type: none"> Lengthy cooking time when cooking from fresh Exposed heating element considered unsafe 	

Figure 2.1: a comparison table of frequent participant responses to different ecook appliances.

2.1 Rice

During the transition phase when the participants cooked with electricity as much as possible, rice was a staple in many of the studies. In contrast to the baseline phase, rice was often also cooked with EPCs (electric pressure cookers) as well as rice cookers. Rice cookers were used in 99.2% of rice cooking events in IISD’s study. EPCs were used the most often for cooking rice in the KAPEG study, with only 2% and 8% of other rice cooking events respectively being performed with induction or infrared cookstoves. Similarly, PEEDA found that 73% of rice dishes were cooked with an EPC, as did WACN where 99% of rice and pulse

During the transition phase.... rice was a staple in many of the studies.

dishes were cooked together in an EPC with a separator used. EED found that rice was one of the dishes most frequently cooked in an EPC.

2.2 Beans, lentils and pulses

In the KAPEG study, 10% of EPC cooking event involved lentils, with CEEZ and WACN studies also finding that the EPC was preferred for pulses. Bahir found that the EPC was often used for pulses which needed more than 1 hour of cook time. The EPC was found to be used to boil in EED's study.

CIRCODU describes how participants particularly liked to use the EPC to make ground nut paste as they liked its taste and texture. In contrast, NAMHUS's study found that daal was most frequently prepared using an induction cooker.

EPC was preferred for pulses.

2.3 Vegetables

For cooking vegetables, there was greater variation in ecook appliance chosen. CEEZ found that vegetables were prepared in an EPC, whereas CIRCODU found vegetables were regularly steamed in a rice cooker as it was deemed a tasty way of preparation. Infrared and induction stoves were more widely used to cook vegetables, including in KAPEG's study, NAMHUS and WACN (induction was used in 63% of vegetable cooking events). The Jahangirnagar study discovered that electric hotplates were often chosen to prepare vegetables.

For cooking vegetables, there was greater variation in ecook appliance chosen.

2.4 Meat and fish

Again, meat and fish tended to be cooked with a variety of ecook appliances, often due to the plethora of ways to cook meat including boiling, frying and roasting. NAMHUS found that meat, particularly chicken, was cooked on induction or infrared stoves, whereas EED found that meat and rice were the most common dishes cooked in the EPC. CEEZ found that broiler chicken was most commonly cooked in an electric pan or 4-hotplate cooker, beef and other meat was most commonly cooked in an EPC as well as airfryers, and meat was also cooked in an electric frying pan.

meat and fish... plethora of ways to cook meat including boiling, frying and roasting.

2.5 Stews and soups

For stews and soups, EPCs were often used in Bahir's study, with S Divin finding that when using the one pot in the EPC, it was easier to mix staples and stews to pressure cook together, leading to pressure cook being the most dominant process during transition at 48% frequency.

2.6 Water heating and tea

According to the WACN study, an electric kettle was most used to heat water, whereas in the CEEZ study both microwaves and kettles were used to heat water. On the other hand, in 73% of tea preparation in the WACN study, an induction stove was used.



Figure 2.2: Participants of the (clockwise from the top-left) TaTEDO, Kijani, PEEDA, Kijani.

2.7 Reheating

As with at the baseline phase, the microwave was the key appliance for reheating food. Kijani’s findings backed this up, alongside EED finding that the microwave is regularly used to reheat food, particularly rice.

3. What is the experience of cooking entirely with electricity?

During the endline survey, participants were asked to reflect on their time cooking with electricity. This data gave insights into their positive and negative experiences, as well as how the ecook appliances interacted with their expectations.

3.1 Sensory

Taste is central to the cooking and eating experience, with its subjectivity also leading to mixed responses to food produced with electric appliances. In both ABF and NAMHUS studies, participants discussed how EPCs produced food with a softer texture, with ABF participants also arguing that the taste is improved. 83.3% of participants in the Kijani paper agreed that food tastes better when cooked with electricity. Moreover, all TaTEDO respondents said that there are foods which taste better with electricity, and 70% of households said that no food tasted worse with electricity. In contrast, other study participants said that there was little change in the taste (KAPEG) or were undecided as to whether there was a taste difference (80% Jahangirnagar respondents aligned with this view). This is promising for ecook, as it potentially means that the entire menu can be prepared with electricity without forfeiting familiar and traditional tastes. However, at the other end of the spectrum, 6 out of the 10 households in the NAMHUS study said that food prepared with ecook tasted worse, yet the NAMHUS report that this can be changed through additional training so that the ecook devices can be more effectively used to create familiar tastes.

Taste is central to the cooking and eating experience.

The ecook devices are thought to be aesthetically pleasing (ABF), with 100% of participants in the Jahangirnagar study agreeing or strongly agreeing that their ecook appliances looked good in the kitchen.

3.2 Heating experience

Participants in the IISD and Microenergy Cambodia study were pleased with the heat capacity of the induction cookstoves that they were given. Similarly, 100% of participants in the Jahangirnagar study agreed or agreed strongly that the stoves cooked fast enough which led to IISD participants to shift their practices so that they prepared the food before cutting it as the ecook equipment heated up more rapidly than traditional fuels. However, because the stoves cooked faster, some participants in the ARIN study found their food would burn more regularly, which was attributed to a lack of knowledge about how to effectively operate the ecook equipment. On the other hand, in the Jahangirnagar study, 100% of participants agreed or strongly agreed that the appliance did not burn the food and that it is easy to control the heat that the appliances produce.

....the stoves cooked fast.... shift their practices so that they prepared the food before cutting it as the ecook equipment heated up more rapidly than traditional fuels.

An issue raised in both the Microenergy Cambodia and IISD was that the induction cookstoves would automatically shut-off or reduce the power unexpectedly, often in the middle of a cooking process. This led to frustration and was reported as the least positive feature of the induction cookstoves in the IISD study.

3.3 Time-related

In 11 studies, participants discuss how ecook reduces cooking time (ARIN, KAPEG, CIRCODU, CREEC, Jahangirnagar, TaTEDO Microenergy Bangladesh and Microenergy Tanzania). This was particularly highlighted in the Barhir study, where charcoal cooking was found to be 3 times longer than using ecook. The time saved coupled with the autonomous nature of some ecook devices was often used productively (for example to complete chores, as found in the TaTEDO study), with participants in the Jahangirnagar (70% participants), Microenergy Bangladesh and Tanzania and Kijani discussing how it enabled them to multitask. Features of the ecook devices which were noted by participants to enable multitasking were the timer (ABF and NAMHUS), and the reduction of monitoring and supervision the devices needed (WACN).

In 11 studies, participants discuss how ecook reduces cooking time.

However, in some cases, ecook was found to be slower than baseline fuels. Participants in CIRCODU and EED both remarked that the electric hotplate was very slow. Similarly, the EPC was disliked for the length of time it required to depressurise after cooking in the ABF study.



Figure 3.1: Participants working with enumerators in (clockwise from the top-left) Finovista, Kijani, Jahangirnagar University, Jahangirnagar.

3.4 Effort

According to one participant in TaTEDO’s study, the simplicity of ecook had increased their motivation to cook, meaning they feel it requires less effort. This partially stemmed from not having to find fuels to cook with as they could access mains electricity to cook. However, on many occasions throughout different studies, households experienced black- or brownouts, which often resulted in them completing their cooking on a baseline fuel (see section 5.1). This added extra effort to their cooking experience as they had to shift fuels part way through a cooking session.

...the simplicity of ecook had increased their motivation to cook.

Ecooking appliances can be safely used inside and so are not subject to wind or weather conditions which reduce the efficiency of traditional fuels and also the cook’s level of comfort (TaTEDO, CIRCODU). However, for the low-income participants in the Finovista study, this led to concerns about whether there was enough space inside for the appliances to be kept. As a result, some had to keep the appliances on the floor during the course of the study.

Ecook was generally found to be easy to use by study participants (Microenergy Bangladesh, Microenergy Tanzania), with 100% in the Jahangirnagar study agreeing or strongly agreeing that the appliances are easy to cook with. Ecook was also widely thought of as easy to learn how to use, with 75% of participants in the WACN study reporting it was very easy to learn, and with 10/13 households in the CIRCODU study also finding it easy to learn because of the manuals that were provided with the equipment.

... also widely thought of as easy to learn how to use.....

Similarly, in the IISD baseline survey, 80% of participants anticipated that it would not be difficult to learn how to use an induction cookstove, whereas in the endline survey, 93% of participants said that learning how to use the induction cookstove was not difficult. However, TaTEDO participants still felt that training on how to use ecook is beneficial and that others wanting to use ecook would need to be trained too, perhaps indicating a consensus that using ecook is ‘easy when you know how’.

3.5 Safety and hygiene



Figure 3.2: The body of an induction stove which has been melted in the Finovista study.

According to the PEEDA study, all households felt that electricity was a safe primary source of cooking energy. This rating was slightly lower in the CIRCODU study where 10/13 households said it was safe, and 75% said ecook was safe to use in the Jahangirnagar study. Participants tended to link ecook's health benefits to its lack of smoke, which is significant as indoor air pollution causes 3.8 million premature deaths per year². 50% of participants in the CIRCODU study remarked on the convenience of a clean and smokeless kitchen, with KAPEG, TaTEDO and EED participants also positively remarking on this. For participants in the ARIN study, the smoke-free kitchen became a safe place for children to be as they were no

longer asked to leave during cooking events. Lack of charcoal dust was also a discussed benefit of ecook in the CREEC study.

...the smoke-free kitchen became a safe place for children....

Although the TaTEDO study found that participants were pleased that there was no naked flame on the appliances given to them, other studies found that hotplates were disliked due to their exposed heating elements, with one household in the EED study banning children from using the hotplate without supervision because of this. In the CIRCODU study, concerns were also raised about the how hot the EPC cover got, as well as the safety of removing pressure from the EPCs. Moreover, the overheating of the wiring and induction cookstove lead to the body melting in two low-income households in the Finovista study, indicating that safety concerns are valid, and that the existing safety of the participants infrastructure should also be accounted for.

4. What barriers prevent people from cooking entirely with electricity?

Barriers refer to misconceptions or practical reasons why ecook was not adopted for all cooking events.

4.1 Electrical infrastructure

At the household level, wiring and plug infrastructure was often poor, with PEEDA having to upgrade and repair sockets, wires and electrical circuits so that households could participate in the study. This included rewiring in all low-income households and one middle-income household, socket installation or upgrading in 3 low-income and 2 middle-income households and all miniature circuit breakers were upgraded to 16A from 6A in low-income households. Similarly, NAMHUS found that the miniature circuit breakers were inappropriate sizes, leading to the power tripping. ABF called the household wiring system 'obsolete' (pg21) after the ecook stack was found to be overloading the system.

At the household level, wiring and plug infrastructure was often poor

In the Finovista study, dangerous wiring was a key concern of the participants before the study began, with low-income houses having exposed and charred wiring visible. These concerns were

² World Health Organization (2018), *Burden of Disease from Household Air Pollution for 2016*



Figure 4.1: Participants receiving training and ecook devices in the (clockwise from top-left) TaTEDO, PEEDA, ARIN, TaTEDO.

warranted, with lower-income households finding that the wiring would overheat leading to the melting of the body of the induction cookstove. Similarly, in Kijani’s study, ecook devices burnt because of poor electrical wiring, earthing and installation systems. For middle-income households in Pune in the Fionovista study, the more significant issue was not having enough plug points which reduced opportunities for parallel

cooking.

In several studies, households shared electricity meters, reducing power stability and bandwidth. In the TaTEDO study, some households shared a meter with other neighbours and rotated who would pay for the electricity. As a result, there were some periods where participants were waiting for others to pay for their rotation of power, leading to blackouts. Shared meters were also found in some rental houses in the EED study. Other studies found that participants did not have the meter power to support their desired ecook stack. For example, 60% of participants in the IISD study had limited electricity bandwidths and as a result had to turn off other electric appliances to use ecook appliances. Similarly, ABF found that some households had no power meter capacity to support multiple electrical appliances.

.....households shared electricity meters, reducing power stability and bandwidth.

However, the most mentioned barrier across the studies was the lack of reliable electricity for households, in terms of both blackouts and brownouts (voltage fluctuations). For participants in the WACN study, these were the main concern as they added both time and labour to cooking events. For CIRCODU, brownouts were of particular concern as they tended to occur in the evenings when participants wanted to cook. 33% of Kijani participants experienced the power failing when they wanted to cook more than 2 times per week. Power outages or fluctuations also lasted for significant periods of time in the context of meal preparation time, with WACN finding that 75% of users had 1-2 outages per week which lasted for a minimum of 13 minutes. During the study period, due to low rainfall amounts reducing the power-generating capacity of hydropower, the Tanzanian government instigated power rationing. As a result 80% of participants in the TaTEDO study experienced power outages of longer than 8 hours, and 20% experienced 5-6 hour power outages. Microenergy Tanzania also reported this, finding that in general there were 4-12 hours of power rationing per day. Other studies who cited voltage fluctuations and cutoffs as a major barrier included KAPEG, ABF, CREEC, Finovita, ARIN, Bahir, Microenergy (Bangladesh and Cambodia), Bahir, CIRCODU, Kijani, NAMHUS, PEEDA and

..... the most mentioned barrier across the studies was the lack of reliable electricity for households.....

CEEEZ, with EED describing electric blackout as the highest frequency reason for not cooking with electricity. The frequency, duration and coincidence with popular cooking time of these interruptions in power as well as how widespread brown- and blackouts were in the areas studied, demonstrates this as a significant barrier.

4.2 Cost

Financial barriers are significant as they dictate whether households are motivated to take up ecook. Ecook appliances were found to have a high upfront cost in several studies, which would become more significant should several ecook devices be purchased so that the household could cook entirely with electricity. ARIN, ABF, Kijani, Bahir, Microenergy Cambodia and Microenergy Tanzania all raised concerns about the upfront cost of ecook technology. However, only 3 out of 10 households were concerned by the affordability of the devices in NAMHUS's study, but this may be because participants did not realise how expensive devices could be. In the IISD study, 53% of participants believed that the devices cost half or less than the actual price when asked to guess how expensive they were. Similarly, Kijani found that participants underestimated the cost of the ecook appliances by 9% to 17%. Moreover, additional accessories often had to be bought, particularly induction-compatible pans and cookware for induction stoves, with Microenergy Tanzania reporting these to be very expensive, particularly in Bangladesh when compared to the cheap aluminium cookware which is typically used (Microenergy Bangladesh). Likewise, ecook equipment is much more expensive than traditional cookware in some places, such as in NAMHUS's study where ecook equipment was 10 times more expensive than LPG counterparts.

..... all raised concerns about the upfront cost of ecook technology.

Running cost of ecook equipment is also an additional cost barrier, as seen in ABF's study where a major participant concern before starting the transition phase was that their electricity bill would increase. The lack of cheap electricity (Bahir) and lack of money to pay for electricity in low- and mid-income households (CEEEZ) was also a concern and barrier to households in the study. For participants in the CIRCODU study, when more electricity units had to be purchased more frequently, their assumptions that ecook was expensive felt validated despite energy and cost savings relative to their baseline fuels. However, as no households considered electricity expenditure a detrimental factor in the endline survey of IISD's study, the perceived barrier of running cost is not universal, yet occasionally the actual cost of using ecook can be more expensive than baseline fuels, as found in EED's study where 50% of households found electric cooking to be slightly more expensive than their baseline LPG fuel source.

..... the perceived barrier of running cost is not universal.....

4.3 Markets

Not only did the market availability dictate which ecook appliances were available for the studies, but they also indicate how easily non-participants could access them. In the NSEG study, it was found that ecook appliances were easily found however not in large quantities, because they were sitting in stock and selling slowly, reducing the desire of shop keepers to buy in a large stock. ARIN found that efficient ecook appliances were not readily and locally available in their study areas in Kenya. The quality of ecook available on the market was also sometimes lacking, with Bahir finding that locally produced stoves were unstandardised and KAPEG reporting that the majority of ecook devices which were affordable were low-quality imports from China and Thailand.

Device aftercare was a segment of the market which several reports said was absent. In S Divin's report, ecook was sold in Kigali, however there was a lack of aftersales care. Moreover, ARIN found that participants did not know where to get repairs and maintenance after the warranty ended. Spare parts were also hard to come by, as seen in Bahir's report, where there were no spares for the inner pot of the EPC sold in the study area. WACN reported that participants perceived electrical appliances as less reliable and needing more repairs due to more frequent breakdowns. If this perception is widespread, the lack of information about repairs and aftersales care may pose a significant barrier to individuals from purchasing ecook appliances.

Device aftercare was a segment of the market which several reports said was absent.

4.4 Awareness and learning

According to Microenergy Tanzania, ARIN and S Divin, there is a reluctance to use ecook due to a lack of knowledge about the benefits, whereas in KAPEG's study, barrier is instead reported to be too few programmes to raise awareness about ecook. Poor preconceptions about ecook were rooted in safety, with participants in the Bahir study being concerned about EPCs bursting under pressure and burning user, while ABF participants were initially sceptical in general about the safety of the devices.

Throughout the studies there are varying ideas about whether training is needed to use ecook appliances. Training can be utilised to reduce perceived barriers. All households in PEEDA's study said that some level of training is needed to transition to 100% ecook, however it is easy to operate when one knows how to. Similarly, ARIN enumerators found that most households needed assistance during the study, particularly when cooking dishes which were not present on the device menu. 60% of participants in IISD's study said they could have learnt how to operate the stoves independently and to the same level as they can having receive training, with 33% saying they could have taught themselves but it would have taken longer.

...too few programmes raise awareness about ecook

5. What difficulties do people encounter when cooking entirely with electricity and how do they overcome these?

5.1 Lack of reliable energy supply

As discussed in section 4.1, reliability of electricity supply was an issue, with 20 of studies reporting power outages or voltage fluctuations during their course. When this occurred, participants tended to revert to the baseline cooking methods and use traditional fuels which do not rely on mains electricity (CREEC, ABF). This was seen in the CEEZ report, where loadshedding was the main driver of households to use non-electric fuels in 50% of the households who would often revert to charcoal. Similarly, in the Kijani study, 80% of respondents used LPG during blackouts. Some participants would wait (ABF), with EED reporting that the second highest reason for not cooking was a blackout. However, the demand to be able to cook led people to more frequently shift fuel rather than wait for extended periods to finish off preparing a meal.

When the supply was an issue, participants tended to revert to the baseline cooking methods and use traditional fuels.

5.2 Cooking capacity

For participants in Finovista's study, having the correct size, number and type of vessel was an issue. This difficulty was also found in TaTEDO's study where participants wanted more or larger pans so that they could accommodate 2kg of food. This was such a difficulty for one large household that

they began using charcoal again so that they could cook enough food for their family. The sizing of pots was found to be an issue particularly specific to ecooking in IISD's study where the size of induction cookers and their pots were described as significantly smaller than the equivalents for LPG stoves. To work around this, participants in the CIRCODU study described cooking one meal in several batches, but then reverting to baseline fuels due to this being too much effort. Similarly, in S Divin's study, large and bulky foods (such as pumpkin and yam) were reportedly avoided so that cooking for a meal would not be larger than the ecook's capacity.



Figure 5.1: Participants cooking using their new ecook appliances in the (clockwise from top-left) NAMHUS, Kijani, PEEDA studies.

Parallel cooking is where several pots can be heated at once to cook several dishes for the same meal or eating event meaning that sequential cooking was adopted. Several studies found that parallel cooking was not possible with the ecook devices provided. Which led to increased cook time and dissatisfaction from participants who found sequential cooking inconvenient (Finovista). Long sequential cooking events were particularly inconvenient for large families where lots of food had to be prepared. As ecook equipment such as EPCs often came with only one pan, the pan also had to be washed between sequential cooking events (CREEC). EED's study calculated that their households needed an average of 3.4 cooking

hobs/ecook appliances to successfully parallel cook. In both the EED and CIRCODU studies, recommendations were made to increase cooking capacity of ecook devices relating to appliance size and ecook stacking possibilities.

5.3 Inability to cook certain foods with ecook appliances

Certain foods were not viable options to cook with the ecook appliances provided in the studies. This led to these foods not being cooked, or, if they were considered very important to the participants, they would be prepared on the baseline fuels instead of ecook devices. One of the most prevalent foods which was not compatible with the ecook provided was roti/chapati. PEEDA, TaTEDO, NAMHUS and ABF all reported participants struggling to prepare this food. Finovista did provide participants with an electric roti maker, however participants reported that they were too stiff when produced this way, and so resorted to baseline fuels. PEEDA reported that the steamed dumpling was found to be incompatible in their study, with TaTEDO identifying pilao, and CIRCODU participants finding that roasting was an incompatible process meaning that roasted cereals and coffee could not be prepared. However, this may also reflect insufficient tailoring of ecook device combination to the household's diet during the participant consultation phase.

One of the most prevalent foods which was not compatible with the ecook provided was roti/chapati.

5.4 Demographic modifiers

Age, family size and affluence are demographic markers which modified which difficulties were faced, and the ways in which participants attempted to overcome them.

Age was significant in relation to level and confidence with interacting with ecook devices. In IISD's study, they asked whether participants felt that they could have learnt to use ecook devices without the training that they received. 33% of participants said they thought it was possible, 3% said they thought it possible but it would take longer. The only participant who thought it would not have been possible was the eldest participant in the study. Similarly, ABF found that elderly participants were hesitant to use the EPC provided, and the older members were also reluctant in PEEDA's study. This suggests that targeted intervention would be beneficial for elderly people in order to improve their confidence using new technologies.

Age was significant in relation to level and confidence with interacting with ecook devices.

Family size and occupation was particularly significant for cooking capacities, as larger families need larger pots to enable parallel cooking and ensure a reasonable length of cooking time. Households with working professionals as the main cooks highly valued time savings, and as a result, LPG tended to be used rather than electricity during periods of time constraints NAHMUS's study as it was faster at preparing. It should be noted that whether it is school term-time or a holiday period can also influence family cooking practice (CREEC). Freezing and reheating food was a more common practice in households with working women (NAMHUS).

Family size and occupation was particularly significant for cooking capacities.

Affluence particularly related to the ability of low-income families to purchase ecooking equipment upfront as well as the state of their infrastructure. As explored in section 4.1, low-income households tended to have lower-standard electrical infrastructure.

6. Conclusions

Cooking experiences are highly personal and cultural. Therefore, when seeking to influence cooking practices, it is vital that the viability and practicality of the transformation are investigated. In this summary report, the qualitative data from the 'MECS All-Electric' challenge fund was examined and compiled to explore the implications and practicality of households cooking entirely with electricity.

Cooking experiences are highly personal and cultural.

The majority of households had a positive experience, as they were able to produce tasty and pleasing traditional dishes, whilst saving time and effort. They reported the ecook devices easy to use and operate, with good heat capacity which allowed faster cooking (albeit this leading to initial issues around burning food) whilst being smokeless and not having a naked flame present. The automation of EPCs meant that some participants were able to be more hands-off with their cooking, allowing time for other activities such as chores.

A wide variety of ecook devices were used by our partners in their studies, including EPCs, ecook stoves (induction, infrared and hotplate), as well as rice cookers, kettles and more. Participants demonstrated themselves becoming more confident and comfortable with these devices, using EPCs and ecook stoves particularly regularly for rice, beans and pulses, vegetables and meat. Unlike in the baseline phase, the appliances were not always used in task-specific ways, with vegetables being steamed in a rice cooker (CIRCODU) and tea being made in the microwave (CEEZ).

Participants demonstrated themselves becoming more confident and comfortable with these devices.

However, there were also significant barriers and difficulties to using ecook. Initial preconceptions of ecook (such as having high running costs and being unsafe) led to reluctance to take it up. Alongside widespread lack of affordable ecook devices and an absence of financing options, this led to often low proportions of ecook in the baseline fuel mix. Moreover, participants were reliant on our partners financing their devices for the study, and often also for additional items such as induction-compatible pans.

Once using ecook in the study, participants often had issues with the capacity of the devices, struggling with the reduced volumes of food that they could cook in one event, and frustrated by sequential cooking and its additional time and effort burden. However, the most significant barrier to complete adoption of ecook and its consistent use was unreliable electricity supply and poor domestic electrical infrastructure. Fluctuating voltages and blackouts were a common feature of 20 out of 21 studies. As a result, participants continued to use their baseline fuels during blackouts to complete meal preparation. Unsafe wiring, meters with reduced bandwidth and micro-circuit breakers which were suitable for lower current flows, led to issues with the functioning of the devices, regular electrical tripping and in some cases with their safety.

Overall, these reports have shown that cooking with electricity as a primary fuel is currently more feasible than cooking entirely with electricity. Yet having identified these barriers and the significant benefits ecooking can bring, as well as increasing interest from governments in ecook, it is plausible that cooking entirely with electricity will be possible in the future.

However, there were also significant barriers and difficulties to using ecook.

these reports have shown that cooking with electricity as a primary fuel is currently more feasible than cooking entirely with electricity..

