Analysis of Factors Affecting Adoption of Electric Cooking Options in Electrified Community of Nepal

FINAL REPORT

December 2021

Submitted To: Loughborough University, Modern Energy Cooking Services, (MECS)

Submitted By: Practical Action Consulting Private Limited

In consortium with Ajummery Bikas Foundation and National Association of Community Electricity Users-Nepal

Abbreviations

ABF	Ajummery Bikash Foundation
A2EI	Access to Energy Institute
BG	Biogas
CBS	Central Bureau of Statistics
CREE	Community Rural Electrification Entities
ECAs	Electric Cooking Appliances
EPCs	Electric Pressure Cookers
EoI	Expression of Interest
Gram	gm
GoN	Government of Nepal
HHs	Households
ICs	Induction Cookers
KVA	kilo-volt ampere
kWh	Kilowatt Hour
LPG	Liquefied Petroleum Gas
MoEWRI	Ministry of Energy, Water Resources and Irrigation
NACEUN	National Association of Community Electricity Users Nepal
NDC	Nationally Determined Contributions
NEA	Nepal Electricity Authority
PAC	Practical Action Consulting

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ACKNOWLEDGEMENT

We would like to express our sincere gratitude to UK aid, MECS program and Loughborough University for entrusting the study team with this research. This research would not have been successful without the valuable guidance of Mr. Richard Sieff, Ms. Melinda Barnard-Tallier, Ms. Karin Tranccoso, Mr. Ed Brown, Mr. Simon Batchelor, Mr. Martin Price. The regular MECS partner meeting aided the study through better coordination and shared knowledge. The MECS webinar series on maintaining cooking diaries was very useful in guiding the design and administration of the cooking diary which forms the major basis of information collection and analysis.

We would especially like to thank Mr. Indra Kumar Shrestha and Mr. Saroj Shrestha of Bhumechuli Community Rural Electrification Entity in Kavrepalanchowk for their engagement and ownership towards the project. We also extend thanks to Mr. Nawa Raj Dhakal, Deputy Executive Director of Alternative Energy Promotion Centre (AEPC) and Mr. Sagar Gyawali of Nepal Electricity Authority (NEA) for their support and guidance in the course of the research.

Special thanks go to Nora Schürhoff and Mattias Nilsson from A2EI for the great collaboration as well as for providing processed smart meter data, and the generation of figures and statistics used within this report.

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DISCLAIMER

This research study is funded by the UK Aid through Modern Energy Cooking Services (MECS) Program managed by Loughborough University. The design of the study, administration of research and analysis of findings is administered by a consortium of Practical Action Consulting (PAC), Ajummery Bikas Foundation (ABF), and the National Association of Community Electricity Users Nepal (NACEUN). The findings and recommendations of the study relate directly to the geographic locations, socio economic and cultural context of the study locations. The views, recommendations and findings expressed in the report do not necessarily reflect the UK government's official policies or the institutions involved in the study.

EXECUTIVE SUMMARY

This study report provides an overview of the findings of an electric cooking pilot in Kavrepalanchowk district, Bagmati Province, Nepal. The study was conducted among 44 households (HHs) in a community electrified through an electricity co-operative and aimed to understand the cooking practices and preferences, and fuel choices of households through the implementation of the Cooking Diaries methods.

For the pilot, households were provided with either induction cookers (ICs -14 HHs) or electric pressure cookers (EPCs -15 HHs) or a combination of both (EPC+IC – 15 HHs) to assess their suitability to cook a local menu and local acceptance. HHs were monitored over six months using various methods, including an adaptation of cooking diaries pioneered by MECS, to understand their cooking behavior and fuel choices before and after the EPCs and ICs were introduced. The cooking diary study was divided into four phases (baseline, controlled, choice, end line) during which different project interventions were carried out and monitored. A baseline scenario around fuel choices, food habits, and cooking behavior of participants was established in the baseline phase. During the controlled phase, the study HHs were supported with tariff incentives applicable to this phase of the study, to encourage them to use the new appliances as much as possible, and to understand the impact of electricity tariff incentives on their cooking behavior. Prior to the controlled phase, the capacity of HH energy systems and distribution systems to support electric cooking load was also assessed through safety audits. Smart meters were used to remotely monitor real-time electricity consumption after the introduction of ECAs in study households. Other interventions included training for users on proper and safe use of electric cooking appliances. During the choice phase, participants were asked to cook on appliances of their choice and record the use and dishes cooked in electric cooking appliances. Similarly, in the end line phase, participants were asked to cook using the cooking fuel and stoves of their preference and record the data for all fuel/stove use cases.

A baseline survey carried out before the pilot found that fuel stacking is a common practice among the studied HHs. Liquefied petroleum gas (LPG), firewood, electrical appliances, and biogas were their baseline fuels. Rice cookers and electric kettles were among some of the existing electrical appliances used for cooking. Households that owned a rice cooker reported that they used it just occasionally. It was not used at all during the baseline phase of the cooking diary study. The local menu includes rice as a staple, lentil soups, curry, tea, and dheedo (flour pudding).

Following are the key takeaways from the study.

The study findings confirm eCooking has been well-integrated into household cooking practices and that people will choose to cook consistently with electricity if ECAs are made available. The introduction of ECAs saw eCooking increase from 0% of all cooking events in the baseline phase to 35% in the end line phase. This significant and sustained use of ECAs has also continued after the pilot. Correspondingly, the proportion of times LPG was used to cook declined significantly after the introduction of ECAs; falling by 20% between the

baseline and the end line phases. Woodstove use also declined after ECAs were introduced, reducing by 15% in the end line phase compared to the baseline phase. It clearly shows that the total number of clean stackers also increased from the baseline to the end line phase.

Seasonal variation had an impact on water heating events and therefore the use of electricity changed over time--significantly higher water heating events were observed in the winter. The number of cooking events, and types of dishes, may also have been affected by seasons, festivals, and the frequency of larger gatherings.

Electric cooking appliances could be used to cook most of the common dishes: rice, lentil soups, soupy curry, fried curry, meat, leafy vegetables, and milk. The induction cooktop was used to cook greater variety of dishes than the EPC. The use of EPC remained limited mostly to cooking rice and lentil soups/beans in the end line phase. Most of the EPC users wanted a spare cooking pot/chamber for electric pressure cooker so that they could conveniently cook multiple dishes for a meal without having to empty the pot. On the other hand, induction cooktop was found to be more compatible with majority of local dishes (including dishes that required frying). However, good quality induction base utensils would be crucial to enhance the utility of induction cooktop. Critically, the findings show that providing households with more than one ECA leads to greater use of eCooking and reinforces the point that more than one ECA is needed to keep people from stacking traditional fuels.

The findings also show that firewood can be replaced by electricity for foods that need reheating as ECAs require less time to start than firewood. HHs found it easy to use ECAs, especially ICs for reheating. ECAs seem to have completely replaced woodstoves for rice, lentil soups and soupy curry, whereas for cooking partially cooked items, woodstoves seem to be used as much as LPG stoves. However, the findings show that some fuel staking will continue. LPG is a familiar fuel and people have accustomed themselves to cook a much larger variety of local dishes on LPG cookstoves using different types and sizes of utensil. Firewood, where collected from community-managed forests, is considered much cheaper than electricity and the woodstoves can be built locally almost free of cost. This may be one of the key incentives for woodstove dependent households to keep using traditional fuels.

The study findings suggest that the utensils also play a crucial role in adoption of ECAs. Whereas the wok remained the most used utensil throughout the study phases, and the pressure cooker was the second most used utensil, it was found that HHs did not cook foods that needed deep frying using EPCs as it was not compatible.

The study reveals that the average electricity consumption per day per user is 0.6 kWh in the controlled phase, 0.5 kWh in the choice phase, and 0.3 kWh in the end line phase. The reduction in usage is found sharper for EPCs. One reason for this could be that participants were willing to experiment with the less familiar EPC when tariff incentives were provided during the controlled phase but less so in the other phases. Whereas ICs had less drop off because the technology was more familiar and potentially seen as less of a risk to use. Further, HHs who had both appliances continued using both the appliances. This again

supports the point that providing households with more than one ECA leads to greater use of eCooking and that HHs need different kind of ECAs to meet their cooking practices.

The use of ECAs peaked at 7 AM in the mornings and, 6 pm in the evenings. As all households cook around same time, it was found that the existing local electricity distribution system is not capable of withstanding high peak loads and needs an upgrade, which requires significant investment from the utility. The study also found that upgrading the household electric connection to 15 Ampere (against the baseline of 5 Ampere capacity), supported by appropriate household electric wiring system, can sufficiently hold the electric cooking load of EPC and IC for one family. During the safety audit of household wiring, all the study HHs needed meter upgradation and a dedicated wiring in the kitchen to be able to use ECAs. HHs were also provided an electricity safety training to avoid any negative impact (such as electrical hazards) of electric cooking resulting from unsafe handling of ECAs.

Recommendations

- The study has shown HHs are encouraged to use electricity for cooking if supply reliability is ensured with fewer power interruptions, standard voltage, and less response time to address supply disruption. When supported with awareness and electricity bill incentives, HHs were found to be more likely to transition to e-cooking at a much faster rate. Therefore, it is recommended that plans and programs be directed towards consumer awareness to boost demand. Post purchase behavior reinforcement to facilitate sustained use is also very important. User involvement in awareness campaigns will enhance demand through peer learning and hence scaled up deployments.
- Tariff incentives are also needed to kick-start the market. Further exploration and larger pilots would be needed to determine ways to incentivize e-cooking.
- Developing quality eCooking appliances can boost the eCooking market. This urgently needs a robust standardization and labeling regime to not only support quality control but to also communicate this information to users to enable informed buying decisions.
- Strengthen power supply reliability. Frequent power cuts led to less frequent eCooking.
- Strengthening localized supply chain with hassle-free aftersales service is very important. During the pilot, faulty appliances had to be brought to Kathmandu, over 60 kms away from the project site, for repairs. Therefore, locals need to be trained to repair appliances so households can continue without losing many days to cook on electricity.
- Imparting a sense of ownership and capacity building support to local stakeholders is of prime importance. Not only among the HHs, but positive changes in behavior was also seen in other market actors such as electricity services providers when capacity building support was provided to them. The Bhumechuli Community Rural Electrification Entities (CREEs) invested to upgrade its distribution infrastructure during the research period as they found members' increasing interest in cooking using electricity.

Although the study was partly affected by COVID-19 and field mobility of the study team was limited due to the prohibitory order imposed by the Government of Nepal, best possible efforts were made to ensure study activities went ahead smoothly through locally-stationed staff, as well as the local electricity cooperative.

1. Introduction

This study report is being submitted as the final deliverable for the assignment awarded by Loughborough University to Practical Action Consulting Nepal, under the agreement PO40114819 (Analysis of Factors Affecting Adoption of Electric Cooking Options in Electrified Community of Nepal, entered into in May 2020 between the two parties). The consortium of Practical Action Consulting (PAC), Ajummery Bikas Foundation (ABF), and the National Association of Community Electricity Users Nepal (NACEUN) executed the study.

1.1 Background

The Government of Nepal has demonstrated a keen interest in ensuring universal access to modern energy and clean cooking solutions, particularly electric cooking, through the 15th Five Year Development Plan and the energy sector White Paper (GoN, 2018). The energy sector roadmap published by the Ministry of Energy, Water Resources and Irrigation (MoEWRI) underscores the government's vision to promote 'electric stove in every household'.

Furthermore, Nepal's Second Nationally Determined Contributions (NDC) envisions that 25% HHs will have adopted electric cooking as a primary mode of cooking by 2030. Nepal has been promoting clean cooking solutions for more than four decades, however, just 36.5% of total HHs use clean fuel as a primary energy source for cooking (CBS 2017).

Although public interest in electric cooking is growing--as suggested by the increasing imports of electric cooking appliances (Nepal Ministry of Finance 2021) -the use of electricity as the primary source for cooking remains negligible. To achieve the national goal of wider adoption of electric cooking, it is important to design user-centric interventions that can drive social acceptance for sustained use of electric cooking appliances (ECAs). To that end, it is important to understand the bottlenecks and factors that could hinder or influence the adoption of electrical appliances for cooking at scale. Therefore, this study explores the factors affecting the uptake of electric cooking at the household level.

This is a pilot based in Mangaltar village in the hill region[1] of Nepal. As per the World Bank's energy access diagnostic report based on the multi-tier framework, although electricity access in more than 63% of total HHs in this region is at or above Tier 3, access to modern energy cooking services for over 72% HHs is at or below Tier 1. The large number of households with an electricity connection but not yet using it for cooking highlights the significant potential to increase uptake of electric cooking in the hilly region of Nepal.

The studied community was electrified through a community-based rural electrification entity (popularly referred to as CREE) called Bhumechuli Mangaltar Rural Electricity Co-operative Limited. In Nepal, CREEs play a pivotal role in expanding the reach of grid

[1] Nepal is divided into three ecological zones: the mountains, the hills and terai (the plains).

electricity to rural and remote areas. They buy electricity in bulk from the Nepal Electricity Authority (NEA, a state-owned utility company), sell it to the local community, and manage the overall local distribution system using the revenue they generate from electricity sales. However, limited demand for electricity and underloaded transformers continue to cast doubt on their economic viability. Efficient electric cooking (e-cooking) is in the best interest of CREEs for two reasons: first, the majority of HHs still use firewood for cooking; second, according to the database of the National Association of Community Electricity Users Nepal (NACEUN), over 30% of transformers operated by CREEs are operating at way below their full capacity due to the limited productive and cooking loads. In addition, increased sales of electricity due to increased demand for electricity for cooking can directly improve the economic viability of CREEs.

The study involved: i) Distribution of induction cookers (ICs) and electric pressure cookers (EPCs) among 44 HHs within the jurisdiction of Bhumechuli CREE, ii) Implementation of various interventions to promote adoption and use of electric cooking, and iii) Monitoring the use of EPCs and ICs over six months using various methods to understand cooking behavior and fuel choices before and after project interventions.

The study makes an important contribution to better understanding the relevance of electric cooking in the local socio-cultural and power supply context, its compatibility with the local menu, and the factors affecting the sustained use of electricity for cooking. The above knowledge is expected to enable policymakers and development practitioners to design and implement appropriate interventions to support cooking using electricity at scale.

1.2. Study Objectives

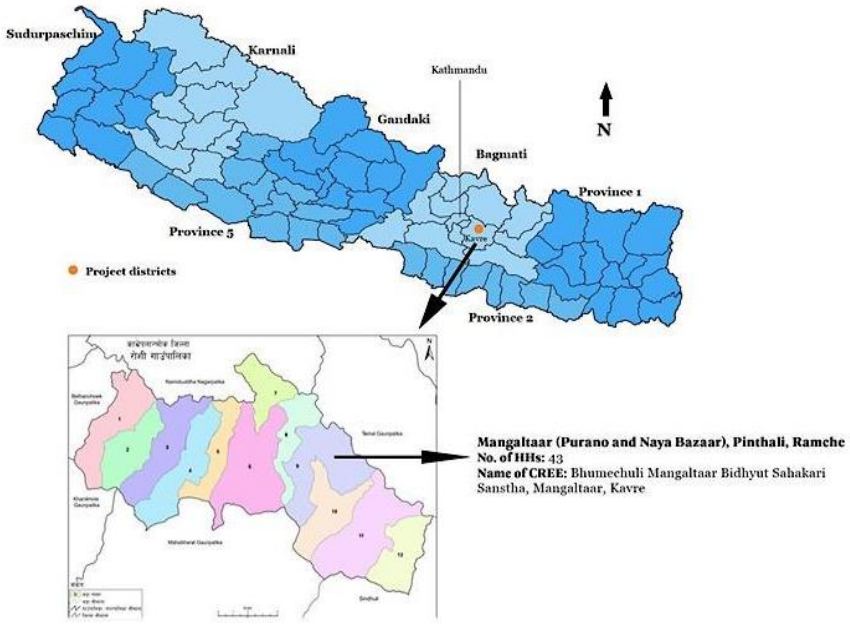
The overall aim of the study is to understand the viability and acceptance of electric cooking appliances, especially electric pressure cookers and induction stoves in community, electrified through community rural electrification entity in Nepal.
The main objectives of the study are:

- To understand the cooking behavior and fuel choices of the people in Mangaltar village, a representative of a hill population in Nepal.
- To identify factors affecting the use of electricity for cooking
- To assess the suitability of ECAs to cook local menus
- To assess the local acceptance of ECAs
- To assess the capacity of local electricity distribution systems to support e-cooking

2. Study Methodology

The study was conducted in the area served by Bhumechuli Mangaltar Rural Electrification Co-operative Limited (Bhumechuli CREE), located in Roshi Rural Municipality, Kavrepalanchowk district, Nepal (see Figure 1 for a map of the study site). The village represents a typical hill community of Nepal and has a heterogeneous population (representing particularly Tamang, Brahmin, Chhetri and Newar communities) in terms of ethnicity.

Figure 1: Map of study site



The study used a mixed-method approach to collect information during its various phases. The key methods used were: i) HH surveys (baseline and exit surveys); ii) Cooking diary study, and iii) Real-time measurement of energy consumption.

The study was divided into three major parts as shown below:

Preparation

1. Selection of CREE and study clusters
2. Awareness activities about the study and electric cooking (through live cooking demos and IEC materials)
3. Selection of study households
4. Baseline survey
5. Electricity safety audit and energy meter and house wiring upgradation support
6. Distribution of electric cooking appliances (ECAs): electric pressure cookers (15 HHs) or induction cooktop sets (14 HHs) or both (15 HHs);
7. Users' training on correct use and maintenance, and safety.

Cooking Diary Study

8. Baseline Phase

9. Controlled Phase: the project covered the cost of the total electricity consumed by each ECA during this phase
10. Choice Phase
11. End line Phase

Knowledge dissemination and outreach

12. Exit Survey
13. Data Analysis and Reporting
14. Sharing Workshop

The study was affected by the lockdown imposed by the Nepal Government in response to the COVID pandemic, and the central team could not visit the study site as frequently as planned. However, the deployment of enumerators from within the community and coordination support from the Bhumechuli CREE allowed the project team to effectively avoid major impacts on the study due to the lockdown. While methods used to collect data had to be adapted to the changing situations, special care was taken to avoid any inconsistencies.

Major activities conducted during each phase of the study contributing to the successful completion of this research are discussed in sections 2.1-2.3.

Enumerators and data collection

Four enumerators recruited from the community, collected data and coordinated local activities. Enumerators were provided with an orientation on the objectives and nature of the study and all kinds of survey forms and tools used during the study. In addition, each enumerator was given a set of induction cooktop (IC) and an electric pressure cooker (EPC) and a use-cum-operation training before the start of the research. The objective here was to prepare them as cooking champions and enable them to provide use-cum-operation related support to HHs throughout the study.

To record data during the baseline survey and all phases of the cooking diary study, KOBO Toolbox, a digital platform that allows enumerators to collect data offline using an android device, and upload the data to the cloud whenever they have access to the Internet, was used. Records maintained by participants in their respective cooking diaries were entered into the KOBO form on tablets provided to enumerators. Data uploaded by the enumerators were extracted from the KOBO platform in excel format for further analysis. Analysis of the complete database was performed using SPSS and MS Excel.

To measure the cooking time, fuel used, and electricity consumed by ECAs, studied HHs were also provided with a table clock, weighing machine, and a smart meter (see table 1). Of the three pieces of equipment, the smart meter was returned to the project after the completion of the study. The smart meters were supported by the Germany-based Access to

Energy Institute (A2EI)[2]. A2EI's smart meters automatically captured electricity data such as power and energy on a 5-minute or 1-minute interval and transmitted data to the server. By connecting smart meters to each appliance, detailed information was captured on how an individual user operated the electric cooking appliances. A smart meter was connected to each ECA to monitor the exact power consumed by it. To ensure that the smart meter only recorded the power consumption by the IC and EPC, the corresponding power sockets and the chords of the IC or EPC were tied together using a zip tie. The data (energy consumption, voltage, appliance, and on-off time) were recorded, displayed on the meter itself, and were remotely fetched to the A2EI server for further analysis. Due to the unavailability of the right measurement tool, consumption data for biogas was not collected during the study.

Table 1: Tools and method used to measure different fuel types

Technique	Equipment	Accuracy	Installation	Procedure
Weight	Weighing machine	5-10 gram (gm)	Placing a bag of biomass or a liquefied petroleum gas (LPG) cylinder (excluding the stove and the regulator) and standing still for a few seconds locked the weight on the machine. So, installation of the weighing machine wasn't required.	The weight of biomass was taken manually before and after every recording period. The weight of the whole LPG cylinder was weighed (measured by enumerators once a week.)
kWh/sec	Smart meter		A smart meter was attached to each electric cooking appliance being studied. They were installed close to the appliance so that it was accessible for the participants to take note of the measurements.	Energy consumed (the difference in kWh readings before and after cooking a dish) was noted manually. Real-time data was extracted remotely.

2.1. Preparations

The success of the study hinged on, among other things, the selection of the right CREE, the right study households (HHs), and the proper dissemination of information on electric cooking, the objectives of the study, and the costs and benefits of participating in the study. Below we discuss the major activities conducted to achieve the aforementioned goal.

2.1.1. Selection of CREE and study clusters

Selecting the right CREE was a rigorous exercise involving a series of assessments, primarily based on the power supply capacity, existing load conditions, size of the consumer base,

[2] The Access to Energy Institute (A2EI) collaborated with PAC for this assignment primarily in mobilizing and data collection through smart meters. For more information on A2EI visit - https://a2ei.org/

prior association with electric cooking projects, and the concerned CREEs' demonstrated interest in increasing sales. In addition to these parameters, the concerned CREEs' relationship with the local government (rural municipality), and financial records with the NEA distribution center were also taken into consideration. The final assessment led to the selection of the Bhumechuli CREE for this pilot.

The selection of study clusters within Bhumechuli CREE was based on: i) Strength and reliability of electricity distribution system ii) Type of settlements: clustered HHs, and iii) Road accessibility.

Based on the above criteria, four different clusters (see table 2) connected to three different 100 kilo-volt ampere (KVA) transformers were selected for this study. One enumerator was assigned for each cluster.

2.1.2. Activities to raise awareness about the study and cooking using electricity

After the selection of study clusters and before the actual research, several meetings with CREE executives and cluster-based live cooking demonstration events were conducted to raise awareness among members of the target clusters about electric cooking. The central project team, with the support of enumerators, conducted the meetings and demonstration events.

2.1.3. Household selection

At the end of each demonstration event, enumerators provided information about the planned e-cooking study and solicited expression of interest (EoI) from the HHs in the audience to participate. HHs were carefully selected based on the following criteria:

- The primary cook consents to participate and is capable of filling data in the cooking diaries
- The HH cooks at least two times a day
- The HH is willing to have a dedicated power socket in the kitchen (in case the HH does not already have it), and pay for house wiring and energy meter upgrade (from 5 Ampere capacity to 15 Ampere) if recommended by the energy auditors
- The HHs is to be a member of the Bhumechuli CREE

A total of 46 HHs were selected based on the aforementioned criteria. Two HHs dropped out during the study. A total of 44 HHs completed the study.

2.1.4. Baseline survey

After the selection of study HHs, a baseline survey was conducted. A baseline survey questionnaire was used to collect information on socio-demographic characteristics, access to clean cooking, fuel choices, user behavior, electricity supply status, and household decisions-related information.

2.1.5. Electricity audit and up-gradation support

Before the distribution of ECAs to the participant HHs, an electricity safety audit was carried out at both the household and system levels. The maximum and minimum voltage in the participating HHs was 210 V and 185 V respectively during peak load (especially evenings). Before the study, most of the HHs owned a 5 Ampere meter connection, generally considered sufficient for basic electrical needs such as lighting, watching television, and charging mobile phones. The participating HHs were advised to upgrade their meter to 15 Ampere in case they had a power meter with lower capacity. The Bhumechuli CREE was also advised to upgrade its local electricity distribution infrastructure at points within the study clusters that faced voltage fluctuation issues.

2.1.6. Electric cooking appliances (ECAs) and users' training

The distribution of ECAs was one of the major interventions of the project. Study HHs received ECAs after the baseline phase of the cooking diary study (explained in Section 2.2.). It was made sure that the HHs made the necessary changes in their energy meter capacity and wiring systems before they started using the appliances.

Each HH was given an IC or EPC or both (see table 2 for the breakdown of HHs in each cluster based on the ECA/s they received). Acknowledging the time and effort they contributed to the study, the HHs were allowed to keep the appliances, weighing machines, and table clocks they received from the project even after the completion of the study. Along with the ECAs, HHs were also given hands-on training on using and operating the appliances safely.

Table 2: Breakdown of HHs in each cluster based on the ECA/s they received

Cluster Name	Total HHs	Interventions (HH#)
Mangaltar Old Bazaar	11	EPC+IC (7); EPC (2); IC (2)
Mangaltar New Bazaar	11	EPC+IC (8); EPC (1); IC (2)
Ramche	11	EPC (6); IC (5)
Pinthali	12	EPC (6); IC (5)

2.1.7. Incentives on electricity bills

The project covered the cost of the total electricity consumed by the ECAs (promoted by the project) in each of the studied HHs during the controlled phase of the cooking diary study (explained in Section 2.2.). Electricity consumption data for each HH was obtained from the smart meter attached to each ECA. The objective of providing incentives on the use of ECA was to encourage HHs to use and experiment with the new appliances as much as possible, and to make sure that HHs' perception about electricity being expensive (if such a perception exists) did not affect the overall objectives of the study. Another important reason for providing incentives on electricity consumption was to understand the impact of electricity tariff incentives on HHs' fuel choices.

2.2. Cooking Diary Study

'Cooking diary study' is a noble approach to track and understand the changes in cooking practices of HHs in response to various technological and behavior change interventions. This methodology has been pioneered by MECS and was first used in Kenya. Since then, it has been adopted in several countries to improve the understanding around changes in cooking practices in different cultures and contexts resulting from HHs' transition to a different fuel or cooking technology. The study also involved the measurement of electricity consumption data, which was then matched with cooking diary findings to track change in the usage of ECAs over time and understand the possible reasons for those changes. The study uses two types of forms:

a) Cooking diary form - intensive: HHs input data on every fuel and appliance used, and every dish cooked, time, and cooking process for a given phase.

b) Cooking diary form - light: HHs just record the use of ECAs and types of dish cooked using them.

For the convenience of the HH to record the data, a day was divided into two recording periods

i The first period starts at dawn and ended at 1 pm
ii The second period started at 1 pm and ended after the HHs retired for the day

In the rural context of Nepal, it is difficult to differentiate between breakfast and lunch, and evening snacks and dinner as HHs have unique routines and have meals at different times of the day, usually depending on their occupation. Furthermore, the use of cooking appliances is not limited to the preparation of meals. For this reason, the initial part of the day in the cooking diary form is referred to as the first recording period and the rest of the day as the second recording period of the day.

Before the study, a cooking diary and training (on how to fill data on cooking diary) were provided to each participating HH to record everyday data on their fuel and appliance use, and cook, processes, and names of dishes cooked.

The cooking diary study is divided into four phases, conducted over six months:

2.2.1. Baseline phase

Participants were asked to follow their usual cooking practices and record the data in the **intensive cooking diary form**. The objective of this phase was to establish a baseline scenario around their fuel choices, food habits, and cooking behavior before the introduction of ECAs in the next phase. The data was collected every day for three weeks in this phase.

2.2.2. Controlled phase

A cooking appliance of participants' choice (IC or EPC or both) was deployed and a smart meter was attached to each ECA. Participants were asked to use the ECA as much as possible and record the data in the **intensive form**. One major difference between the controlled phase and the *transition phase* (in the cooking diary approach) suggested by MECS is that the electricity bill for cooking with ECAs was paid for by the project during the controlled

phase of the study. The objective of this provision was to encourage participants to get used to the new cooking device/s and experiment with different dishes on their menu without having them to worry about possible increase in their electricity bills. Another important objective was to assess the impacts of tariff incentives on cooking behavior. In this phase, the data was collected every day for a month.

2.2.3. Choice phase

Participants were asked to cook in appliances of their choice and record the use of ECAs and dishes cooked on them in the **cooking diary light form**. The objective of this phase was to track any change in behavior around electric cooking over time among study HHs. The data was collected every alternate day, for three months.

2.2.4. End line phase

Participants were asked to cook using the cooking fuel and stoves of their preference and record the data for all fuel/stove use in the **intensive form** of their cooking diary. The objective of this phase was to analyze any change in their cooking behavior and to assess the acceptance of ECAs among study HHs. This phase lasted for a month and the data was collected for all days.

Table 3: The timeline of different study phases

Study Phase	Timeline
Baseline phase	02-27 February 2021
Controlled phase	9 March- 13 April 2021
Choice phase	18 April- 22 July 2021
End line phase	25 July- 24 August 2021

2.3. Knowledge dissemination and outreach

2.3.1. Exit survey

An exit survey questionnaire, mainly incorporating open-ended questions related to the HHs' perception, fuel choices, and experience with the new ECAs, was developed. Enumerators used a paper-based survey form to administer the survey.

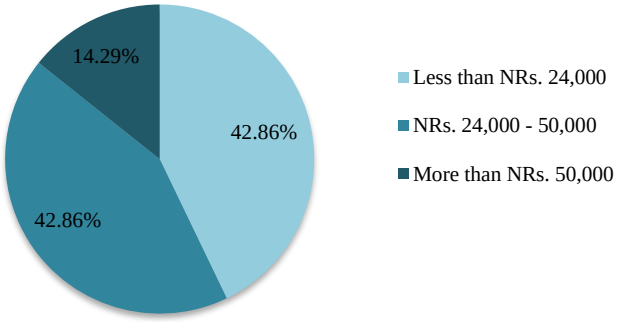
2.3.2. Stakeholder meetings and sharing workshops

Stakeholder meetings were conducted at the local level to disseminate information about the study's objective and to seek their support for the study. A national-level sharing workshop was organized to share the findings of the research.

3. Household Profile

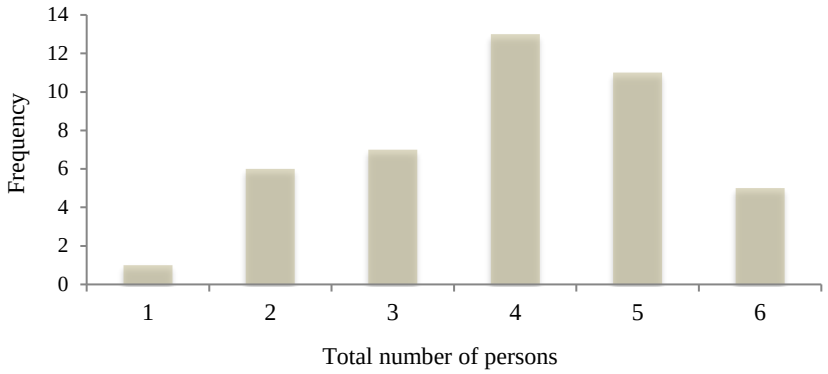
This section is based on findings of the baseline survey conducted before the cooking diary study. The study village is predominantly a farming community--agriculture is the primary source of income for 24 and a secondary source of income for nine HHs. The majority of HHs (about 63%) have multiple sources of income. In terms of average monthly household income, the majority of the HHs (about 57%) earn more than Rs 24,000 (see figure 2). This implies that the majority of them fall within the middle income or higher income groups. More than 80% of the HHs have saving accounts in banks/financing institutions, which means there is a good presence of financing services in the area. Every HH involved in the study lives in a permanent structure. Except in one house where five people share a room, the average room to person ratio in the HHs is 1.24.

Figure 2: Distribution of HHs based on monthly average household income range



Households were asked the total number of family members who have their evening meal regularly in the family kitchen. The question was used to determine the family size of the study households. In Nepal, there is a general tendency to count separated family members into family size. The above question was intended to avoid such confusion during the data collection. Figure 3 shows that the study HHs have family size of 1-6 members. The average family size is four members. Twenty-six households have at least one child (aged or below 16 years) in the family. Average family size of the HHs without a child is 3.4. Average age of the respondent in HHs without a child is 51 years. The above two information may suggest that either the HH does not have a child or all the children of the family are adults.

Figure 3: Distribution of households based on family size



3.1. Cooks' information

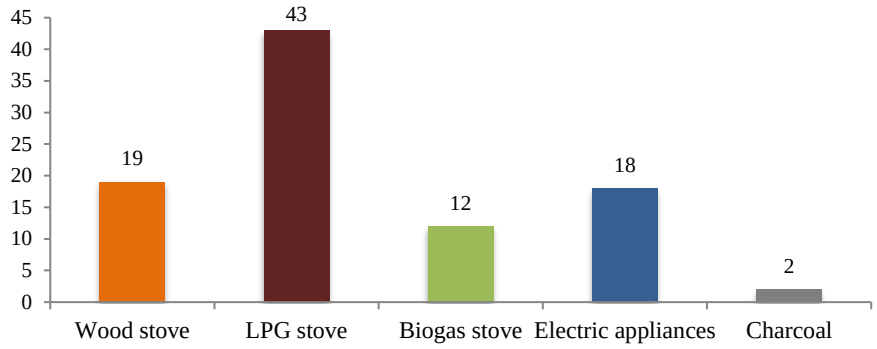
Primary cooks are predominantly female (in 34 HHs). In just five HHs, just one person did the cooking and that person is female in all five HHs. The rest of the HHs have multiple cooks. Interestingly, a male member is one of the regular cooks in almost 70% (i.e. 30 HHs) of the study HHs.

3.2. Common fuel types

The HHs used liquefied petroleum gas (LPG), firewood, electrical appliances, and biogas as their baseline fuels. Few used charcoals, but only occasionally. LPG was the most commonly owned baseline fuel in the study area since every household used an LPG stove (see figure 4). Whether or not LPG is also the most used cooking appliances is discussed in section 4, where cooking diary findings are discussed. The most frequently cited reasons for using LPG were: i) quick-cooking ii) easy availability of the stove and iii) cleanliness. Firewood was the most common cooking fuel after LPG. Most of the HHs that used firewood (89%), collected them from nearby forests and only a few reported that they have to purchase them from local markets or mobile vendors. Frequently cited reasons for using a woodstove were: i) Better taste; ii) Free fuel and iii) Easy availability of the stove. Out of the 19 HHs that used wood stoves, five used it outside the house in an open space while the rest used it inside their houses.

Most of the firewood users reported that their consumption of firewood increases in the winter as they need to reheat the food more frequently. They also need to heat water for drinking/cleaning utensils; therefore, the consumption of both firewood and electric kettle increases during this time. In winter, space heating also consumes more firewood. Electric cooking is not common, except a couple of them use rice cookers occasionally and 17 study HHs use an electric kettle for water heating.

Figure 4: Distribution of fuel types used by HHs



As seen in the figures 5a and 5b, the majority of HHs use multiple cooking fuels and hence fuel-staking is a common practice here. The reasons cited most frequently for using multiple cooking appliances in the order of frequency are i) Time saving and, ii) To be able to cook multiple dishes together. Of those who stack cooking fuel, just 9% are into clean stacking (see figure 5b), whereas the rest have either firewood or charcoal in their cooking fuel fix. All in all, 46% have already transitioned to clean cooking, whereas the rest are yet to make that transition.

Figure 5a: Distribution of HHs based on their response to: Do you use multiple cooking appliances on a regular basis?

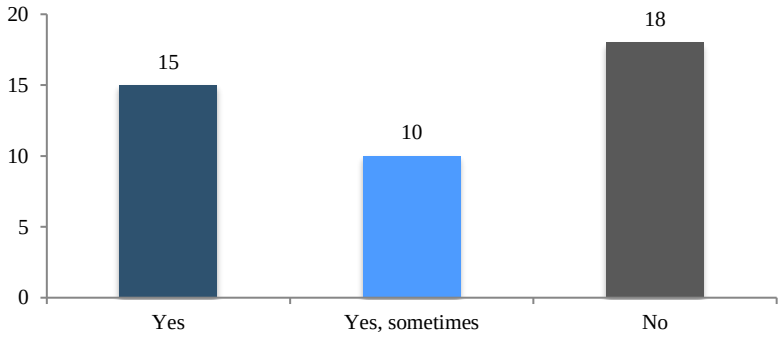
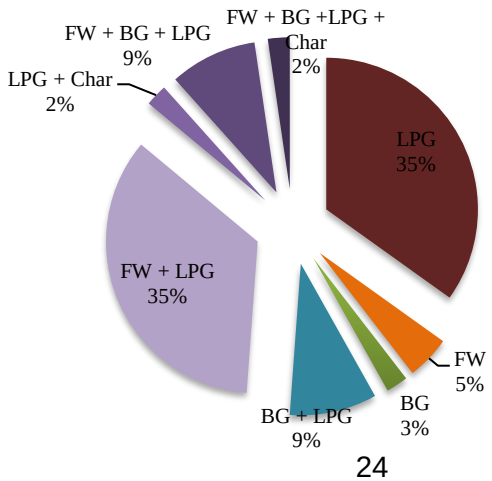


Figure 5b: Proportion of households using different fuel combinations; Here, LPG = liquefied petroleum gas; FW = firewood; BG = Biogas; Char= Charcoal



3.3. Common dishes and cookware

Rice is a staple in Nepal, and so is true in the study village. It is generally cooked both in the mornings and evenings. Other common dishes are different kinds of curries, lentil soup, and beans (often used interchangeably in the village), tea, and dheedo, which is a traditional dish usually prepared on a wood stove by gradually adding flour to boiling water while stirring.

Similarly, the most common cookware (see pictures below) used in the study HHs are: i) wok (*karai*) ii) pressure cooker iii) saucepan iv) casserole pot (*dekchi*) v) cauldron (*kasaudi*).

Figure 6: Different types of utensils used by HHs

3.4. Intra-household decision dynamics

Although women are the primary cooks in approximately 75% of HHs, their participation in decisions related to the purchase of cooking appliances remains low. For the purchase of biogas, LPG, and electric appliances for the family, women were sole decision-makers in just 8% (versus 42% for men), 26% (versus 41% for men), and 28% (versus 44% for men) of the study HHs respectively. Purchasing a biogas system, an LPG and electric appliances was a joint decision in 50%, 33% and 28% of the study HHs respectively. On the other hand, the difference between men and women's role was found to be lower in decision-making related to the purchase of woodstove. Out of 19 HHs that reported using woodstove regularly, women made decision to purchase the stove in six HHs whereas the decision was made by men in seven HHs and it was a joint decision in six HHs.

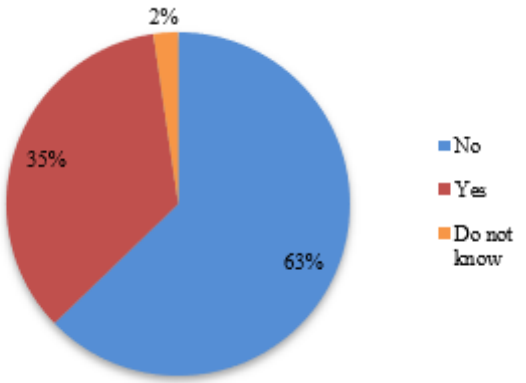
3.5. Electricity supply situation

Power supply interruptions seem common in the area; about 35% of study HHs suggested that they experienced a power interruption a week before the survey (see figure 7). Almost all HHs that reported having experienced power interruptions suggested that frequency and duration of interruptions were less than three times and below two hours. This puts the study HHs in the reliability Tier 5 of the ESMAP's Multi-tier Framework. According to the

2019 World Bank report, about 31% HHs in Nepal are at reliability Tier 5. When asked about power supply reliability in the area, HHs stated that it was fair (77%) or good (23%).

The average monthly electricity consumption among the study HHs is 36 kWh (units). However, the mode and median values for the monthly electricity consumption of the study HHs are 20 and 17 kWh (units) respectively. This means majority of the households consume far less than the average electricity consumption in the group.

Figure 7: Distribution of HHs based on their response to the question: Did you face power interruptions in the past week?



4. Cooking Diary Findings

In this section, we present a comparison between the fuel use data from the baseline, controlled and end line phases obtained using the cooking diary method. Because of methodological differences, electricity consumption data obtained from the smart meter will be presented separately in Section 5.

4.1. Heating events

In the majority of houses, each meal may constitute multiple cooked food items; and times when different types of meals are cooked during a day may vary across families. Therefore, for ease of analysis, a day was divided into two recording periods: morning (start of the day until 1:00 pm) and evening (from 1:00 pm till the end of the day). Each cooking event reported below represents one dish cooked. The recording was done separately for cooking events and water heating events to avoid confusion. Reporting of the two is also done separately.

Table 4: Total number of dishes cooked over different phases of the study

Phases	Total cooking events			Average cooking events per day
	Morning	Evening	Total	
Baseline	2663	2439	5102	
	52%	48%	100%	5.7
Controlled	3224	2852	6076	
	53%	47%	100%	4.7
End line	2872	2529	5401	
	53%	47%	100%	4.2

The total number of dishes cooked during the mornings and the evenings did not vary much throughout the study phases. The total number of dishes cooked in the mornings was just marginally, but consistently higher than that for the evenings (see table 4.) during all three phases. The average number of dishes cooked per day was 5.7 for the baseline, which decreased to 4.7 for the controlled and 4.2. for the end line phases.

Table 5: Total number of water heating events over different phases of the study

Phases	Total no. of water heating events		Total	Average no. of water heating events per day
	Morning	Evening		
Baseline	1131	810	1941	
	58%	42%	100%	2.2
Controlled	701	464	1165	
	60%	40%	100%	1.1
End line	553	335	888	
	62%	38%	100%	0.9

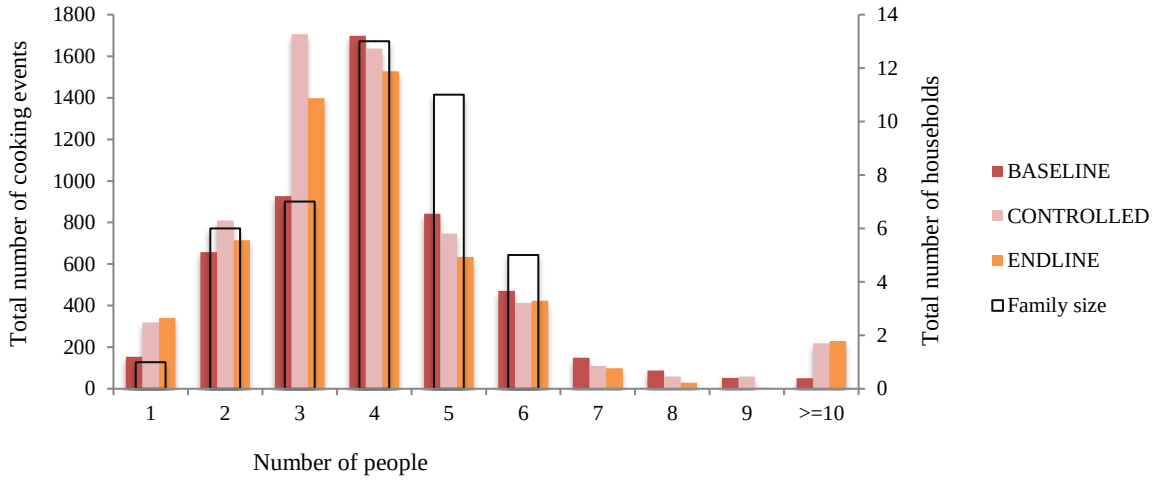
As seen in cooking events, the total number of water heating events was found to be higher during the mornings than it is for the evenings. The difference between the total number of water heating events in the mornings and the evenings is higher than it is for cooking events (see table 5). This difference does not vary much with phases, which means the introduction of the electric cooking appliance/s did not have much of an impact on the time (morning time and evening time) of the water heating events.

The average frequency of water-heating events declined slightly from 2.2 to 0.9 as we moved from baseline to the end line phase. This may suggest the seasonal variation in the need for warm water. In the winter, households are more likely to warm water to perform activities such as washing hands, bathing, and doing dishes. The baseline phase coincided with winter, which may explain the higher frequency of water heating events during this phase.

4.2. Total number of people dishes were prepared for

The total number of adults and children a dish was cooked for did not change much throughout the study phases. The average number of adults and children per dish was three and one respectively. If children are to be assigned equal weight as adults, the average number of people per dish is four. This is consistent with the average family size of the study households. Figure 8 shows the distribution of cooking events based on the total number of people the dish was prepared for.

Figure 8: Number of people cooked for per cooking event for different study phases

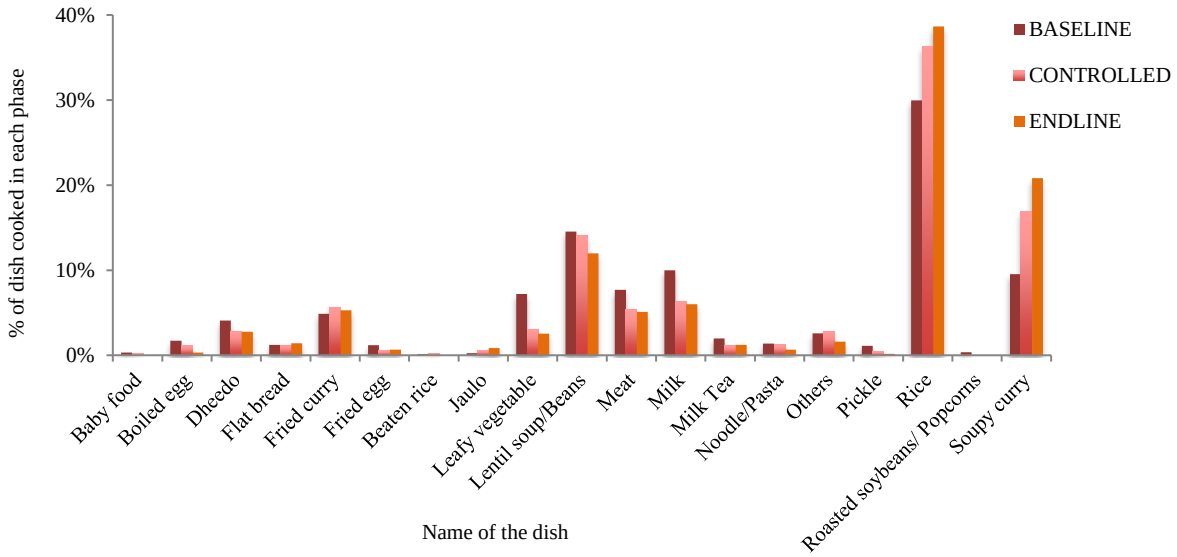


While there were some changes in the total number of persons the dish was cooked for across the study phases, the curves for all phases seem to peak at around 3-4 people which is below the average family size of the study population. This implies the study households cooked majorly for people within their household, and not much for outsiders.

4.3. Common Dish types

Rice, lentil soup, and soupy curry were the major constituents of the menu in all study phases. The terms 'lentil soup' and 'beans' are often used interchangeably, and the ingredients are cooked in the same way in the study area. Therefore, they were merged during analysis, although they were put as separate options in the cooking diary form. It is a common practice in Nepal to eat rice with soupy curry or lentil soup/beans in the mornings as well as in the evenings. This may explain higher bars for rice, lentil soup/beans, and soupy curry than other food items for all three phases in figure 9. Some may also eat pickles, fried curry, and meat with rice. Meat is generally considered a luxury food. Baby food is generally cooked just for infants. Older children generally have the same meal as adults. Milk is also one of the regularly consumed food items (see figure 9).

Figure 9: Distribution of different dishes in the menu for different study phases



As seen in figure 9, the most common foods such as rice and soupy curry were prepared more often after the introduction of electrical appliances in the controlled and end line phases, as compared to the baseline. The frequency of traditional meals (such as dheedo) which are generally cooked using a woodstove, declined. Similarly, after the introduction of electric appliances, households seemed less likely to cook leafy vegetables, meat, egg, and milk.

For snacks (in 'other' category), households ate diverse food types including beaten rice, corn/beans (depending on the season is eaten boiled or roasted), momo (Nepali dumplings that could contain either meat or vegetables), noodles (stir-fried or soupy) and fried rice. This diversity in food items was seen through all three phases of the study. The variation in the proportion of dishes cooked in the baseline phase as opposed to the end line phase suggests possible impacts of the introduction of electric cooking appliances in the regular menu of the study households (see table 6). As shown in table 6, rice and soupy curry were cooked more often in the end line phase as opposed to the baseline phase. Soupy curry can generally supplement for both lentil soup (i.e. soup or gravy for rice) and curry. Huge

increase in the proportion of soupy curry in the menu in the end line phase may explain the reduction in the variety of soup and curry dishes (mainly lentil soup/beans, leafy vegetable, meat, egg). This may also have led to the decline in the overall average cooking events per day in the end line phase (table 1). Local temperature and harvests significantly influence the consumption pattern of some foods such as leafy vegetables and potato (which are generally harvested during winters in the study area), beans and dheedo every year. Interestingly, milk tea and milk also decline significantly in the end line phase. Dheedo, which is generally cooked on woodstove, is also cooked less in the end line phase as compared to the baseline phase.

Table 6: Top 20 foods cooked during the baseline and the end line phase

	Baseline		End line		% Change
	Frequency	Percent	Frequency	Percent	
Soupy curry	489	9.6%	1125	20.8%	11.2%
Rice	1533	30.0%	2087	38.6%	8.6%
Jaulo	12	0.2%	45	0.8%	0.6%
Fried curry	249	4.9%	286	5.3%	0.4%
Fish	8	0.2%	19	0.4%	0.2%
Flat bread	63	1.2%	77	1.4%	0.2%
Potato/Yam	17	0.3%	14	0.3%	-0.1%
Beaten rice	6	0.1%	2	0.0%	-0.1%
Roasted Beans/ Popcorns	18	0.4%	8	0.1%	-0.2%
Baby food	17	0.3%	0	0.0%	-0.3%
Noodles	73	1.4%	36	0.7%	-0.8%
Milk Tea	101	2.0%	65	1.2%	-0.8%
Other	84	1.6%	43	0.8%	-0.9%
Pickle	56	1.1%	9	0.2%	-0.9%
Dheedo	209	4.1%	149	2.8%	-1.3%
Egg	149	2.9%	53	1.0%	-1.9%
Meat	393	7.7%	275	5.1%	-2.6%
Lentil soup/Beans	744	14.6%	646	12.0%	-2.6%
Milk	512	10.0%	324	6.0%	-4.0%
Leafy vegetable	369	7.2%	138	2.6%	-4.7%
TOTAL	5102	100%	5401	100%	

4.4. Reasons for heating water

The majority of the time, water heating was carried out to prepare tea and drinking water (see table 7). This pattern remained the same after the introduction of electric cooking appliances. However, as we move from baseline to end line, the number of water heating events decreases significantly for almost all purposes. During winters, people generally drink more tea and warm water to keep themselves warm. Similarly, they also use warm water for washing hands and bathing. Some households also heat water to add into lentil soup and baby food, wash dishes and clothes, clean chicken, and brew alcohol. The water heating events gradually decline as we move from the winter to the warmer seasons. The declining trend in the proportion of water heating events for all purposes as we move from baseline to end line phases, therefore, may be either due to seasonal variation, or due to the introduction of electric cooking appliances. This will be explored further in the later sections.

Table 7: Number of water heating events for each purpose

Reasons for water heating	Baseline		Controlled		End line	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
For bathing	53	2.7%	35	3.0%	2	0%
For drinking	817	42.1%	443	38.0%	389	44%
For tea	936	48.2%	673	57.8%	494	56%
For washing hands	98	5.2%	6	0.5%	3	0%
Other	34	1.8%	8	0.7%		
	1941	100.0%	1165	100.0%	888	100.0%

4.5. Reheating food

For every dish cooked, cooks were asked if the food cooked was warmed, cooked fresh, partially cooked, or soaked before cooking. The responses are presented for before (baseline) and after (controlled and end line) the introduction of electric cooking appliances.

Table 8: Purpose of cooking events before and after the introduction of electric cooking

Baseline	Morning		Evening		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cooked raw	2468	93%	2160	89%	4628	91%
Partially cooked	49	2%	52	2%	101	2%
Soaked before cooking	90	3%	62	3%	152	3%
Warmed	56	2%	165	7%	221	4%
Grand Total	2663	100%	2439	100%	5102	100%
Controlled	Morning		Evening		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent

Cooked raw	3079	96%	2579	90%	5658	93%
Partially cooked	35	1%	22	1%	57	1%
Soaked before cooking	75	2%	49	2%	124	2%
Warmed	35	1%	202	7%	237	4%
Grand Total	3224	100%	2852	100%	6076	100%
End line	Morning		Evening		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cooked raw	2815	98%	2427	96%	5242	97%
Partially cooked	3	0%	5	0%	8	0%
Soaked before cooking	38	1%	29	1%	67	1%
Warmed	16	1%	68	3%	84	2%
Grand Total	2872	100%	2529	100%	5401	100%

Households generally cook fresh food (as may be inferred from a high percentage of the dish being cooked in raw condition) (see table 8) in all three phases. Partial cooking also has a low frequency, meaning either the practice is not common, or the food that requires to be cooked partially is not as common. Although the difference is small, reheating seems more common in the evenings than it is in the mornings. People are more likely to cook fresh meals in the mornings. A similar trend was observed in all study phases. Soaking ingredients before cooking is also not common - the practice generally depends on ingredient types. Although the proportion of reheating dishes cooked seems to have declined slightly between baseline and end line phases, the introduction of electrical cooking does not seem to have changed much.

Oftentimes, reheating, soaking, and partially cooking food depend on the type of food items and ingredients used to cook them. While the number is too small, lentil soups/beans and flat bread (soaking here probably means leaving the dough for a while before rolling them into flatbread) are more likely to be soaked before cooking than other food items. Likewise, in terms of the proportion of times the dish was cooked, the number of times the dishes were reheated may seem very small, but lentil soups/beans, pickle, 'other' which mostly consisted of snack items, and fried curry are more likely to be reheated than other items in the menu.

Figure 10: Use proportion of cookstove for reheating in the baseline(above) and end line (below) phases

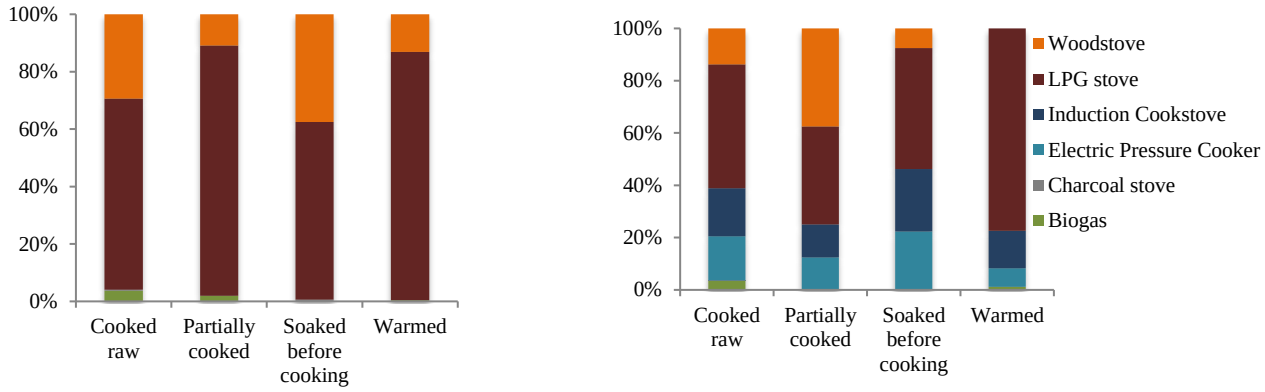


Figure 10 suggests that LPG and woodstove used to be the appliance of choice for reheating and cooking dishes in various conditions during the baseline phase. Towards the end line phase, however, electric cooking appliances seem to have become an important part of the mix for a dish that requires ingredients to be soaked (most likely beans and similar ingredients). For reheating food, electric appliances seem to have completely replaced woodstoves, whereas for cooking partially cooked items, woodstoves seem to be used as much as LPG stoves. Since just 16 cooking events (out of 5401; i.e. <1%) involved partially cooked items in the end line phase, data related to preferred appliance for cooking partially cooked ingredients is inconclusive. On the other hand, replacement of woodstove by electric appliances for reheating (which generally takes less time than cooking raw ingredients) may suggest households' preference for electric cooking for quick cooking. Although induction cookstove seems to have been used more often than electric pressure cooker for reheating food, their use proportion does not vary much with the food condition (before cooking events).

Generally, food cooked for later or the leftovers are warmed before they are eaten. The comparison between the reheating data in table 8 and leftover data in table 9 (which is higher than reheating data) suggests that not all food cooked for later or leftovers are reheated before they are eaten. Food cooked for snacks such as beaten rice, popcorns or roasted beans, and flatbread is generally not reheated before eating.

Table 9: Number of cooking events intended to prepare food for later or that produced leftovers

Baseline	Morning		Evening		Grand Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cooked for later	131	5%	52	2%	183	4%
Leftover	583	22%	369	15%	952	19%
No	1949	73%	2018	83%	3967	78%
Grand Total	2663	100%	2439	100%	5102	100%
End line	Morning		Evening		Grand Total	

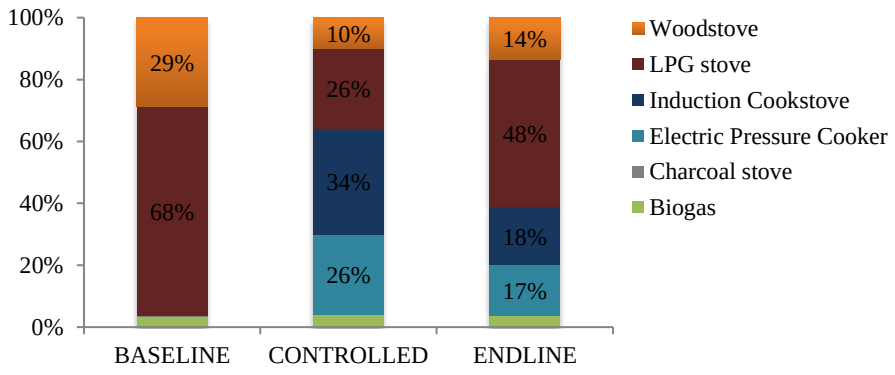
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Cooked for later	25	1%	8	0%	33	1%
Leftover	383	13%	242	10%	625	12%
No	2464	86%	2279	90%	4743	88%
Grand Total	2872	100%	2529	100%	5401	100%

Table 9 suggests that food items cooked in the mornings are more likely to be saved for later than those cooked in the evenings. Comparison between baseline and end line data suggests that precooking and leftovers were less likely after the introduction of electric cooking. However, this must be read with caution. In some places, especially where a fridge is not commonly used, people refrain from keeping leftovers of certain types of food in the summers lest it might rot due to relatively high temperatures. Note that the end line phase took place during the summer. Therefore, seasonal variations may have played a role here. Or this could also mean households are cooking just enough for a meal after the introduction of electric cooking.

4.6. Cooking appliances and fuels

Figure 11 suggests that LPG stove, followed by woodstove and biogas stove, is the most used cooking appliance in the baseline phase. This changes as we step into the controlled and end line phases. Electric cooking appliances are the most used cooking appliances during the controlled phase. The use of LPG declines significantly in the controlled phase; although the proportion of times it is used goes back up in the end line phase, it is lower (by 20%) than it was for baseline phase. While the proportion of times biogas stove was used remains unchanged throughout the study period, the proportion of times woodstove was used declines significantly after the introduction of electric cooking appliances. The proportion of times woodstove was used increases in the end line phase as compared to the controlled phase; however, it mirrors the LPG case in that it is lower (by 15%) in the end line phase when compared with the baseline phase.

Figure 11: Proportion of times cooking appliance was used during different phases



While the total number of households using electric cooking did not change between controlled and end line phases (see table 10), the use of electric cooking appliances (in terms of the proportion of dishes cooked) declined significantly during the end line phase vis-a-vis that during the controlled phase. The greater usage of electric cooking appliances during the controlled phase may be attributable to the use-based incentive offered by the project for that particular phase.

Table 10: Total number of households using different fuels for cooking

Phases	Biogas	Charcoal	Electricity	LPG	Wood
Baseline	11	1	0	43	34
Controlled	9	0	43	39	30
End line	11	1	43	42	24

The total number of households using a woodstove or charcoal as a part of their fuel mix declined from 34 in the baseline phase to 24 in the end line phase. On the other hand, **the total number of clean stackers also increased from mere two households during the baseline phase to 19 during the end line phase** (see figure 12). The single fuel users during the baseline were LPG users, whereas the single fuel users during the controlled phase were electricity users.

Figure 12: Distribution of study households based on the types of fuel mix

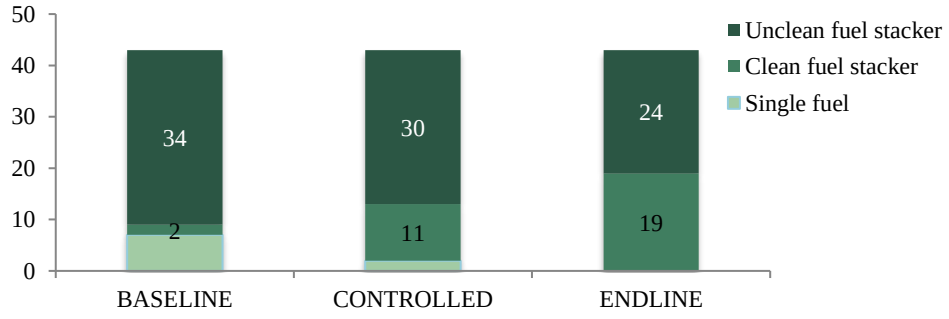


Figure 13: Proportion of times cooking appliances were used during different phases in each study household- a) Baseline Phase; b) Controlled Phase; c) End line phase

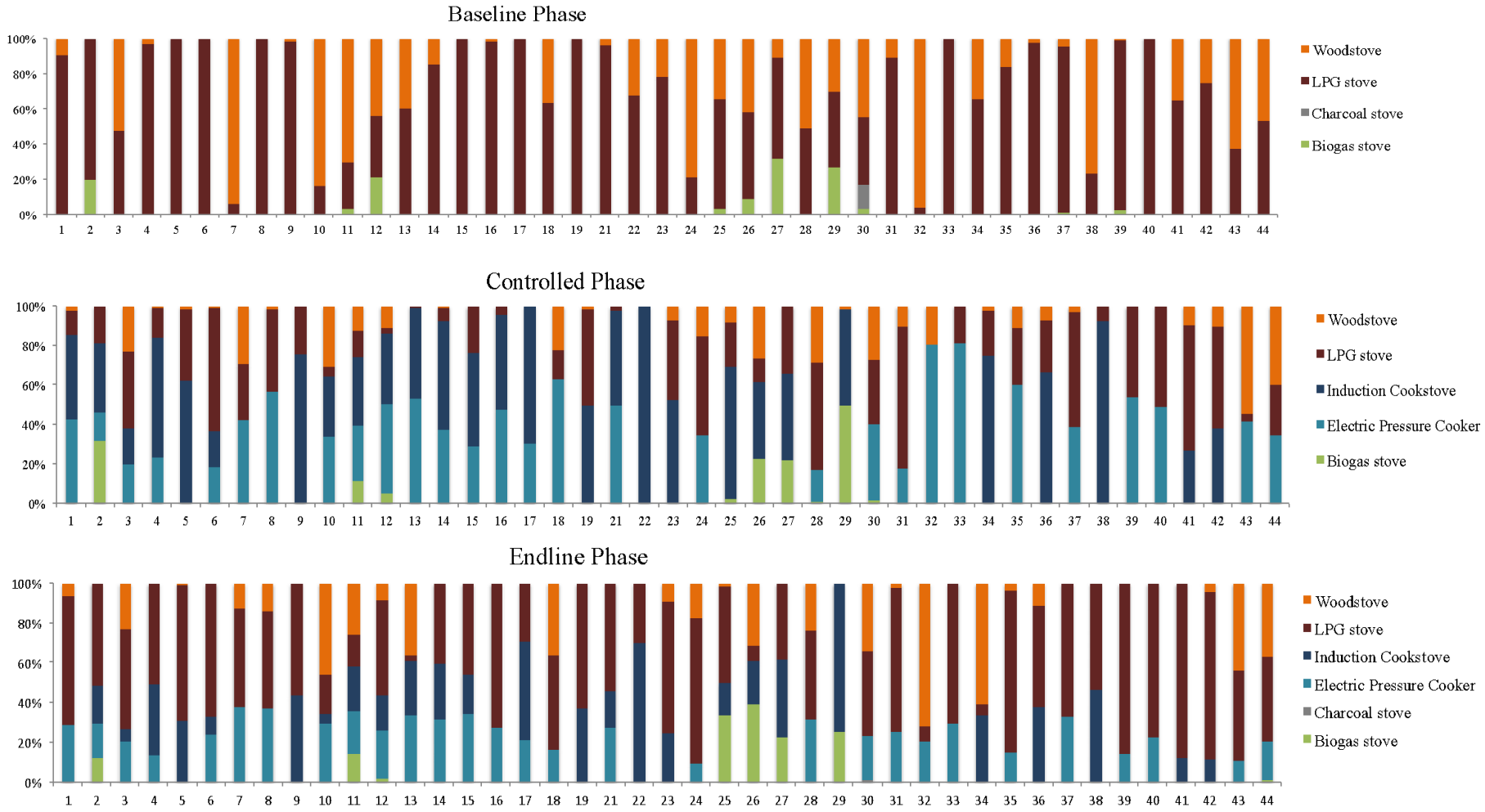


Figure 13 (a) shows the proportion of times dishes were cooked using certain cooking appliances in each study household during the baseline phase (i.e before electrical cooking appliances were introduced). It shows that an LPG stove was the appliance of choice most of the time, followed by the woodstove. Every household (all 43 households) used LPG during this phase, whereas 34 households used woodstoves, and 18 households used biogas stoves (see table 10). Just one out of 43 households used a charcoal stove (grey bars) during this phase. Only seven households used just one cookstove (100% LPG stove). This implies the rest of the households (36 HHs) practiced fuel stacking, out of which only two were found to be into clean stacking (specifically a mix of LPG and biogas) during this phase.

Thirty households used an LPG stove to cook over 50% of the dishes they cooked during the baseline phase. Nine households used a wood stove to cook over 50% of the dish they cooked during the baseline phase. Out of 11 biogas stove users, only four used it to cook 20% or more of the total dishes. The rest of them used biogas stoves to prepare on an average just 3% of the dish. Few had reported during the baseline survey that they do have rice cookers, however, almost all rice cooker owners said that they used it only occasionally. However, no one used electricity for cooking any dish in the baseline phase.

Figure 13 (b) shows the proportion of times dishes were cooked using different appliances during the controlled phase, i.e. after the introduction of electrical cooking appliances. During this phase, every household used electric cooking, 39 households used LPG stoves, 30 households used woodstoves, and nine households used biogas stoves. According to figure 13 (b), electric cooking (represented by blue bars) significantly replaced LPG and woodstoves during the controlled phase. Note that this is the phase when any increase in electricity consumption resulting from the use of electric cooking appliances introduced by the project was paid for by the project. This message seems to have encouraged study households to switch to electric cooking.

In 26 households, electric cooking was used to cook 50% or higher proportion of dishes. Two households, an exclusive LPG stove user (i.e. HH17) and a fuel stacker using a mix of LPG and woodstove (i.e. HH22) during the baseline phase, used electricity to cook 100% of dishes they cooked during the controlled phase (see figure 10). The rest of the households (i.e. 41 HHs) practiced fuel stacking during this phase-out of which **11 households practiced clean stacking (specifically either a mix of electricity and LPG or a mix of electricity and biogas) during the controlled phase**. Eight households still used the LPG stove to cook more than 50% of dishes during this phase. Only one household used a wood stove to cook more than 50% of dishes. During the baseline phase, just four households used biogas stoves to cook more than 20% of the total dish during this phase as well. Charcoal was completely abandoned during this phase.

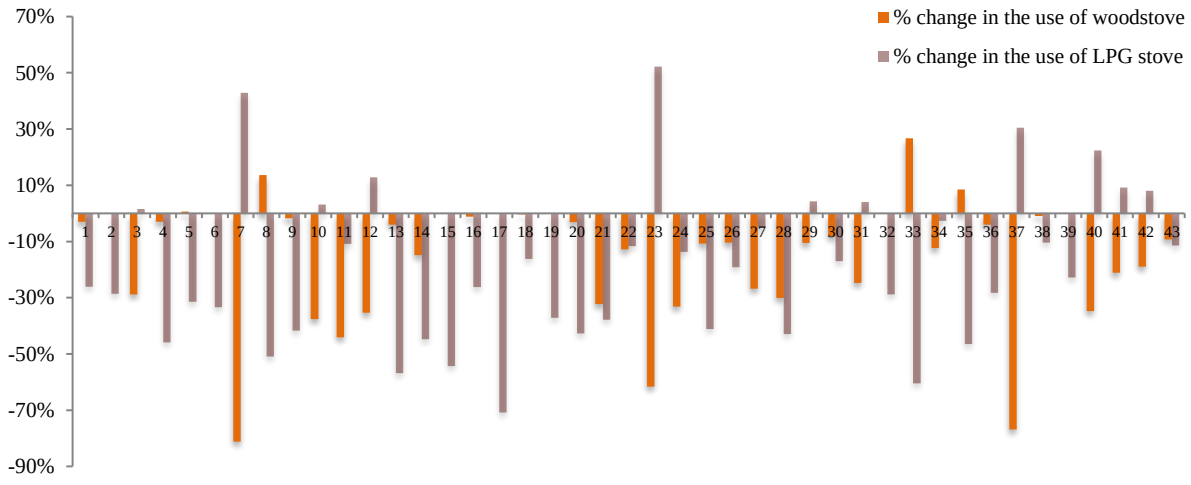
Figure 13 (c) shows the proportion of times dishes were cooked using different cooking appliances during the end line phase. During this phase, all 43 households continued to use electric cooking appliances, whereas LPG stove users increased to 42 from 39 households in the controlled phase. However, the woodstove users declined to 24 households (as opposed to 30 households in the controlled phase, and 34 households in the baseline phase; see table

10), and 11 households used biogas and one household used charcoal stove during the end line phase. During this phase, 19 households practiced clean stacking, mostly a combination of an electric appliance and an LPG stove.

Although figure 11 suggests that, all in all, the proportion of times woodstove and LPG were used declines between baseline and end line phases, figure 14 suggests that some of the households are outliers and indeed used LPG and woodstove more during the end line phase. The use of LPG increased in 11 households, and the use of firewood increased in 4 households between the baseline and the end line. The use of firewood and LPG declined in the rest of the households between the baseline and end line phases. The increase in the use of LPG in all 11 households seems to coincide with the decrease in the use of woodstove in those households. However, in majority of the households where LPG use increased, the absolute percent change (decrease) in the use of woodstove is relatively higher which means electric cooking must also have contributed to the decrease in the use of woodstove.

Similarly, in four households where the use of woodstove increased between the baseline and the end line phases, the use of LPG declined. Here again, the increase in the use of woodstove does not seem to match with the decrease in the use of LPG (which is higher in all cases). In 20 households, the introduction of ECAs led to the decrease in the use of both LPG and woodstove. In just one household that used both woodstove and LPG stove in the baseline, only the use LPG declined (by 16 percent) while the proportion of dish cooked on woodstove remained same in the endline phase. All seven households that relied exclusively on LPG in the baseline phase used it less (on average by 39 percent) in the end line phase. Therefore, the introduction of ECAs seems to have led to the decrease in the use of either LPG or woodstove or both in all households.

Figure 14: Percent change in LPG and firewood consumption in terms of the proportion of dishes cooked in each household between the baseline and end line phases



Dish-based analysis suggests that electric cooking appliances could be used to cook most of the common dishes: rice, lentil soups, soupy curry, fried curry, meat, leafy vegetables, and milk. The induction cooktop seems to have been used to cook greater variety of dishes than

the electric pressure cooker (see figure 15 and 16). The variety of dishes cooked on both appliances declines as we move from the controlled to the end line phases. Similarly, the use of electric cooking appliances to cook all of the above dishes also declines consistently between the controlled and the end line phase (see figure 17 a-h).

Figure 15: Proportion of dishes cooked on an induction cooktop during controlled (left) and end line (right) phases

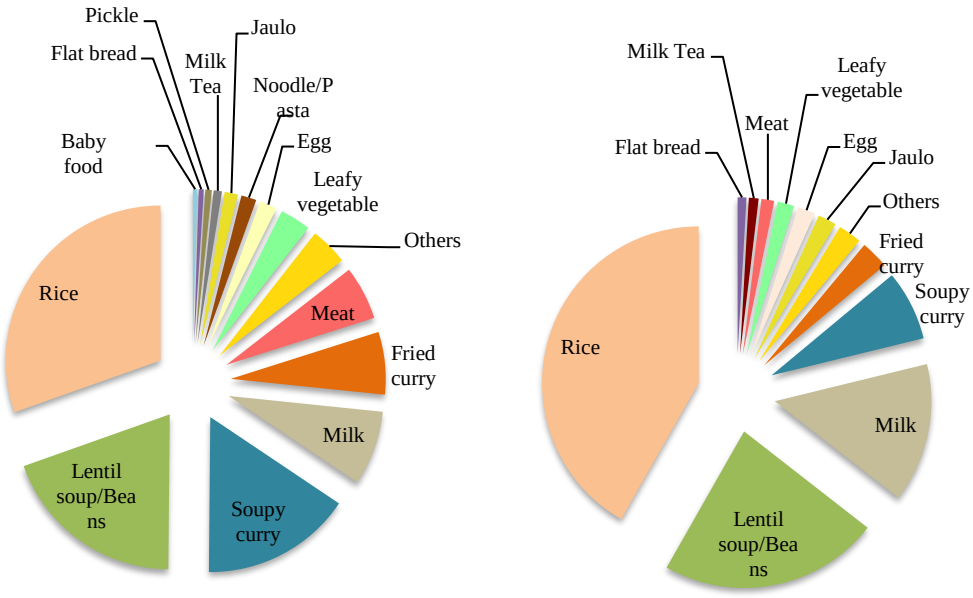
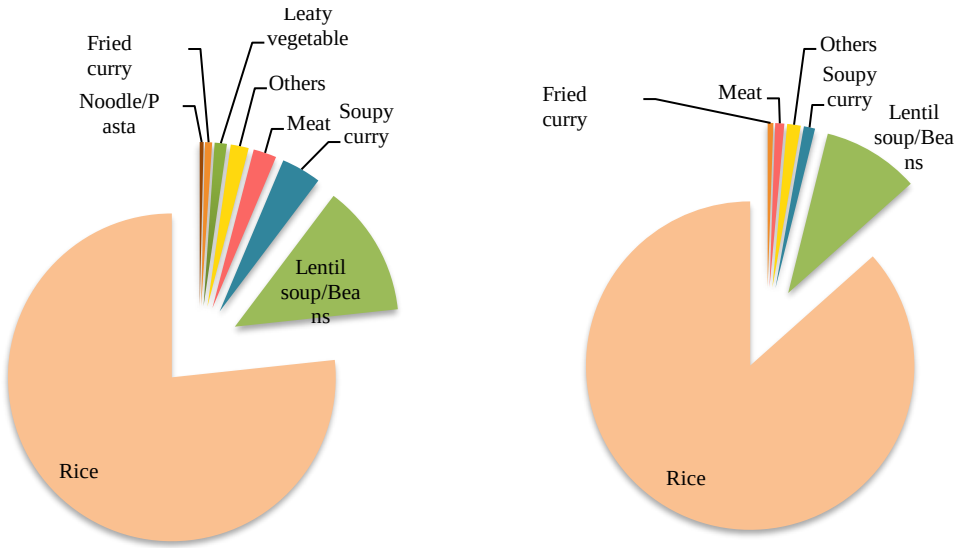


Figure 16: Proportion of dishes cooked on an electric pressure cooker during controlled (left) and end line (right) phases

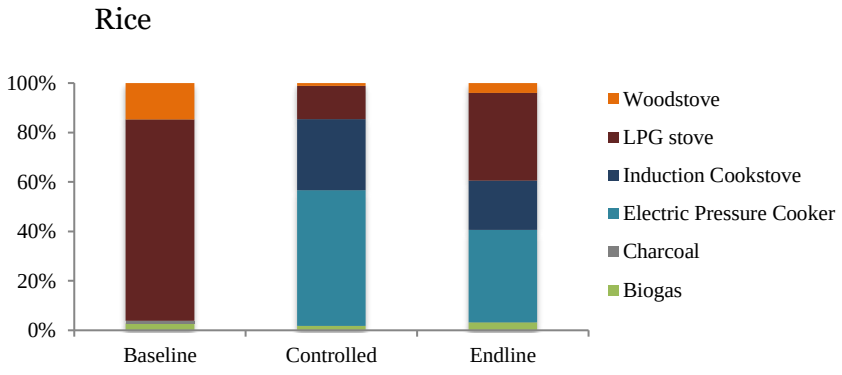


The use of an electric pressure cooker remained limited mostly to cooking rice and lentil soups/beans in the end line phase. EPC seems to be more popular for cooking dishes requiring slow cooking. During the controlled phase, households had started to complain about the quality of the induction base wok (cookware used to prepare food that requires partial or complete frying) provided by the project. This could have limited the ability of households to use induction cooktops during the end line phase, particularly for food that requires frying, including soupy curry (which is generally fried partially before adding water to make a gravy), fried curry, leafy vegetables, and meat. While the proportion of times soupy curry was cooked increased significantly between the baseline and the endline phases, figure 17c suggests that it was cooked mostly on LPG stove, and very less on ECAs. The use of an induction cooktop for heating milk, however, did not change much between the controlled and end line phases.

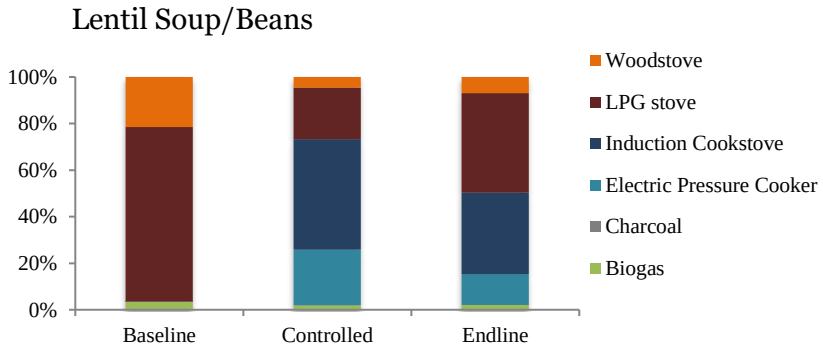
None of the electric cooking appliances was used to cook dheedo (see figure 17 a-h). Dheedo needs to be stirred frequently and at a specific temperature. This may be one of the reasons why people do not prefer to cook it on EPC since it does not allow users to adjust temperature as per need. On the other hand, dheedo is usually cooked in a wok and needs to be stirred with force, as the dish gets sticky after the water is let to dry up. The cooking surface of an IC provided by the project is made up of glass-ceramic, which could break if force is exerted on it. The above two reasons may have caused households not to prefer IC to cook dheedo. Interestingly, the proportion of use of woodstove to cook all major food items seems to have declined between the baseline and the end line phase, except in the case of dheedo, which remained cooked mainly on wood but was prepared far less frequently (figure 9). This suggests that households were more inclined to use clean fuel after the introduction of electric cooking appliances.

Figure 17: The proportion of use of different fuels to cook major dishes

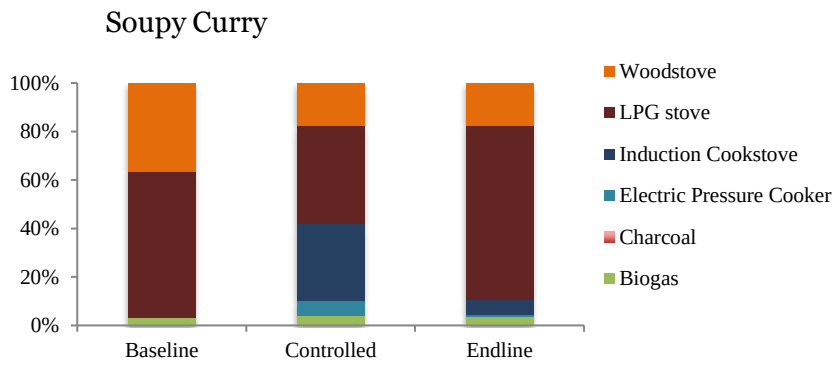
a)



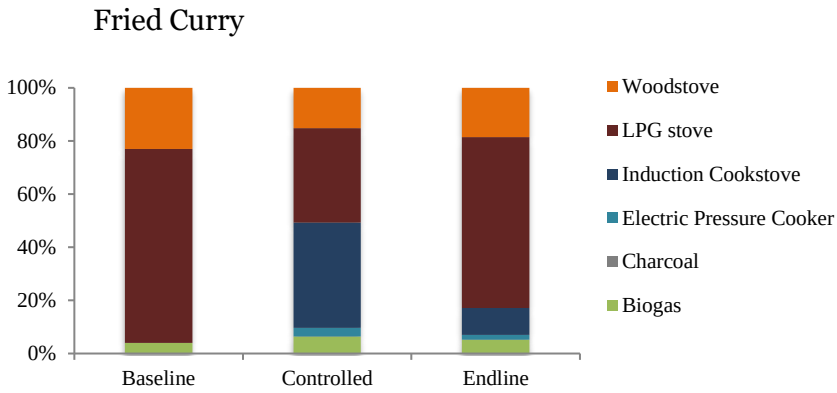
b)



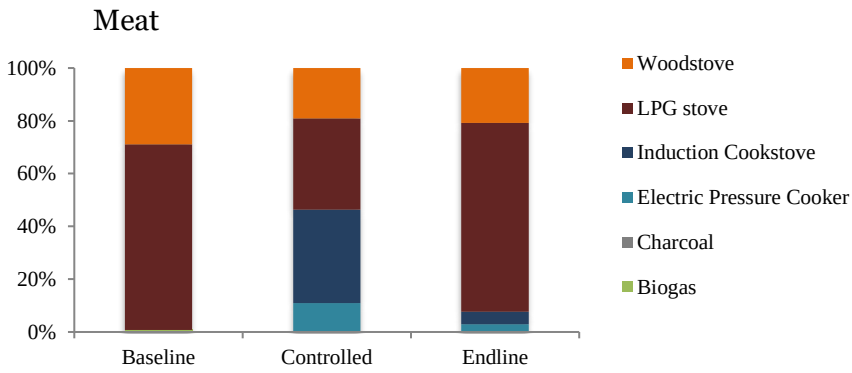
c)


Soupy Curry
100%
80%
60%
40%
20%
0%
Baseline
Controlled
Endline
Woodstove
LPG stove
Induction Cookstove
Electric Pressure Cooker
Charcoal
Biogas

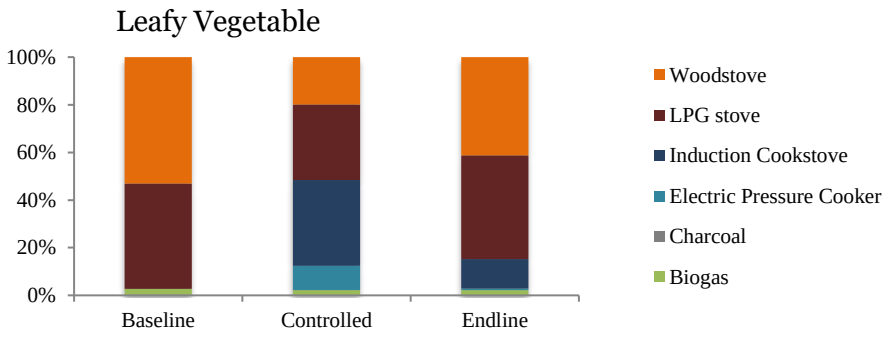
d)


Fried Curry
100%
80%
60%
40%
20%
0%
Baseline
Controlled
Endline
Woodstove
LPG stove
Induction Cookstove
Electric Pressure Cooker
Charcoal
Biogas

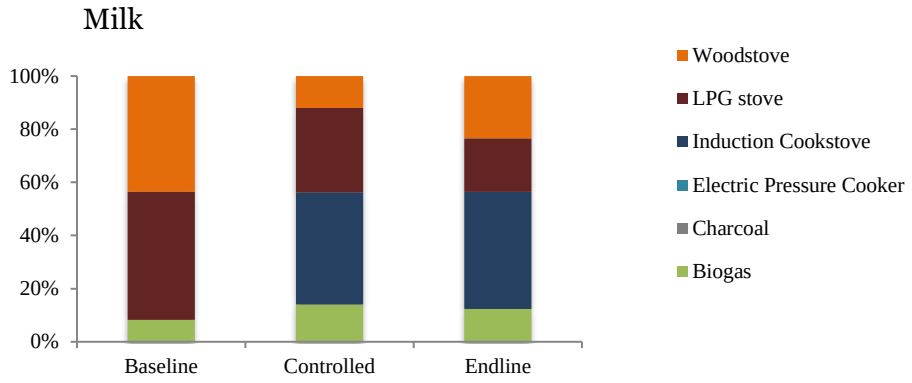
e)


Meat
100%
80%
60%
40%
20%
0%
Baseline
Controlled
Endline
Woodstove
LPG stove
Induction Cookstove
Electric Pressure Cooker
Charcoal
Biogas

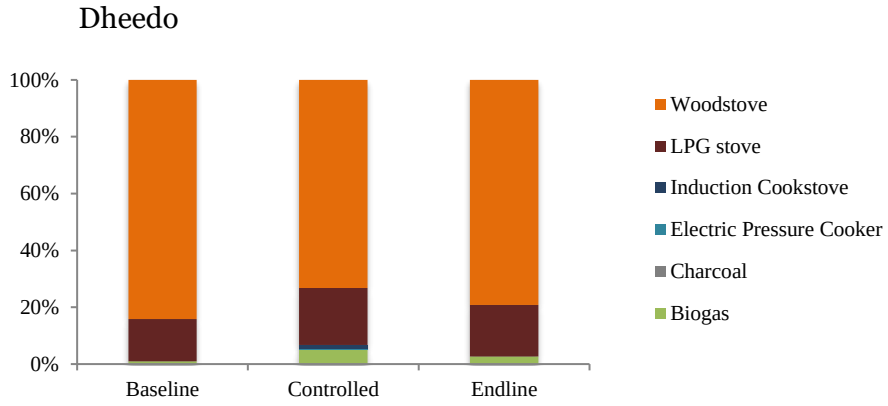
f)


Leafy Vegetable
100%
80%
60%
40%
20%
0%
Baseline
Controlled
Endline
Woodstove
LPG stove
Induction Cookstove
Electric Pressure Cooker
Charcoal
Biogas

g)



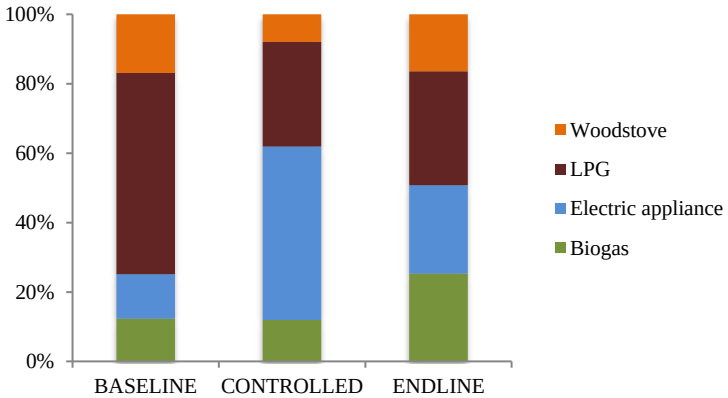
h)



4.7. Water-heating appliances and fuels

Fuel use for water heating changed over the course of the pilot. Figure 18 suggests that the use proportion of firewood for water heating did not decline much between the baseline and the end line phases. However, the use of electric appliances and biogas increased by 13% each between the same periods. The use of LPG on the other hand seems to have declined towards the end line phase. In both controlled and end line phases, induction cooktop remained the most frequently (i.e. more than 80% of the times) used electric appliance used for water heating events.

Figure 18: Use proportion of different fuels for water heating during each phase



Water heating is one of the most frequently performed activities involving a cooking appliance in the majority of study households. Forty-two households reported water-heating events during the baseline phase. During the controlled phase (see figure 19(b)), 34 households reported water-heating events and this further declines to 32 during the end line phase (see figure 19(c)). This decline could be attributed to different seasonal needs (for hot water) of the households.

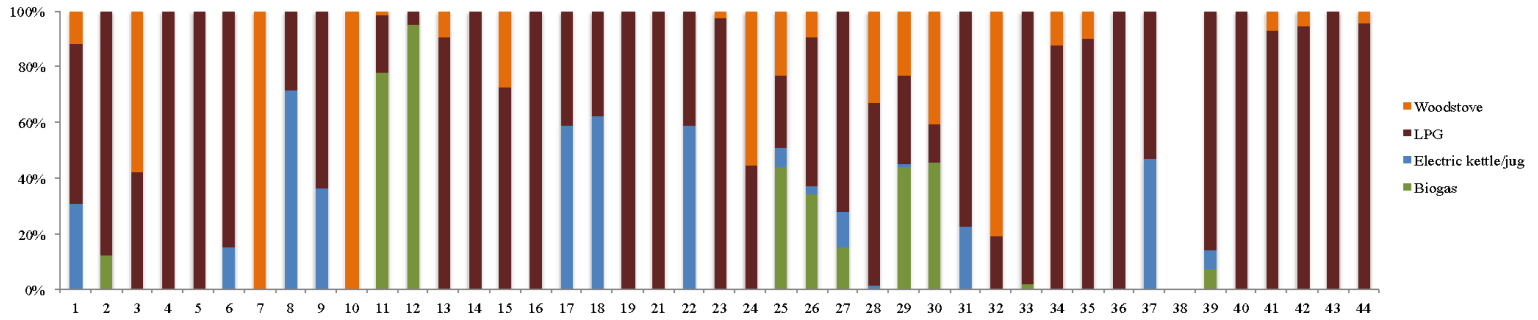
Figure 19(a) suggests that the LPG stove was the most preferred stove for heating water among the majority of study households during the baseline. Forty households (i.e. 95%) used LPG, 20 households used woodstove and 10 households used biogas to heat water at least once during this phase. However, unlike for cooking, some households (36%) also used electric appliances, particularly electric jugs or kettles to heat water. During this phase, nine households used LPG and two households used woodstove exclusively for water heating events.

In contrast, in the controlled phase, 29 households (85%) used electric appliances (electric kettle, electric pressure cooker, or induction cooktop), 20 households (59%) used LPG stove, 10 households used woodstove and seven households used biogas to heat water. Clearly, the use of electricity for water heating events increased significantly during this period, whereas the proportion of times used declined for all other fuel types. During this time, 12 households used electricity, three households used LPG and one used wood exclusively to heat water.

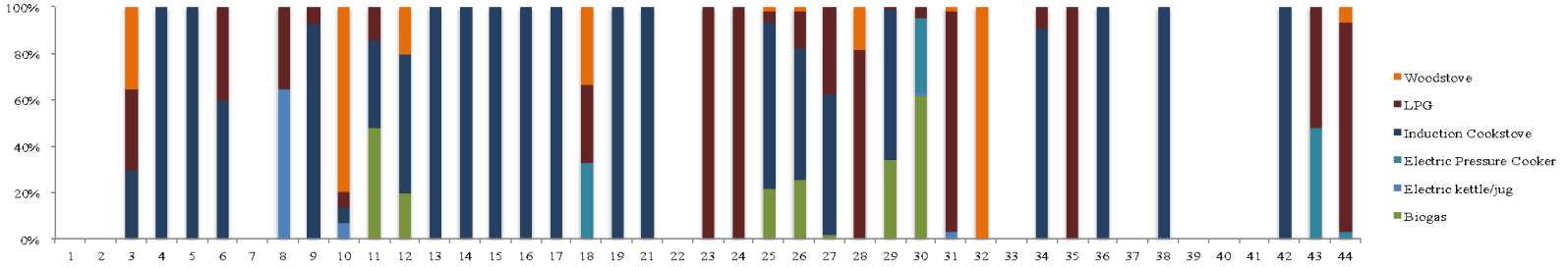
During the end line phase, the proportion of times electricity was used for water heating events declines as compared to the controlled phase (see figure 18). Only 53% of the households (as opposed to 85% in the controlled phase) used electricity for water heating, whereas the total number of households using LPG went back up to 72% (as opposed to 59% in the controlled phase) during the end line phase. Interestingly, the percentage of households that used woodstove to heat water declines from 50% in the baseline phase to 22% in the end line phase. During the end line phase, five households used electricity and 11 households used LPG exclusively to heat water.

Figure 19: Proportion of times each water heating appliance was used in each study household during (a) baseline phase, (b) controlled phase, and (c) end line phase

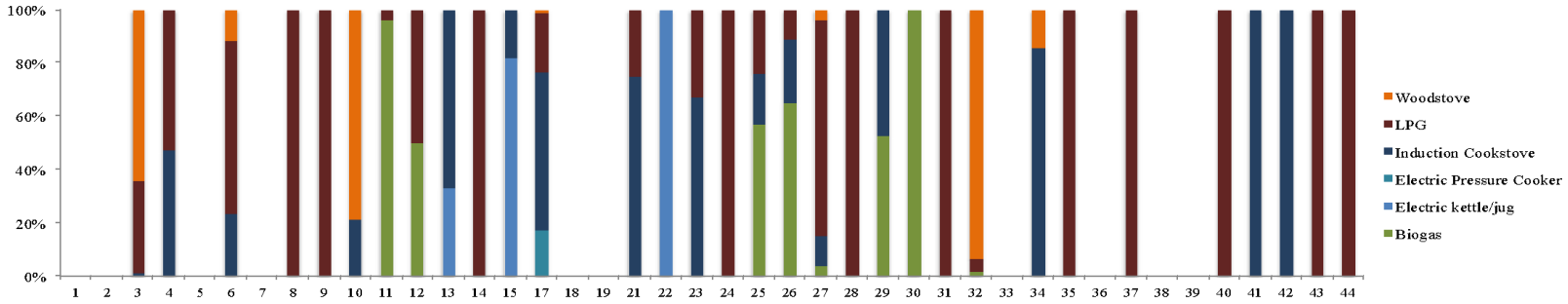
a)



b)



c)



4.8. Common utensils for cooking

Figure 20 shows that the most used utensils throughout the study phases were woks, pressure cookers, and electric pressure cookers. Although the proportion of use for preparing dishes may have changed across the study phases, the pattern of use mostly remained the same. In other words, the wok remained the most used utensil throughout the study phases, while the pressure cooker was the second most used utensil (figure 20). Note that, all the households that received induction cooktops from the project also received a set of an induction-base pressure cooker and a wok.

However, given that the electric cooking appliances were not used as much during the end line phase for food items requiring frying, the high use proportion of wok (as may be seen in figure 20) may suggest the use of other fuel types for fried food.

Figure 20: Use a proportion of each utensil in each study phase

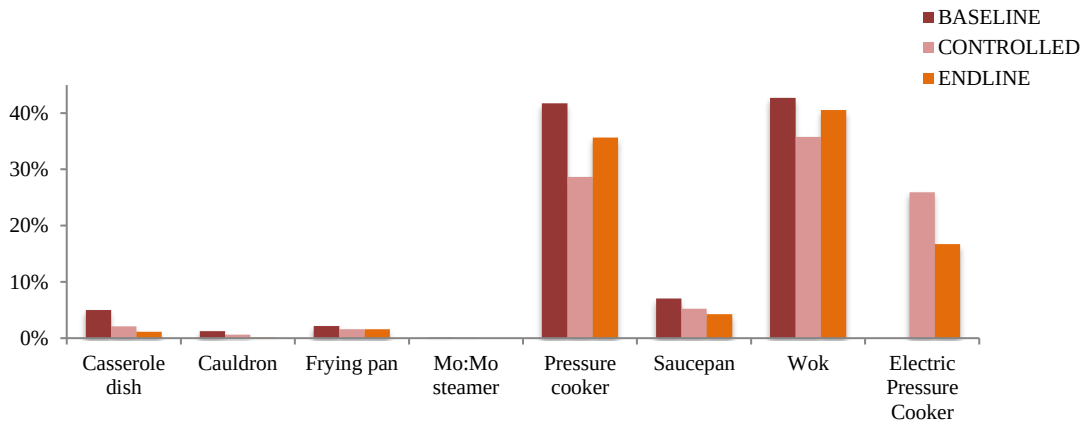
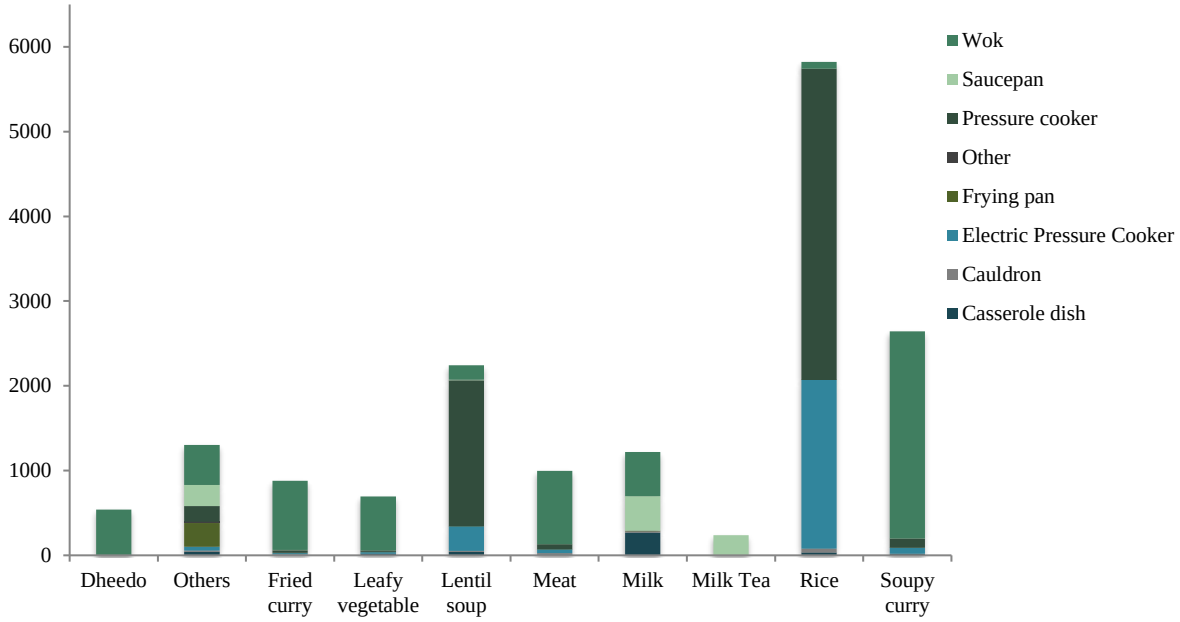


Figure 21: Total number of times each utensil was used to prepare major dishes



Lentil soup/beans and rice usually are pressure-cooked directly without frying. Electric pressure cookers are found to be used more for the two dishes, whereas their use for other types of dishes seems to be low. Other curry items generally are stir-fried first even if they are intended for soupy/gravy curry items. Figure 21 shows that households generally prefer wok to prepare dishes that require frying.

Figure 22: The proportion of cooking events when the lid was used in each utensil

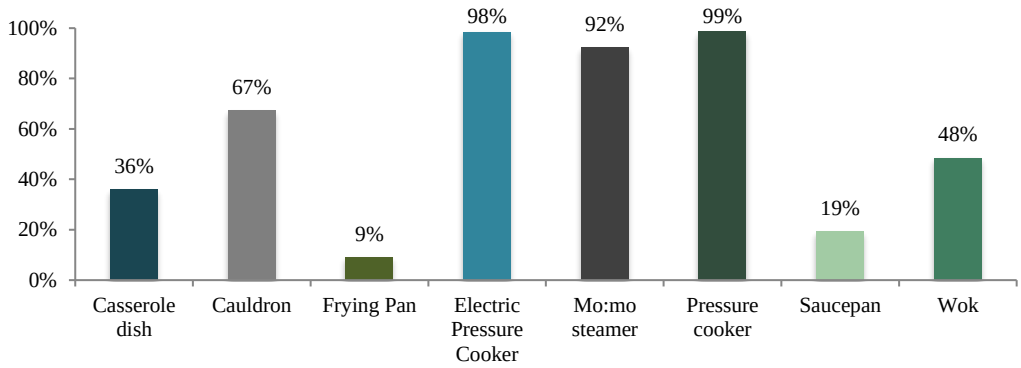


Figure 22 shows that a lid was used almost 100% of the time for the pressure cooker and electric pressure cooker. Momo steamer (used for making Nepali dumplings) is always used with its lid on. The lid is not used for frying pan, which is generally used for quick frying. The figure shows that casseroles, cauldrons, and woks are used with as well as without the lid. While using a lid may be an efficient practice, however, for certain dish types, stirring the ingredients frequently and frying them with spices are common practices.

5. Electricity consumption for cooking

5.1 Average electricity consumption

Figure 23: Average HH Daily electricity consumption of ECAs

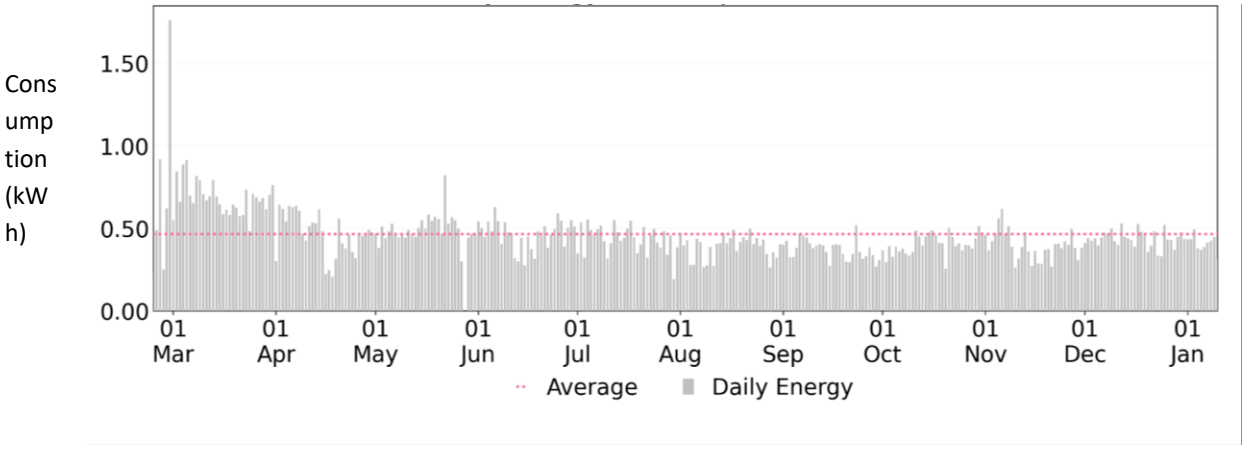


Figure 23 represents the average HH daily electricity consumption of electric cooking appliances deployed during the research period. It reveals that the average electricity consumption per day per user was 0.5 kWh for the entire pilot period. The average electricity consumption per household is 0.6 kWh in the controlled phase, 0.5 kWh in the choice phase, and 0.3 kWh in the end line phase.

Figure 24: Aggregated overall weekly electricity consumption of ECAs

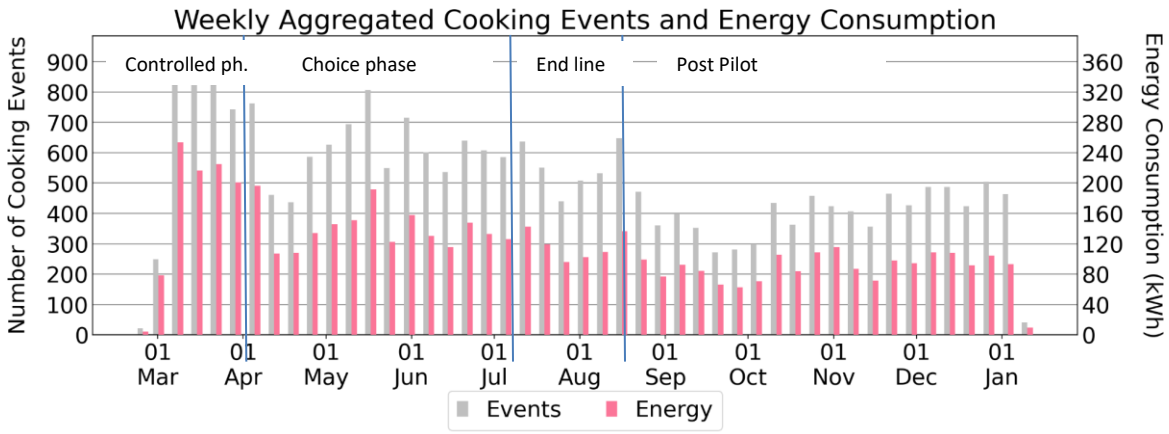


Figure 24 shows that there is an abrupt decline in the number of cooking events in the third week of April, this corresponds to the end of the controlled phase and the beginning of the choice phase. Although the average number of cooking events and energy consumption seem to decline as we move from controlled to the end line phases, the weekly aggregated graph does not indicate specific trend as there is increment and reduction during different weeks ranging from 80 kWh to 250 kWh per week. Similarly, 100 kWh to 140 kWh during the end line phase. Overall, 23671 cooking events were recorded, corresponding to 5483 kWh. Translating those numbers into a reduction of CO2 emissions, it is found

that baseline fuel gets reduced by 15% for woodstove, and 20% for LPG stove 33% when stacking with ECAs.

Controlled Phase:

During the controlled phase, we see the highest electricity consumption and number of cooking events within the whole pilot study. After a short increase within the first two weeks of the phase, the usage stays above 200kWh and 740 cooking events per week. This can be translated into an average number of cooking events per person per day of 2.5 within this period. The observed behavior can be explained as during this phase, the participants were encouraged to cook entire meals on ICs or EPCs and their incremental electricity use was covered through tariff incentives. Also, enumerators visited households every alternate day to address any difficulties they faced during the use of ECAs. This also shows that households feel somehow comfortable when enumerators visited them as these technologies were new to them.

Choice Phase:

During the choice phase, which started on 18 April 2021, households continued using ECAs, but with reduced intensity. In the first week of the choice phase the weekly consumption decreased from 240 kWh to 120 kWh due to supply reliability problems. During this phase, overall weekly electricity consumption stays above 100 kWh and 460 events per week. This can be translated into 1.5 cooking events per HH per day within this period. This reduction can be attributed to a lack of tariff incentives, irregular electricity supply, and flexibility to use the fuel of their choice. However, one of the weeks during the choice phase saw HH electricity consumption by ECAs reach as high as that experienced during the controlled phase. Right after the controlled phase the study had a one-week gap period before starting the choice phase. The enumerators did not visit study households to collect cooking diary data during that time.

End line phase:

During the end line phase, which started from 25 July, an increasing trend was observed until it reached 140 kWh and then decreased again. The HH electricity consumption of ECAs ranged between around 100 kWh to 140 kWh in the end line phase.

A decreasing trend with some weekly fluctuations can be observed during post pilot phase, when enumerators did not visit households for cooking diary. Electricity consumption over 62kWh and 281 cooking events per week can be observed. This can be translated into 0.93 cooking events per household per day within this period. This relatively stable low usage of electric cooking appliances reflects the long-term usage of those, though the trend does not show an uptick. We see that in the long run, the excitement of the new appliance wears off. Coupled with the cost of electricity, limitation of utensils and unreliable electricity, households use ECAs to cook fewer dishes. It is interesting to note that the post pilot phase is showing a stable and no decrease anymore, which means that people integrated electric cooking into their habits.

The study showed that households were motivated to continue cooking on the controlled phase. Households expressed ease of operation, time-saving, cleanliness, increased safety, health

benefit, less cost of fuel compared to LPG and firewood, and social status to be the driving factors for continuous use.

5.2 Number of active devices and cooking events

Figure 25: Aggregated Cooking Events and Active Devices for ICs only (29HHs)

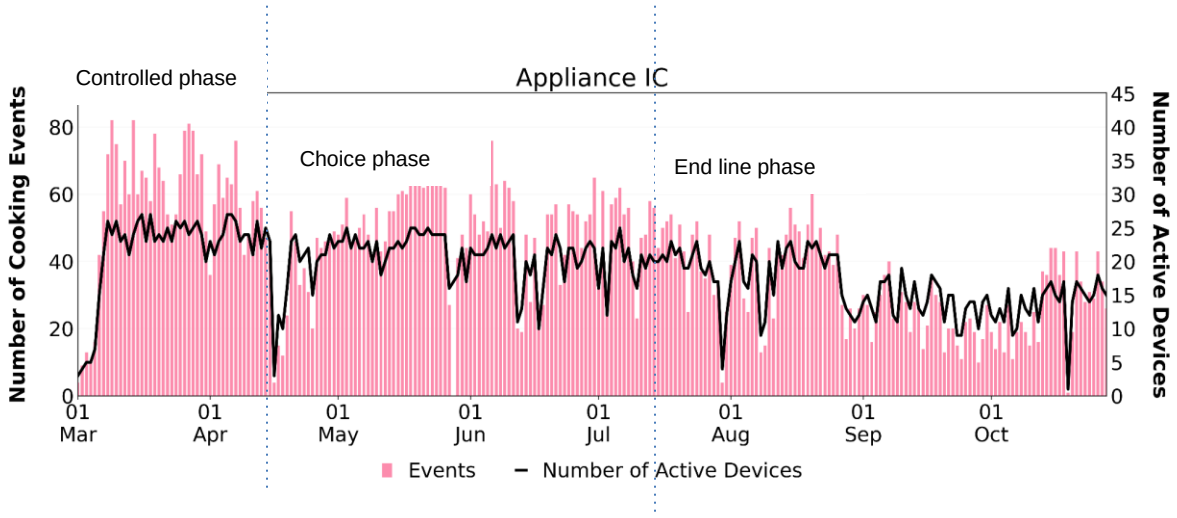
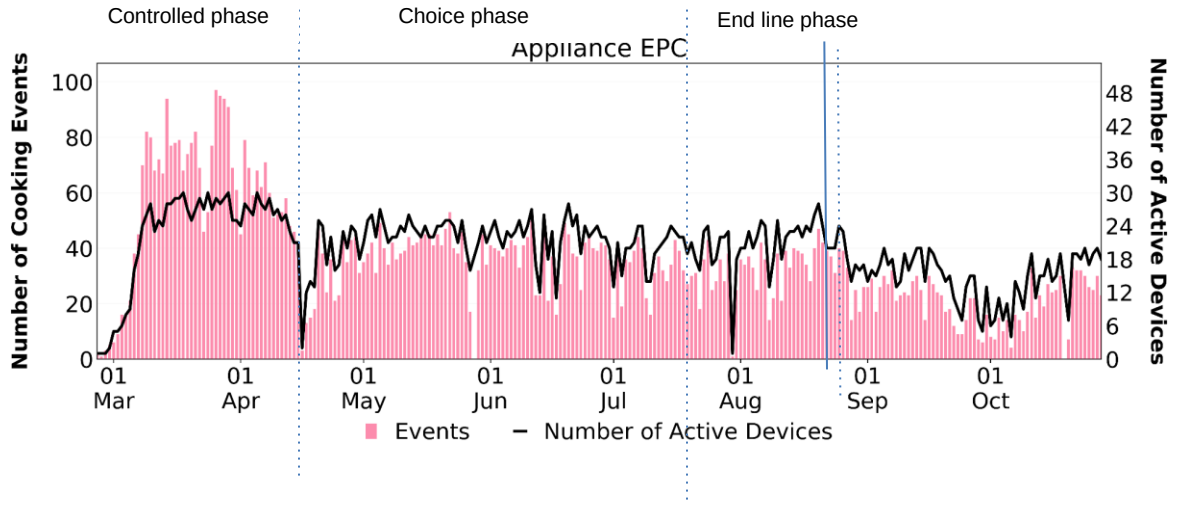


Figure 26: Aggregated Cooking Events and Active Devices for EPCs only (30HHs)



It is interesting to note from figure 25 and 26, that in the controlled phase, EPCs have been used more (up to 100 times per day) than ICs. However, the use of these appliances decreased in both the choice and end line phases. The reduction in usage is sharper for EPC appliances, as it dropped from 100 to around 50 times. In case of IC as well, the decrease can be observed, which anyhow is less significant (from around 80 in the controlled phase to around 50 in choice phase). One reason for this trend could be that participants were willing to experiment with the less familiar EPC when it was free to use during the controlled phase but less so in the other

phases. On the other hand, the drop in the use of ICs was less steep, perhaps because the technology was more familiar and potentially seen as less of a risk to use.

5.3 Insights from study groups

Figure 27: Aggregated Cooking Events and Active Devices for Households with ICs only (14HHs)

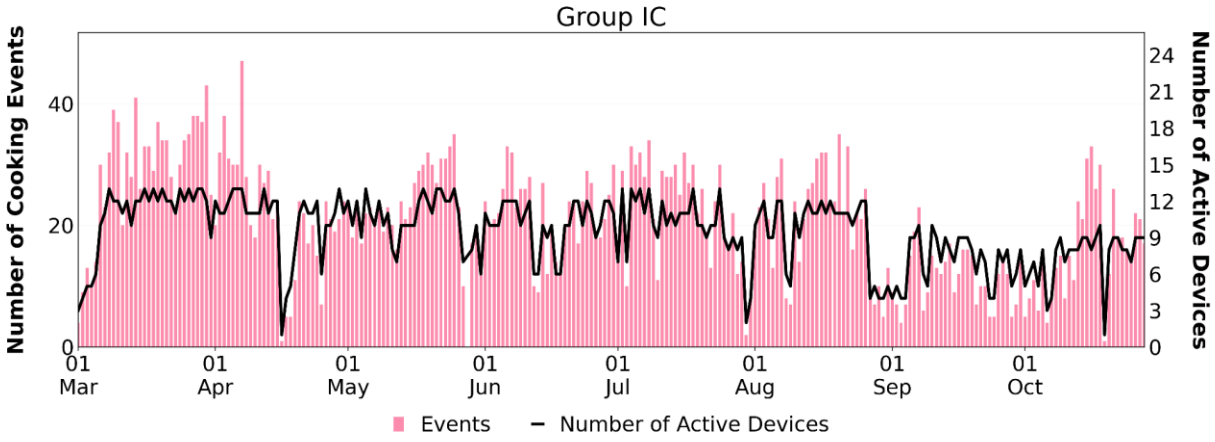


Figure 28: Aggregated Cooking Events and Active Devices for Households with EPCs only (15 HHs)

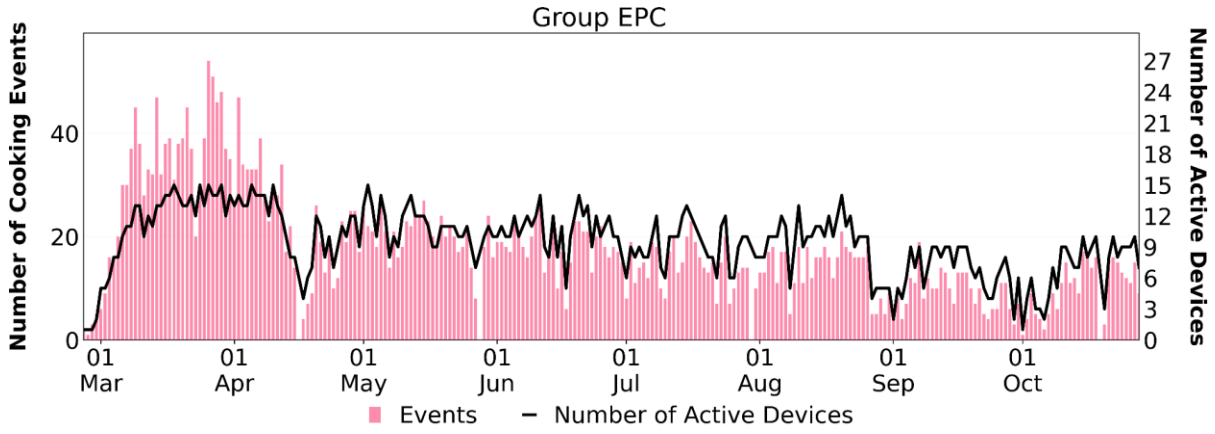
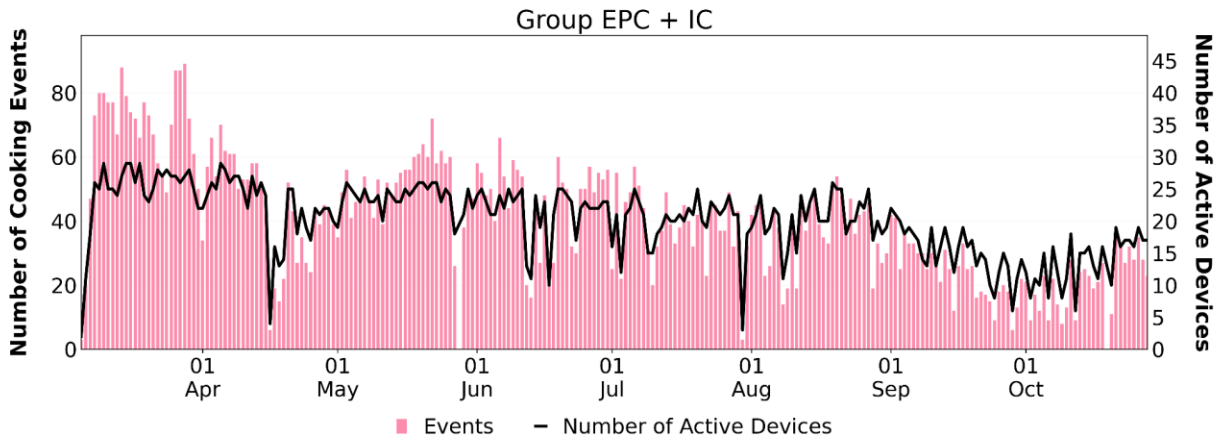


Figure 29: Aggregated Cooking Events and Active Devices for Households with EPCs + ICs (15 HHs)



When looking at Figures 27 - 29 we see that the group who had two electrical devices at home (EPC + IC - Figure 29) used both of them, so that the overall usage per household per day was 3.5 times in the controlled phase in comparison to 2 times among households which either only had an EPC (Figure 27) or IC (Figure 28). This higher number of usage results in less stacking with other cooking stoves and fuels and therefore helps in increasing the health of households. This is an important sign to stakeholders, as it calls for a need for more than one electric cooking appliance in each household in order to stop stacking with other traditional fuels.

5.4 Electric cooking load curve

Figure 30: Aggregated Cooking Events and Energy Consumption only for IC Appliances Distributed over 24 Hours

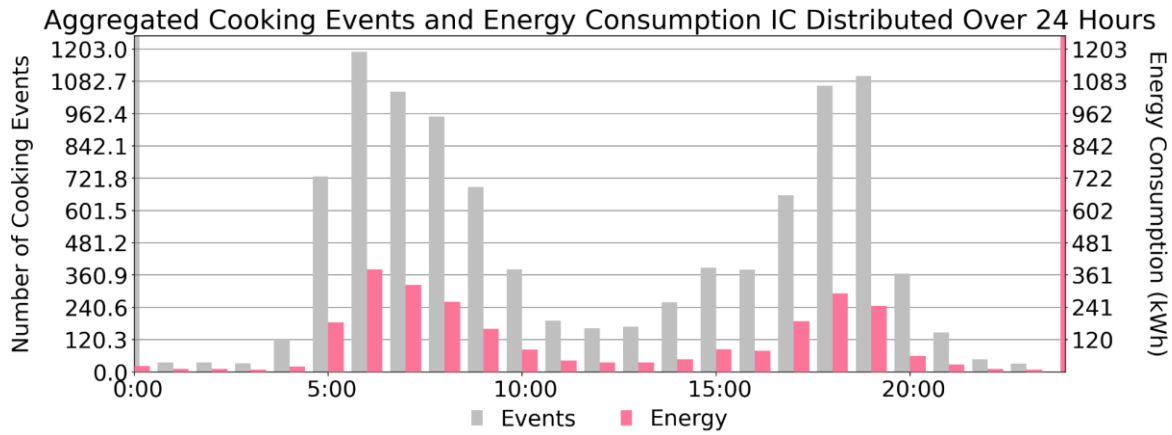


Figure 31: Aggregated Cooking Events and Energy Consumption only for EPC Appliances Distributed over 24 Hours

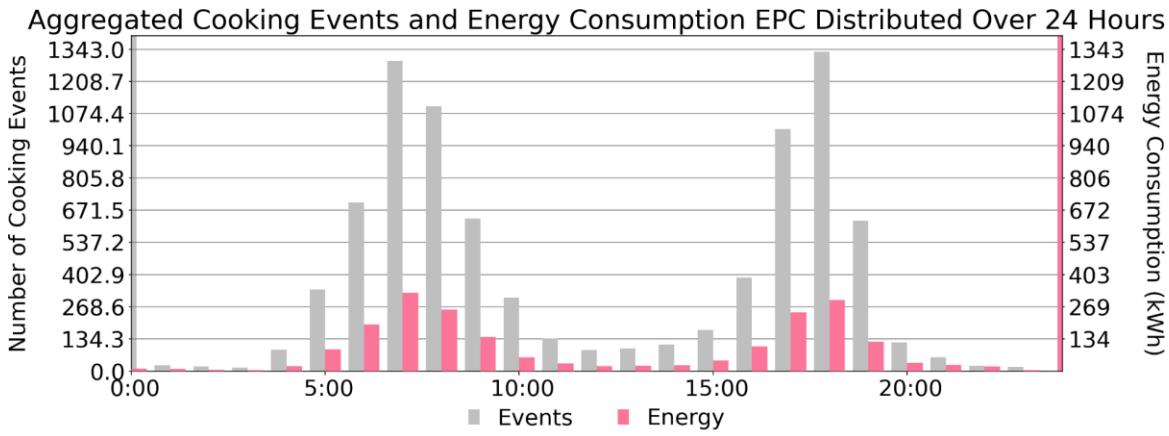


Figure 30 and figure 31 represent the application of ICs and EPCs 24 hours a day. From both figures, it can be seen that the participants used the ECAs (ICs and EPCs) for the preparation of meals during the morning and evening. The use of ICs starts to take off at 5 AM and lasts until 10 AM; the use of ICs peaks at around 6 AM in the mornings. In the evenings, the use of IC starts to take off at 5 PM, peaks at around 7 PM and ends at around 8 PM. The use of IC does not go below 120 cooking events between the morning and the evening peaks, which means it is used throughout the day although at varied intensity. In case of EPCs, the use starts to take off at 5 AM, peaks at 7 AM, and ends at 10 AM. In the evenings, the use of EPCs starts to take off at 4 PM, peaks at 6 PM, and ends at 7 PM. This evening peak coincides almost with the national figure, which is 7:15 PM. As the cooking time coincides with the national evening peak. The existing capacity of distribution infrastructure is insufficient to meet growing e-cooking load during peak time. Therefore, for wider upscale of electric cooking, demand side management needs to be prioritized and incentivizing off peak demand and reducing other peak demands to allow e-cooking in the peak hours. The major difference between the two appliances is that the use of ICs is more between the morning and evening peak times. This shows HHs found ICs swift and easy to use for making quick meals such as afternoon melas and snacks.

5.5 Ranking by smart meters

Figure 32: Ranking by smart meters

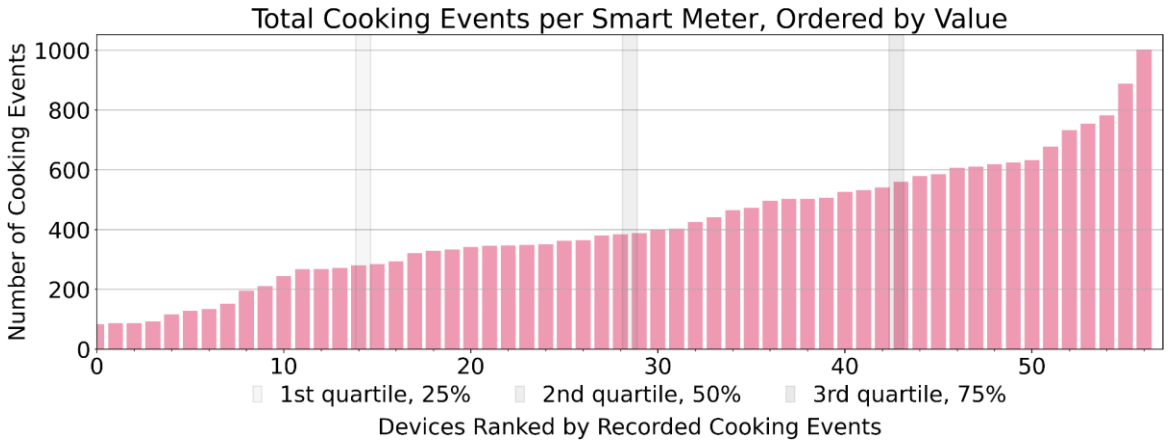


Figure 32 shows the cooking events recorded by each smart meter over the whole pilot period. The share of outliers, both to the bottom and top, is relatively small. The graph suggests that the usage of electric appliances does not vary significantly among the majority of users. The use of electric appliances among 50% of the users between the top 25% and the bottom 25% users ranged between 284 to 391 times over the study period (see table below). Nevertheless, the normal distribution is shifted slightly to low usage, as 50% of users are only accounting for a share of 36% of total cooking. In other words, the majority of users account for lesser cooking events than the average number of cooking events across households of 333.

Table 11: Distribution based on cooking events recorded by smart meters

Quartile (%)	Cooking Events	Share of Cooking Events up to Quartile (%)
0	0	0
25	284	15.1
50	324	35.9
75	391	62.3
100	774	100

Figure 33: Distribution of Minutes per Cooking Event EPC

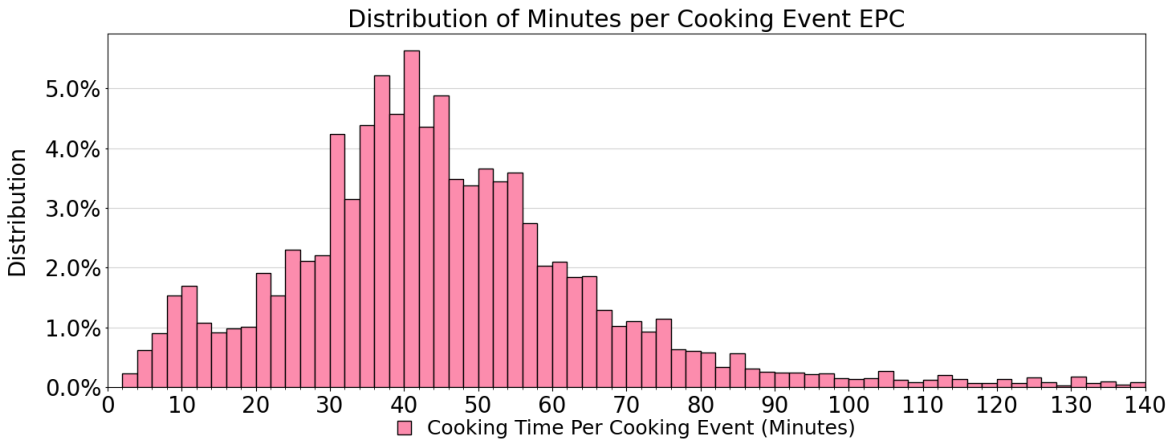


Figure 34: Distribution of Minutes per Cooking Event IC

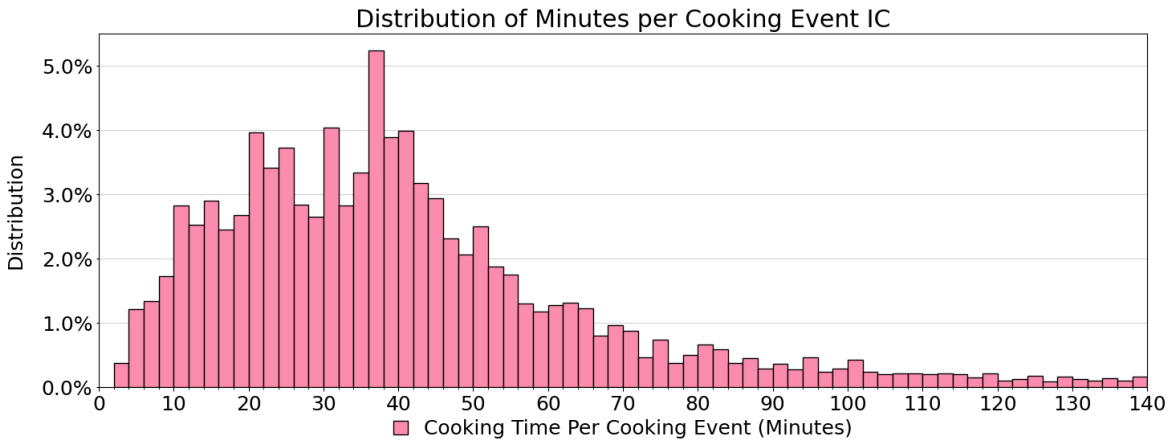


Figure 34 shows that the longest cooking event for IC was for 140 minutes and the majority of events take between 12 minutes to 60 minutes. Figure 33 shows that the longest cooking event for EPC was also for 140 minutes but the majority of events take between 20 minutes to 60 minutes. This shows that HHs use ICs for foods that require fewer cooking times such as tea, snacks.

Figure 35: Distribution of Energy Consumption per Cooking Event for IC

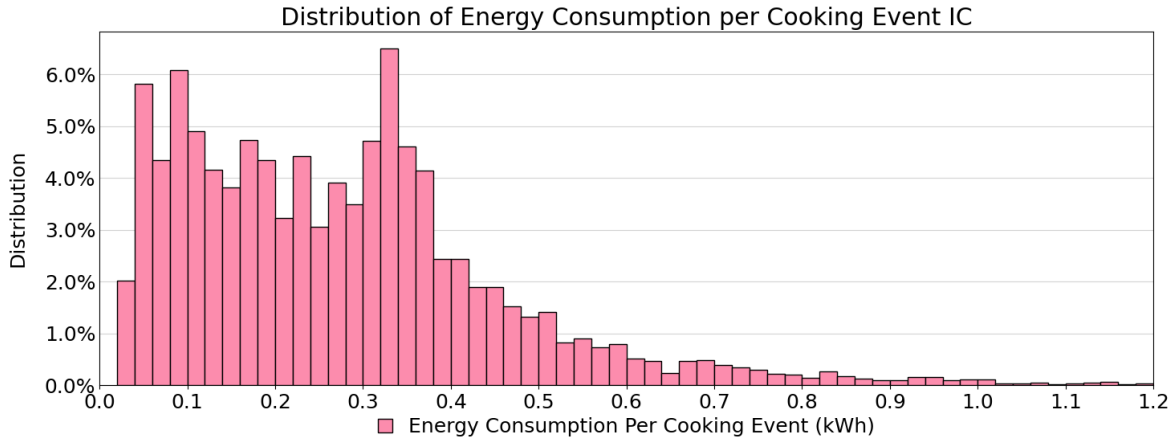
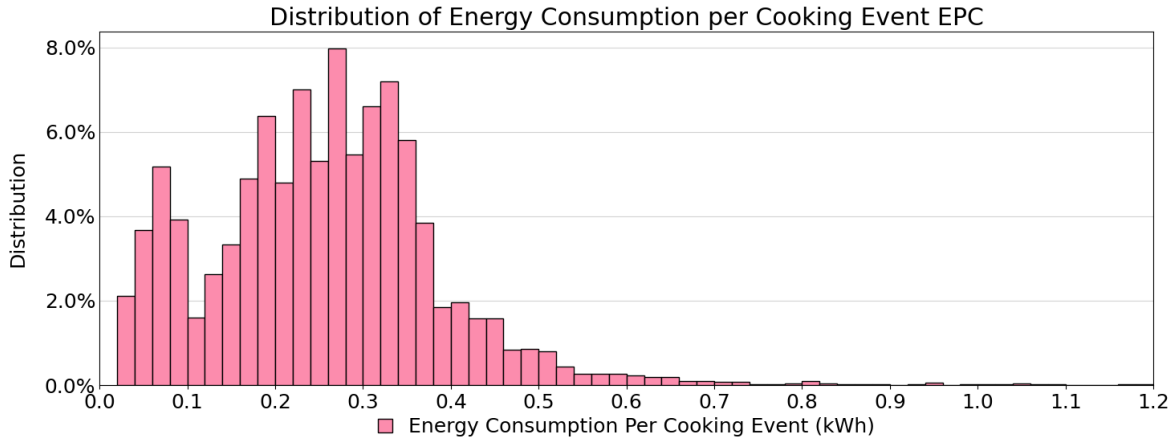


Figure 36: Distribution of Energy Consumption per Cooking Event for EPC



Most of the cooking events in IC consumed less than 0.5 kWh per cooking event. During the study period, one cooking event had 1.2 kWh as the highest energy consumption. Similar to IC, most of the cooking events in EPC consumed less than 0.4 kWh. One cooking event had the highest energy consumption of 1.2 kWh. This suggests that EPCs consumed less energy for foods cooked in study HHs as might be expected given the EPC's lower power demand (although to confirm this direct comparison of EPCs and ICs cooking the same dishes is required).

6. Exit Survey Findings

An exit survey was conducted among all study households at the end of the pilot using open-ended questions. The main objective was to understand the users' feedback on the aspects which may not have been covered under the study phases, such as their overall experience with the appliances, suitability of the appliances for various use cases and experience with electricity as cooking fuel. All the questions were elaborated to the users, responses were duly recorded, and

follow-up questions were asked to extract more responses. The main outcomes of the exit survey are summarized below.

- **Overall impression and adapting to the electric cooking appliances**

Almost all study households reported that they were happy with the performance of the cooking appliances, especially due to their ability to cook significantly faster. They said that the appliances saved their time measurably, particularly while preparing morning meals when they are in a rush for members to leave for work and/or kids for school with lunchboxes. Households using EPCs were found to be happy, particularly because it doesn't require close user attention or 'babysitting' at all during its operation due to the time setting feature. Therefore, the cook could multitask efficiently. Most of the HHs also liked EPCs because they keep the cooked food warm for a longer period of time, which doesn't only save energy but also saves the hassles of reheating the food. They also found the appliances to be clean and aesthetically pleasing.

In the beginning, most of the households were somewhat skeptical about the appliances' ability to cook various dishes and had some safety concerns as well. Besides, they also thought the learning curve would be too steep for them to be able to use the appliances properly.

However, their initial inhibitions were soon overcome, thanks to the pieces of training provided by the project partners. With regular use, they became familiar with the various features, as well as required behavioral adjustments on their part for cooking various dishes conveniently. They were also found to be cognizant of the basic safety considerations while using the appliances. Initially, cockroaches troubled them a lot and a couple of induction cookers needed repairs. Users learned that they need to keep the cooking area free from food remains, as well as moisture, to keep cockroaches away. Most of the users also found special anti-insect chalk to be useful in keeping cockroaches at bay. While most of the households were content overall, a few of them were unhappy they couldn't use the appliances due to power outages or had to adjust their cooking times.

During the pandemic situation arising from the Covid-19 outbreak and the subsequent prohibitory orders issued by the government, almost all the households faced moderate supply shortages and even worse were inflated prices of grocery items and other household commodities. Nevertheless, most of them did just fine because they had already stocked most of the items in sufficient quantities. The supply of LPG cylinders was also partly impaired, which in turn helped them realize the importance of electric cooking appliances as the electricity supply is almost immune to transport restrictions.

Most of the study households said that they are willing to pay for their next purchase of electric appliances as they now understand the associated benefits well. The users were found quite happy to recommend the appliances to their friends, families, and neighbors. They said there is already a significant interest shown by the other households. They said that availability in local markets and repair facilities will certainly create a sizeable demand among a wider segment of the target users.

- **Increasing roles of male members in kitchens**

A vast majority of the study households happily reported increasing participation of male members, especially husbands, in kitchens after the adoption of the electric appliances. The users attributed this encouraging outcome to the 'novelty' aspect of the appliances having visible benefits such as reduced cooking time, cleaner operation, and ease of use. In addition to this, users also found the training, as well as continuous behavioral reinforcement, by the project partners useful in cementing the concept of gender equality, and consequently the voluntary increase in the participation of male members in kitchen activities.

As per the users, this did not only partly relieve women of the workload but also contributed to a congenial environment in the families. Few women members from the study households, however, doubted the male members will continue supporting kitchen activities for a longer period as they may lose interest in the appliances with time.

- **Users' review of the appliances**

All the study households, without an exception, liked the electric cooking appliances in general. They said they could vouch for the superior benefits electric cooking has over the baseline fuel practices in terms of faster cooking, clean operation, and ease of use. Almost all of the households found the training, as well as continuous backstopping, provided by the project partners very useful. They said that they could not have adapted to the appliances so easily had there been no training. A few users also reported that they learned about the appliances themselves with continuous use and shared learning among themselves. Peer learning, as per most of the users, was useful in ensuring proper use of the appliance and record-keeping in the cooking diary.

However, an overwhelming majority of the users had some complaints regarding the size of the utensils, especially the karai or frying pan provided with the induction cookers. These households said it was not big enough to cook vegetables for a large family. A few users also reported that they did not find induction cooker much suitable for cooking roti (flatbreads), dheedho, kheer, and puwa.

In general, most of the households were not satisfied with the induction cookers where the dishes required deep frying at consistently high temperatures. Most of the households reported that rice cooks better in the induction cooker and EPCs. Similarly, most of the users also said the beans and lentils cook faster on induction cookers.

When asked about the changes they would like to see in the appliances, most of the users said they would want an induction cooker to go with any kind of utensil, ferromagnetic or not. They also said it would have been better if the induction cooker could work with utensils of different sizes. Most of the EPC users also wanted a spare cooking pot/chamber so that they could conveniently cook another dish without having to empty the pot.

- **Experience cooking with electricity**

Most of the study households said that they did not have sufficient information about electric cooking before the project started. They knew little and hence were hesitant to buy electric cooking appliances due to the high cost of the appliances and matching utensils for induction cookers.

They also thought electricity bills would be higher, only fewer dishes could be cooked, and that the taste may not also be the same. However, after the start of this study project, they received the correct information and hence got willing to adopt the appliances as the participating study households.

Almost all the users said that the appliances met their expectations in terms of saving cooking time, labor, and ease of use. Some of the households said that they thought the appliances cooked slower in the beginning as they were not fully conversant with their functions. But they soon realized that they are much faster. The reduced dependency on LPG, which needs to be brought from a local store, was one of the main benefits the users acknowledged, especially amid the pandemic situation.

When asked if they noticed a reduction in LPG consumption and hence an increment in savings, most of them said yes. However, a few of them were not sure about it due to the use of multiple appliances. Some of the households also reported a significant reduction in cooking time and hence reported that they had more time for family and livelihood activities.

7. Conclusions and Recommendations

The study findings confirm that the households are interested in cooking on electricity as they continued to cook even after the pilot study.

The use of LPG declined significantly after the introduction of ECAs; the proportion of times LPG was used to cook lowered by 20% between the baseline and the end line phases. The use of woodstove for cooking also declined after the introduction of ECAs. The proportion of times a woodstove was used lowered by 15% in the end line phase compared to that in the baseline phase. It clearly shows that the total number of clean stackers also increased from the baseline to the end line phase.

Electric cooking appliances could be used to cook most of the common dishes: rice, lentil soups, soupy curry, fried curry, meat, leafy vegetables, and milk. The induction cooktop was used to cook greater variety of dishes than the electric pressure cooker. If appropriate utensils are available to cook in, the findings suggest that induction cooktop is compatible with much of the local menu, except for deep frying where most of the households did not find ICs suitable. The use of electric pressure cooker remained limited mostly to cooking rice and lentil soups/beans in the end line phase. EPC seems to be more popular for cooking dishes requiring slow cooking, although cooking dishes that require frying also seem possible in the appliance. This finding

shows that providing households with more than one ECA leads to greater use of eCooking and reinforces the point that more than one ECA is needed to stop people stacking traditional fuels

The findings also show that firewood can be replaced by electricity for foods that need reheating as ECAs require less time to start than firewood. Also, as reheating requires less time, one can close ECA immediately after reheating is done, whereas in the case of firewood, once lit, HHs would have to keep firewood just burning without cooking anything or turn off the fire. HHs found it easy to use ECAs, especially ICs for reheating. ECAs seem to have completely replaced woodstoves for rice, lentil soups and curry soups, whereas for cooking partially cooked items, woodstoves seem to be used as much as LPG stoves.

The study findings show that the fuel staking will continue. LPG is a familiar fuel and people, over the period, have accustomed themselves to cook a much larger variety of local dishes on LPG cookstoves using different types and sizes of utensil. Firewood, where collected from community managed forests, is considered much cheaper than electricity and the woodstoves are almost free of cost.

The study findings suggest that the utensils also play a crucial role in adoption of ECAs. Whereas the wok remained the most used utensil throughout the study phases, and the pressure cooker was the second most used utensil, it was found that HHs did not cook foods that needed frying using EPCs as it was not compatible for deep frying.

The study reveals that the average electricity consumption per day per user is 0.6 kWh in the controlled phase, 0.5 kWh in the choice phase, and 0.3 kWh in the end line phase. The reduction in usage is found sharper for EPC appliances. One reason for this observed behavior could be that participants were willing to experiment with the less familiar EPC when tariff incentives were provided during the controlled phase but less so in the other phases. Whereas ICs had less drop off because the technology was more familiar and potentially seen as less of a risk to use. Further, HHs who had both appliances continued using both the appliances. This again shows that HHs may need different kind of appliances to meet their cooking practices. Also, the study found that the household electric connection upgraded to 15 Ampere, supported by a capable household electric wiring system, can sufficiently hold the electric cooking load for one family.

It was found that the use of ECAs peaks at 7 AM in the mornings and, 6 pm in the evenings. As all households cook around same time, it was found that the existing local electricity distribution system is not capable of withstanding high peak loads and needs an upgrade, which requires significant investment from the utility. The study HHs experienced low voltage problems when industries in the same feeder were operating at the same time of their cooking time. This can be addressed through demand side management by the utility. During the safety audit of household wiring, it was found that all the study HHs needed meter upgradation and a dedicated wiring in the kitchen for them to be able to use ECAs. HHs also need electricity safety training to avoid any negative impact (such as electrical hazards) of electric cooking resulting from unsafe handling of ECAs.

HHs are encouraged to use electricity for cooking if supply reliability is ensured with fewer power interruptions, standard voltage, and less response time to address supply disruption. It

was also found that when supported with awareness and electricity bill incentives, households may transition to e-cooking at a much faster rate. Therefore, it is recommended that plans and programs be directed towards consumer awareness to boost demand. Post purchase behavior reinforcement to facilitate sustained use is also very important. Without post-purchase support, the cooks in Nepali households may be hesitant in using or experimenting with an eCooking appliance due to the perceived risk of not being able to prepare various meals for the household. Users' involvement in awareness campaigns will enhance demand through peer learning and hence scaled up deployments. Users' clubs, user-non-user interactions and users' testimonials could be some of the ways to involve users to disseminate awareness.

Tariff incentives are also needed to kick-start the market. Further exploration and larger pilots would be needed to determine ways to incentivize e-cooking.

As households continue with both the appliances, the development of quality electric cooking appliances can boost the electric cooking market. This urges the need of robust standardization and labeling regime not only to support quality control but also communicating this information to users to facilitate informed buying decision. Besides, it is to be noted that during the research period, faulty appliances had to be brought to Kathmandu, over 60 kms away from the project site, for repairs. Therefore, locals need to be trained to repair such appliances so that households can continue without losing many days to cook on electricity. Strengthening localized supply chain with hassle-free aftersales service is very important.

Based on the study findings, the following actions are recommended:

- Affordable tariff is recommended for wider uptake of electric cooking.
- Programs and projects should be designed by incorporating behavior change communications (use of appliances, cooking demonstrations for diverse foods) with equal importance to post-purchase behavior reinforcement activities.
- Clean stacking should be encouraged and awareness about different clean cooking fuels should be disseminated in an effective manner with the focus on localized campaigns .
- Prevention and corrective measures should be planned well and investments need to be increased significantly to ensure power supply reliability.
- Distribution infrastructure should be ready for changes in electricity consumption due to seasonal variations.
- Availability of quality utensils needs to be ensured together with the implementation of standards for electric cooking appliances.

Document Control Sheet

Issue Status	Author(s)	Reviewed By	Loughborough University Approved By	Issue Date
Draft version	Pooja Sharma Dr. Ashma Vaidya Mr. Shekhar Sharma Mr. Mahendra Prasad Chudal Ms. Subina Shrestha	Richard Sieff	Richard Sieff	25/01/2022
Final version	Pooja Sharma Dr. Ashma Vaidya Mr. Shekhar Sharma Mr. Mahendra Prasad Chudal Ms. Subina Shrestha	Simon Batchelor	Simon Batchelor	26/01/2022
Amended Version				

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