Understanding energy implications at the household level of cooking entirely with electricity in Nepal

Photo credit: WACN survey team, 2022-23

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Executive summary

This study was supported by UK Aid and Loughborough University under Modern Energy Cooking Services (MECS) programme. The aim of this study was to understand the energy implications at the household level of cooking entirely with electricity. Women Awareness Center Nepal (WACN) implemented this study in two urban Saving and Credit Cooperative (SACCOs), located in two different districts of Nepal - Kathmandu and Kavrepalachowk- in Bagmati Province. The approach of the study was as follows:

- Provide EPC, induction cooktop, and electric kettle intervention to 20 members of women SACCOs;
- Collect data on cooking practices in the intervention households using a cooking diary in three phases: Baseline, Transition, and Endline;
- Analyse cooking diary data for energy usage, cost of cooking, and change in cooking practices;
- Conduct exit interviews of participants to understand households' experience with eCooking and challenges in cooking entirely with electricity.

Main findings:

- LPG stoves were used in the intervention households for 95% of heating events in the baseline phase which declined to 13% by the endline phase. eCooking devices were used only for 5% of heating events in the baseline phase which reached 87% by endline phase. Though the study could not achieve 100% cooking in the intervention households using efficient eCooking appliances, the above finding suggests that the transition to eCooking was quick and substantial.
- The study finds that to cook entirely on electricity, the average monthly requirement of an urban household in Nepal will be approximately 52.5-55.1 kWh of electricity.
- By complete transition to eCooking, the average annual LPG saving per urban household will be 53.6-55.9 Kg of LPG.
- Compared to the baseline phase, cooking entirely with efficient eCooking devices will be nearly 50% cost effective in terms of fuel running cost.
- People prefer to cook rice and pulses using EPC; vegetables, tea, milk, noodles, and meat using induction cooktop; and electric kettle is main choice of people for boiling water.

- Average per capita electricity consumption for cooking typical Nepali dishes like rice, daal, beans, meat, and vegetables was less for EPC compared to an induction cooktop.
- The study did not find a change in gender role for cooking after the introduction of efficient eCooking devices in households; in the baseline phase 92% of cooking activity was done by females and in the endline phase also this remained the same.
- Nearly 75% of participants find learning to operate eCooking devices very easy and none of the participants reported any safety concerns like electrocution, during the study period.
- Power outages and low voltage were cited as the main concerns for full transition to eCooking.
- Participants response suggests that stacking of LPG with efficient eCooking devices are mainly due to two reasons: (i) power outages and low voltage, and (ii) cooking many dishes simultaneously on occasions like festivals or when some guests visit their place.
- The use of eCooking appliances has certainly benefitted households by decreasing the cost of energy used for cooking and saving time. Uninterrupted and stable power supply and availability of affordable eCooking appliances and compatible utensils will increase user acceptance.

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CCT	Controlled Cooking Test
EPC	Electric Pressure Cooker
GMA	Global Market Assessment
GoN	Government of Nepal
Kg	Kilogram
kWh	Kilo-watt-hour
LPG	Liquified Petroleum Gas
MJ	Megajoule
NCSCC	Nari Chetana Saving and Credit Cooperative
NDCs	Nationally Determined Contributions
SRMNCSC	Shree Ram Mandir Nari Chetana Skill Cooperative

1.Introduction

Global Market Assessment for electric cooking (GMA) report (2021) ranked Nepal second in all-round GMA score (behind India) for scale-up viability [1]. The enabling environment for eCooking in the country includes the Government of Nepal's (GoN) Nationally Determined Contributions (NDC) target of 25% of all households using electricity as a primary mode of cooking by 2030, increasing domestic hydropower production, rapid electrification of households, growing eCooking appliance market, rising consumer demand, and a supportive policy for cushioning prices of imported eCooking appliances [2,3].

MECS Electric Cooking Outreach (ECO) Challenge fund supported four 6-month eCooking pilot studies in Nepal reaching over 300 households. The findings from these pilot studies suggest that eCooking fits the cultural cooking processes in Nepal [2]. It strengthened the evidence base for eCooking in Nepal by highlighting how women community networks and product quality facilitate swift and sustained eCooking adoption [4]. By the endline phase (month 5), EPCs accounted for 32.5% of heating events in urban areas and 38.8% in rural areas (*ibid*). Another ECO pilot study (PEEDA, 2021) reported that EPCs accounted for approximately 30% of cooking events from the transition to the endline phase [4].

People's acceptance of eCooking appliances is influenced by a variety of factors, including technological, economic, social, cultural, and political issues [4]. Thus, two questions become pertinent from the policy perspective. Is a full transition to eCooking possible in Nepalese Kitchen? What are the barriers to a full transition to eCooking in Nepal? The potential for EPCs to play a role in increasing access to clean cooking and energy saving is now well recognised. However, the multi-functional EPCs from some brands (eg. deep fry or shallow fry function is not available in Phillips EPC) cannot be used for cooking dishes which require deep-frying, shallow-frying or roasting. Also, the availability and use of a single eCooking device in the household may not fit for exploring the above questions. A basic limitation is that availability of a single eCooking device prohibits simultaneous cooking which is common practice in Nepalese households. With the availability of a single eCooking appliance, the cook has a choice to put more time into cooking if he/she wishes to go only for eCooking. Otherwise, stacking different cooking stoves, like LPG or firewood, becomes indispensable if the cook prefers to go for simultaneous cooking for saving overall cooking time. Therefore, it becomes imperative to explore the scope of

availability and use of multiple eCooking appliances in a household, particularly as a mechanism to meet all cooking needs as well as to support simultaneous cooking.

This study aims to gain an understanding of the energy implications at the household level of cooking entirely with electricity in Nepal by generating data for a wider range of eCooking appliances. The objectives of the study are as follows:

Objective

- To understand the energy required to cook entirely with electricity in Nepal.
- To calculate the traditional energy saving by transitioning to cooking entirely with electricity.
- To analyse the cost implications of transitioning to cooking entirely with electricity.
- To understand the household preferences for cooking various local dishes using different electric devices.
- To understand the user experience of cooking entirely with electricity, barriers preventing households from cooking entirely with electricity, the difficulty faced by the households and measures taken to overcome these barriers.

This study brings out energy implications for cooking entirely with electricity and also opportunities and challenges for transition to 100% eCooking in Nepalese households. The approach of this study to achieve the above objectives are as follows:

- Providing EPC, induction, and electric kettle intervention to 20 members of women saving-credit cooperatives in urban locations of Kathmandu and Kavrepalanchok district.
- Collecting data on cooking practices for intervened households using a translated version of the MECS cooking diary.
- Conducting exit interviews of participants to understand households' experience with eCooking and challenges in cooking entirely with electricity.

2. Methodology

The study has adopted the Cooking Diaries methodologies developed by MECS to investigate the compatibility of electric cooking devices with local menus - in terms of what foods can be cooked, energy consumption, and cost (relative to traditional fuels).

Phases of study

i. Household selection
ii. Registration survey and screening
iii. Appliance distribution and training
iv. Cooking diary data collection
v. Exit interview

I. Household Selection

The study was conducted with Shree Ram Mandir Nari Chetana Skill Cooperative (SRMNCSC), Kathmandu, and Nari Chetana Saving and Credit Cooperative (NCSCC), Kavrepalanchok district, Nepal. There were 1350 women cooperative members in SRMNCSC and 399 women members in NCSCC. In the absence of income data, savings by the cooperative members were used as a proxy for economic wellness. Based on the savings amount, the members were divided into two groups i.e. middle/ high income and low income (equal members in each group), in each cooperative (SRMNCSC and NCSCC). After the listing exercise, the study randomly chooses (i) 20 middle/ high income and 20 low-income members from SRMNCSC and (ii) 20 Middle/ high income and 20 low-income members from NCSCC.

Figure 1: Participants during meeting regarding the study
Photo credit: WACN survey team, 2022-23

II. Registration Survey and screening

Meetings were organised at SRMNCSC and NCSCC to sensitise about electric cooking benefits. A detailed Participation Information Sheet explaining the full scope of the study, the confidentiality it entails, and that no participants will be forced into participating, was provided at registration. Participants were made aware that participation is voluntary. All the participants revealed that their primary cooking fuel is LPG. In the meeting (i) in SRMNCSC 13 middle/ high income and 9 low-income members agreed to participate in the study and (ii) in NCSCC 10 middle/ high income and 6 low-income members agreed to participate in the study. From the list of participants willing to participate, a lottery system guided for registration of (i) 5 Middle/ high income and 5 low-income members from SRMNCSC and (ii) 5 Middle/ high income and 5 low-income members from NCSCC, for the intervention. In the registered member households, electricity wiring was inspected and found safe to support e-cooking. Participants signed a consent form which includes consent for the use of photographs and videos. To record the electricity consumption per meal, two appliance-level sub-meter, with electric fittings, were given to the participants.

Figure 2: Distribution of EPC, Induction and Electric Kettle in Kathmandu
Photo credit: WACN survey team, 2022-23

III. Appliance distribution and training

Under this study, three electric cooking appliances were distributed to each participant: 1) EPC, 2) Induction cooktops, and 3) Electric Kettle to understand the uptake and use of the different types of appliances and user compatibility with these modern energy cooking appliances for different dishes prepared by them. The selection of the appliances was done to cater to all cooking needs in Nepalese Kitchens: (a) EPC for dishes that require pressure cooking, (b) Induction cooktops for cooking dishes that require roasting, stirring, frying, and (c) Electric Kettle for boiling. Since the majority of households in the selected geography have similar cooking practices, the inter-household appliance needs do not vary much. The e-cooking appliances were procured from the Phillips distributor (Syakar Company Pvt. Ltd.) in Kathmandu and were transported to the study location for distribution to the selected households. A technician from the distributor provided the live training to the program team. The program team conducted the Controlled Cooking Test (CCT) for EPC, Induction cooktop, and Kettle. The program team carried out the live

demonstration of eCooking appliances for registered participants at the program locations after the baseline survey and distributed the eCooking appliances after the demonstration workshop. Two induction-compatible utensils were also distributed to the participants.

Table 1: Electric Appliances distributed as part of the study

No.	Manufacturer (Name, Brand)	Volume (in liters)	Power	Warranty	Photo
1	EPC- Philips Model No. HD 2139	6	Wattage: 1000 W Voltage: 220 V	2 years	
2	Induction Cooktop- Philips Model No. HD4911	-	Wattage:2100 W Voltage: 220 V	2 years	
3	Electric Kettle- Philips Model No. HD9306	1.5	Wattage:1800 W Voltage: 220 V	2 years	

Figure 3: Participants learning to cook food in EPC in Banepa, Kavre

Photo credit: WACN survey team, 2022-23

Figure 4: After cooking training in Banepa

Photo credit: WACN survey team, 2022-23

IV. Cooking diary data collection

The study used intensive cooking diaries of MECS. The cooking diary captured information like who cooks, whether fresh or reheated, cooking process, appliances used, fuel types, cooking time, number of people the food is cooked for, the energy required for cooking dishes etc., to analyse the transition to different fuel and appliances. A cooking diary data collection training was organised for the enumerators to train the participating households on data that needs to be collected. The participating households were trained to use the notepad form of the cooking diary to measure the fuel and time. A wall clock was distributed to each registered household to put in the kitchen so that they can accurately note down the cooking time and duration. The cooking diary was collected in three phases and the figure below presents the duration of the three phases. In the transition phase, participants were advised to start using eCooking devices to get themselves adapted to it. The transition phase cooking diary shows voluntary use of eCooking appliances by households. In the endline phase, participants were asked to cook 100% with electricity.

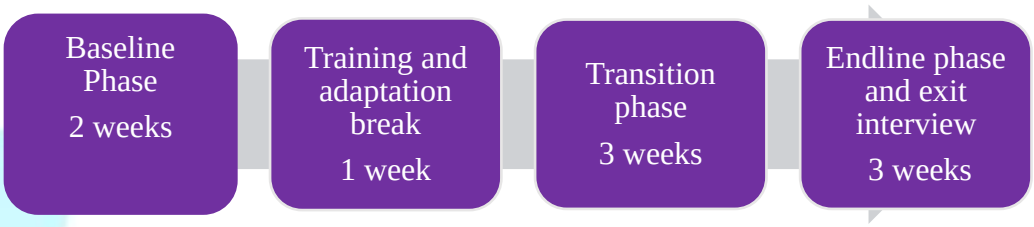


Figure 5: Cooking diary phases and duration

Figure 6: Participants learning to fill up cooking diary

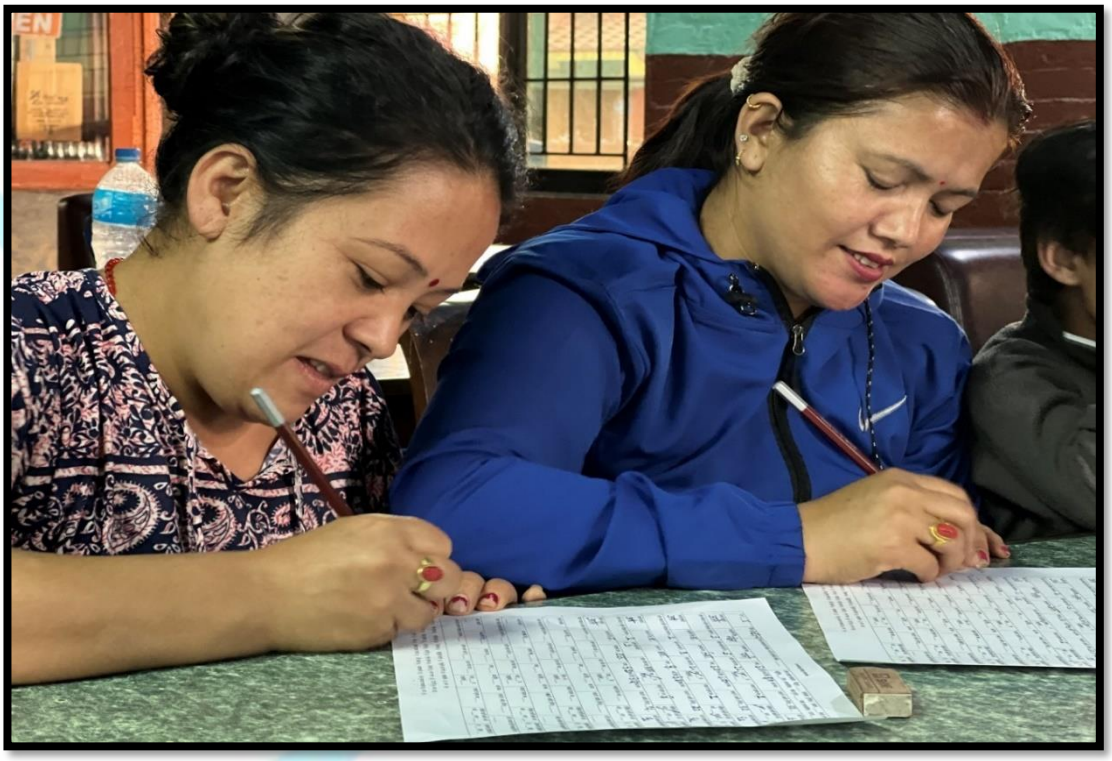


Photo credit: WACN survey team, 2022-23
Figure 7: Participants practising to fill up cooking diary

V. Exit interview

After completion of the cooking diary data collection, an exit interview was conducted in all the participant households (20) using a structured questionnaire. The exit interview was conducted to understand intervention households' cooking experience while cooking entirely with electricity, the taste of food cooked, barriers and challenges faced while cooking entirely on electricity, the change in cooking habits, appliance review, electricity supply status, and related issues to appliance safety, difficulties they encountered and measures taken to overcome these, and after sale-services.

Figure 8: Participant learning to operate Induction cooktop

Photo credit: WACN survey team, 2022-23

Figure 9: Participant using EPC to cook food
Photo credit: WACN survey team, 2022-23

3.Findings based on cooking diary and exit interviews

In this section, we present the findings from baseline, transition and endline phases obtained using the cooking diary method. The response received from exit interviews has also been reported in this section. As a starting point of the analysis, we analyse the heating events from three phases. Table 2 below shows that total of 8,761 heating events took place in 20 households over different phases, out of which only 263 were reheating events. The average heating events per household per day was nearly the same in all the three phases (Table 2).

Table 2: Total number of heating events over different phases

Cooking device type	Phases			
	Baseline	Transition	Endline	All phases
Gas Stove	2,091	1,402	423	3,916
Firewood	9	-	-	9
Rice cooker	80	5	9	94
Electric Kettle	25	461	502	988
EPC	-	795	885	1,680
Induction	-	668	1,397	2,065
Roti Maker	-	1	8	9
All stoves	**2,205**	**3,332**	**3,224**	**8,761**
Average heating events per household per day	7.9	7.9	7.7	7.8

LPG stoves were used for 95% of heating events in the baseline phase which declined to 13% by the endline phase (Fig.10)[1]. The combined percentage of eCooking appliances (electric kettles and rice cookers) in total heating events was only 5% in the baseline phase which increased to 58% (electric kettles, rice cookers, EPCs and induction cooktop) by the

[1] Firewood and Roti (flat bread) maker has been not included because there the use was for a small number of heating events.

transition phase and in the endline phase, it reached to 87%[2]. It reflects that after the introduction of EPC, electric kettle and induction cooktop in the participant's households, electricity became the primary fuel for cooking. This also indicates that throughout the study as participants get adapted to the new range of eCooking appliances they increased their usage for heating events. The transition to eCooking in this study happened over a short period of time, which also suggest that proper training and support was provided to the participants through cooking demonstration and enumerators visits.

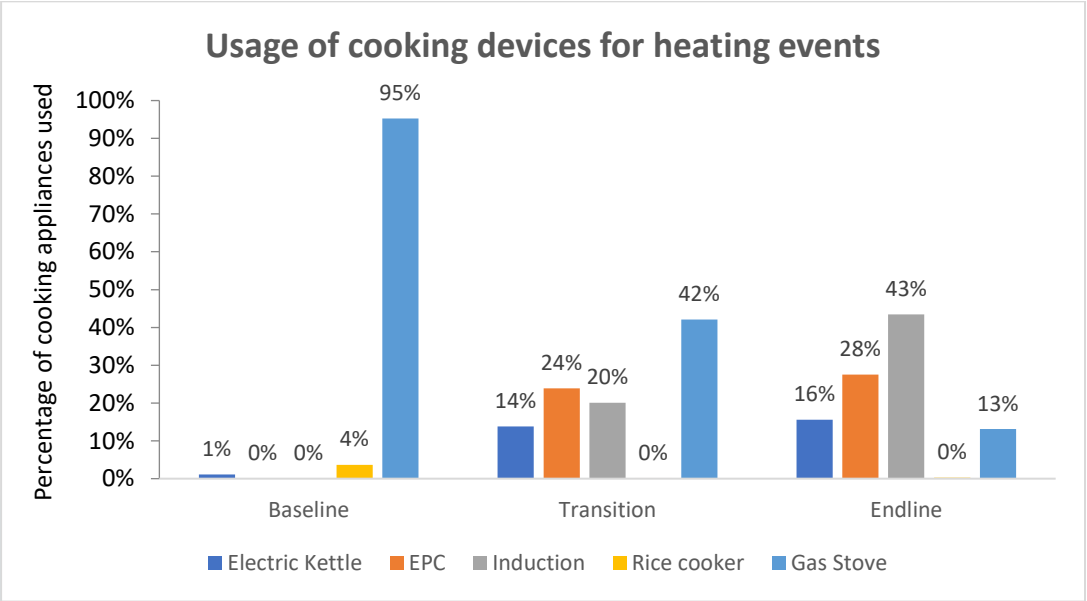


Figure 10: Distribution of heating events over different phases by type of cooking devices

To understand the timing of heating events, the study team divided a particular day's heating events into two recording periods: the morning period which consists of all the heating events from the start of the day till 12:59 pm and the evening period which consists of heating events from 1:00 pm till the end of the day. Figure 11 suggests that the total number of dishes cooked in the morning period was significantly higher than the evening period in all three phases.

[2] In the baseline phase, few participating households were using rice cooker, electric kettle and roti maker, which they had prior to the beginning of the study.

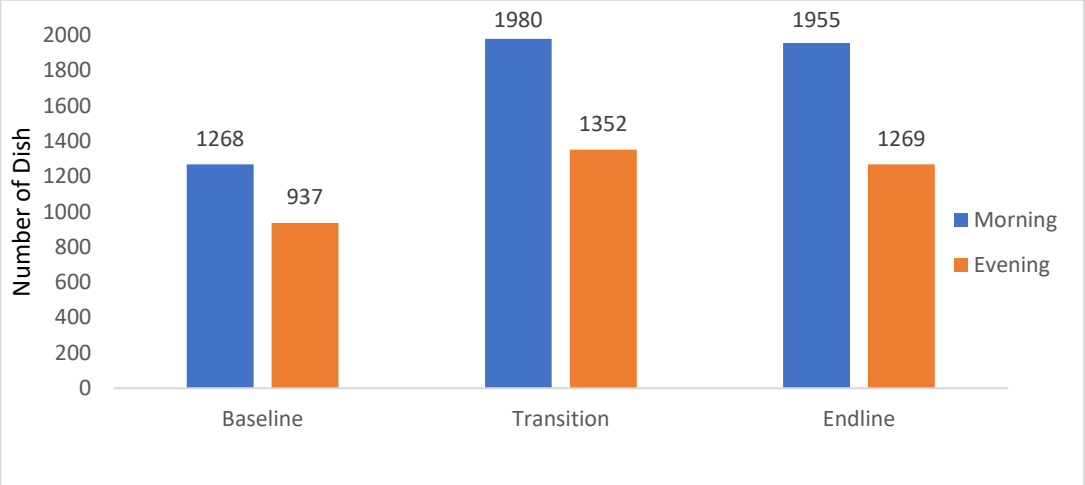


Figure 11: Total number of dishes cooked in morning and evening period

Table 3 presents the heating events done by female and male members over three phases of the cooking diary. There is no major change in gender roles for heating events, as visible from table 3. Females were the main cook carrying out 92% of heating events in the baseline phase which remained 92% even in the endline phase.

Table 3: Gender wise heating events over three phases using different cooking devices

Phases	Cooking device	Gender wise heating events count		Gender wise % heating events	
		Female	Male	Female	Male
Baseline	Gas Stove	1905	186	91%	9%
	Electric Kettle	25		100%	0%
	Firewood	9		100%	0%
	Rice cooker	80		100%	0%
Baseline Total		**2019**	**186**	**92%**	**8%**
Transition	Gas Stove	1291	111	92%	8%
	Electric Kettle	425	36	92%	8%
	EPC	770	25	97%	3%
	Induction	629	39	94%	6%
	Rice cooker	4	1	80%	20%
	Roti Maker	1		100%	0%
Transition Total		**3120**	**212**	**94%**	**6%**
Endline	Gas Stove	354	69	84%	16%
	Electric Kettle	449	53	89%	11%
	EPC	836	49	94%	6%
	Induction	1301	96	93%	7%
	Rice cooker	9		100%	0%
	Roti Maker	8		100%	0%
Endline Total		**2957**	**267**	**92%**	**8%**

3.1 Energy required to cook entirely with electricity

LPG and electricity are the two important fuels used by the household for cooking during different phases. Cooking entirely with electricity can present a transformative value proposition for households. Three cooking devices EPC, induction and electric kettle were provided to the households under the project. However, some households were already using rice cooker and electric kettle. Table 4 presents the cooking device-wise fuel consumption in three phases.

Table 4: Device wise cooking fuel consumption over different phase

Phase	Cooking device	Cooking fuel consumption		
		LPG (in Kg)	Firewood (in Kg)	Electricity (in kWh)
Baseline	Electric Kettle	-	-	9.4
	Rice cooker	-	-	25.9
	Firewood stove	-	16.0	-
	Gas Stove	75.7	-	-
Baseline Total		**75.7**	**16.0**	**35.3**
Transition	Electric Kettle	-	-	109.2
	EPC	-	-	198.9
	Induction	-	-	127.5
	Rice cooker	-	-	1.4
	Roti Maker	-	-	0.3
	Gas Stove	52.9	-	-
Transition Total		**52.9**	**-**	**437.1**
Endline	Electric Kettle	-	-	118.5
	EPC	-	-	221.3
	Induction	-	-	282.5
	Rice cooker	-	-	2.6
	Roti Maker	-	-	2.5
	Gas Stove	15.5	-	-
Endline Total		**15.5**	**-**	**627.3**

Table 5 presents the average weekly cooking fuel consumption in the baseline, transition and endline phase. To prepare table 5 we have divided the phase wise total fuel consumption data (Table 4) by 2, 3 and 3 (number of weeks in each phase) respectively for baseline, transition and endline phase.

Table 5: Average weekly cooking fuel consumption over different phases

Phases	Average weekly cooking fuel consumption over different phases		
	LPG (in Kg)	Firewood (in Kg)	Electricity (in kWh)
Baseline	37.8	8.0	17.6
Transition	17.6	-	145.7
End line	5.2	-	209.1

To bring out a clear comparison of energy required for cooking entirely with electricity we need to convert the different cooking fuels used by the households for cooking into a single unit of measurement. We converted the total fuel used in the same unit by using the specific calorific value of the fuel type. Table 5 has been used along with table 6 to calculate the average weekly energy consumption in MJ.

Table 6: Calorific values and conversion efficiencies of different fuel types

Fuel type	Calorific values
LPG	50.0 MJ/kg
Electricity	3.6MJ/kWh

Source: World Bank (BLG14 Cooking Costs by Fuel Type.xlsx) and IRADe-WACN (2022)

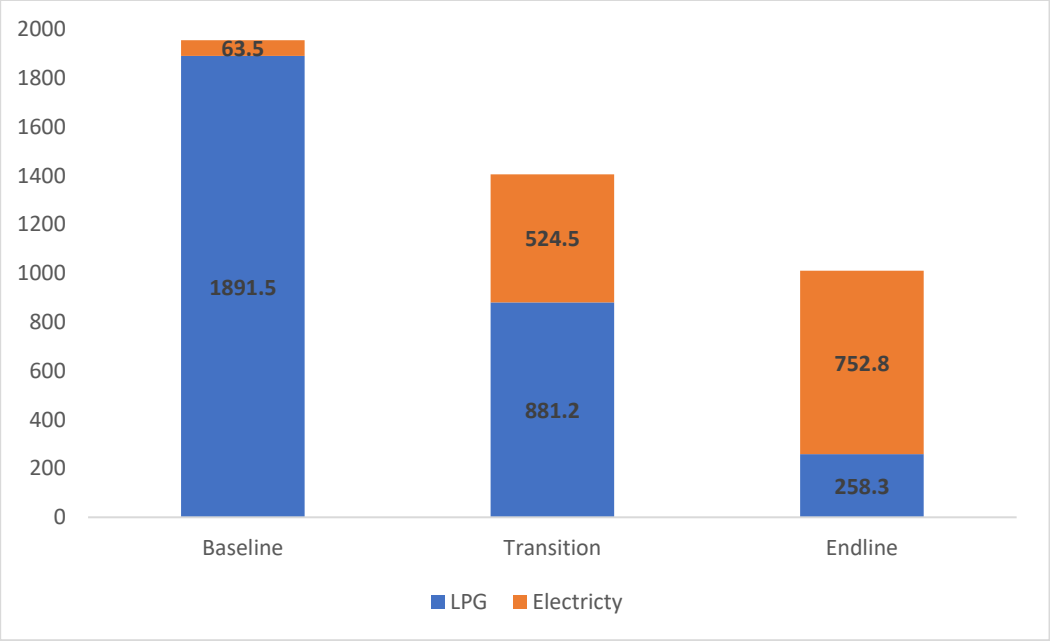


Figure 12: Average weekly cooking energy consumption in different phases (in MJ)

Figure 12 has been prepared using the average weekly consumption of LPG and electricity converted into MJ[3]. Figure 12 shows that compared to 1955 MJ (combined for LPG and electricity) cooking energy consumption in the baseline phase, in Endline phase it came down to 1011 MJ.

The cooking diary data consists of heating events carried on using LPG and electric devices. The energy efficiency of eCooking appliances varies with brand and model and the same is the case with LPG stoves. Electric cooking appliances are far more efficient (70-95% efficiency) versus gas stoves (40- 55%) [2]. Therefore, we have considered two scenarios – (i) eCooking appliances are twice as efficient as LPG and (ii) eCooking appliances are 1.5 times as efficient as LPG- to calculate the extra electricity required to replace LPG in the Endline phase. The analysis has been done for the endline phase where 20 households' average per week LPG consumption was 258.3 MJ and electricity consumption was 752.8 MJ.

[3] We have not considered firewood in our analysis as it was used in very small quantities and only by one household.

Table 7 below presents the finding of this analysis. In scenario 1, the average per month energy requirement of a household for cooking entirely on electricity will be 55.1 kWh. In scenario 2, on an average, a household requires monthly energy requirement for cooking entirely on electricity will be 52.5 kWh. Therefore, we can say that the average monthly electricity demand per Nepalese household will be 52.5-55.1 kWh to cook entirely on electricity, for a family size of 4.45.

Table 7: Scenarios of energy required by a household for cooking entirely on electricity

S.no.	Endline phase	Scenario 1 (1.5 times efficiency compared to LPG stoves)	Scenario 2 (2 times efficiency compared to LPG stoves)
i.	Average electricity consumption per week for 20 households (**in MJ**)	752.8	752.8
ii.	Average weekly LPG consumption per for 20 households (**in MJ**)	258.3	258.3
iii.	Electrical energy (**in MJ**) equivalent of LPG consumption. (**ii/1.5 and ii/2**)	172.2	129.2
iv.	Average per week energy (**in MJ**) required to cook entirely on electricity for 20 households. **(i+iii)**	925.0	882.0
v.	Average electrical energy (**in MJ**) required per week per household (**in MJ**). **(iv/20)**	46.3	44.1
vi.	Average electrical energy (**in MJ**) required per month (30 days) per household. **(v/7) *30**	198.2	189.0
vii.	Average electricity (**in kWh**) required per month per household. **(vi/3.6)**	55.1	52.5
viii.	Average electricity (**in kWh**) required per capita for cooking. **(Participants' average household size is 4.45) (vii/4.45)**	12.38	11.80

3.2 Traditional energy saving by transitioning to cooking entirely with electricity

Cooking entirely with electricity will save traditional cooking fuel like LPG. In this sub-section, we analyse the net saving of LPG energy due to the complete transition to electricity for cooking. Figure 12 above indicates that in the baseline phase average per household weekly energy consumption from LPG was 94.5 MJ (1891.5/20) and from the electricity, it was 3.2 MJ (63.5 MJ/20). When households were provided with electric

cooking devices, they switched their cooking tasks from traditional (LPG stoves) to electric devices.

In scenario 1 (Table 7), average weekly energy consumption per household will be 46.3 MJ for cooking entirely with electricity. An average weekly increase of 43.1 MJ energy per household from electricity in the endline phase, will save average weekly 94.5 MJ energy from LPG, consumed in the baseline phase. The net weekly saving of energy per household in scenario 1 will be 51.4 MJ from LPG. Similarly, in scenario 2 (Table 7), the net weekly saving of LPG energy per household will be 53.6 MJ. Figure 13 presents the quantity of average weekly, monthly and yearly saving of LPG, by cooking entirely with electricity, and its calorific value (MJ).

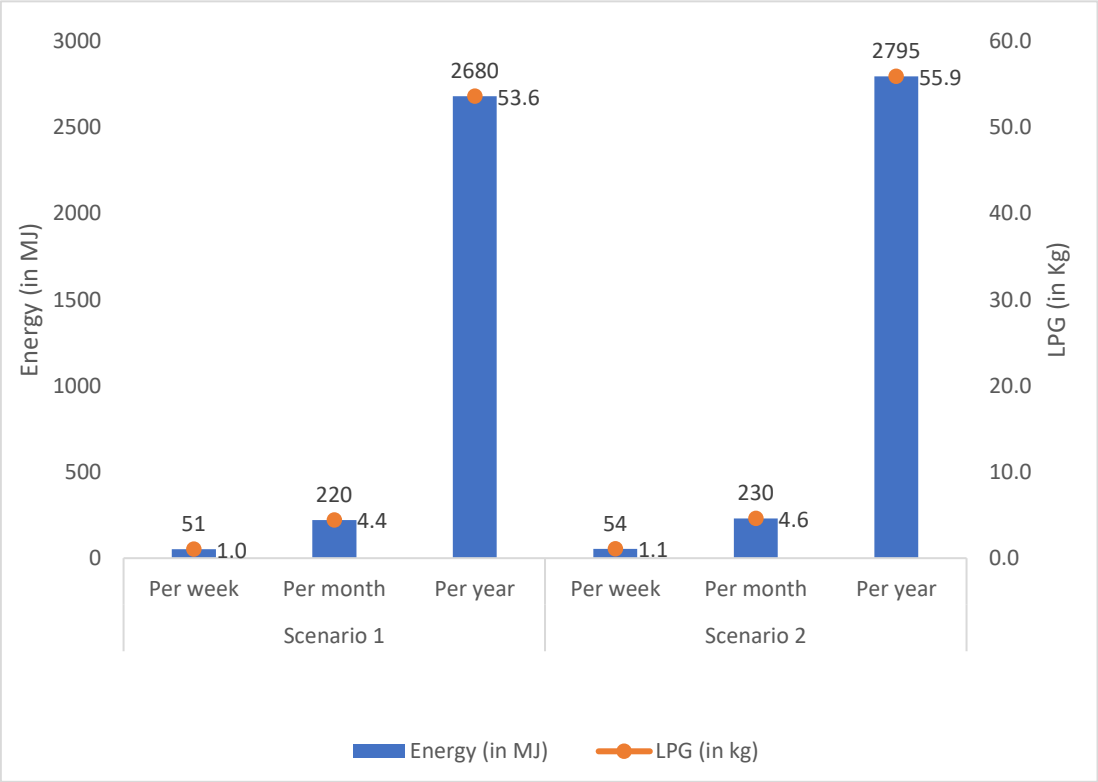


Figure 13: Energy saving from traditional fuel (LPG) in MJ and kg by full transition to eCooking

3.3 Cost implications of transitioning to cooking entirely with electricity

We have assessed the energy consumption of available LPG stoves and electric cooking appliances for cooking regular Nepalese dishes. The monthly changes in the cost of transitioning to cooking entirely with electricity for the households are primarily accounted

by two factors viz. relative fuel cost and energy efficiency. The initial capital cost of procurement of appliances also adds to the overall cost of transition for the households but this has not been analysed here. The analysis here has been restricted to the running fuel cost of cooking devices. There were visible changes observed in cooking energy consumption by the household in the different phases of the cooking diary data collection. In the baseline phase, the average weekly consumption of LPG per household was 1.9 Kg, which declined to 0.9 Kg in the transition and further to 0.3 Kg in the endline phase. Whereas the average weekly electricity consumption for eCooking increased from 0.9 kWh to 10.5 kWh from baseline to the endline phase; LPG was substituted with electricity for cooking.

The average cost of electricity is around NPR 10.0/kWh (USD 0.076). In Nepal, the price of a 14.2 Kg LPG cylinder is NPR 1800 (USD 13.65) and per kg LPG price is nearly NPR 126.76. At prevailing prices of LPG and electricity, we have calculated the average monthly per household cost of cooking for baseline and for two scenarios of cooking entirely with electricity, using table 7. Figure 14 presents the average monthly per household cost of cooking. It is evident from fig.14 that cooking entirely with electricity using efficient devices will save nearly 50% fuel costs.

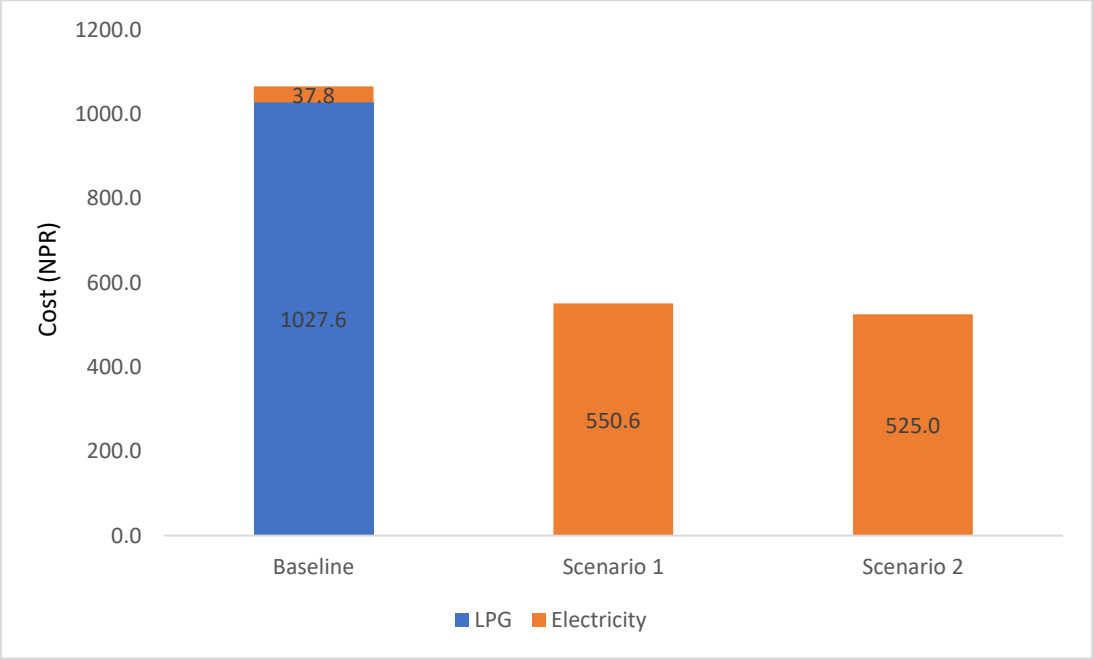


Figure 14: Average monthly per household cost of cooking (in NPR)

3.4 Energy and time required to cook individual dishes using a range of electric cooking devices

The amount of electricity required for cooking a dish by a cooking device depends on several factors such as the efficiency of heat transfer into the pot/food and heat transfer out of the pot, control of the cooking process, cooking practices, etc. In EPC, insulation and pressurization are integrated into the appliance itself. In this study, we recorded dish-wise electricity usage by 20 households cooking using EPC and induction. Based on the endline cooking diary data, figure 15 presents the average electricity (kWh) required to cook 9 typical Nepali freshly cooked dishes using EPC and induction and figure 16 presents the per capita electricity consumed (in Watt) to cook these dishes.

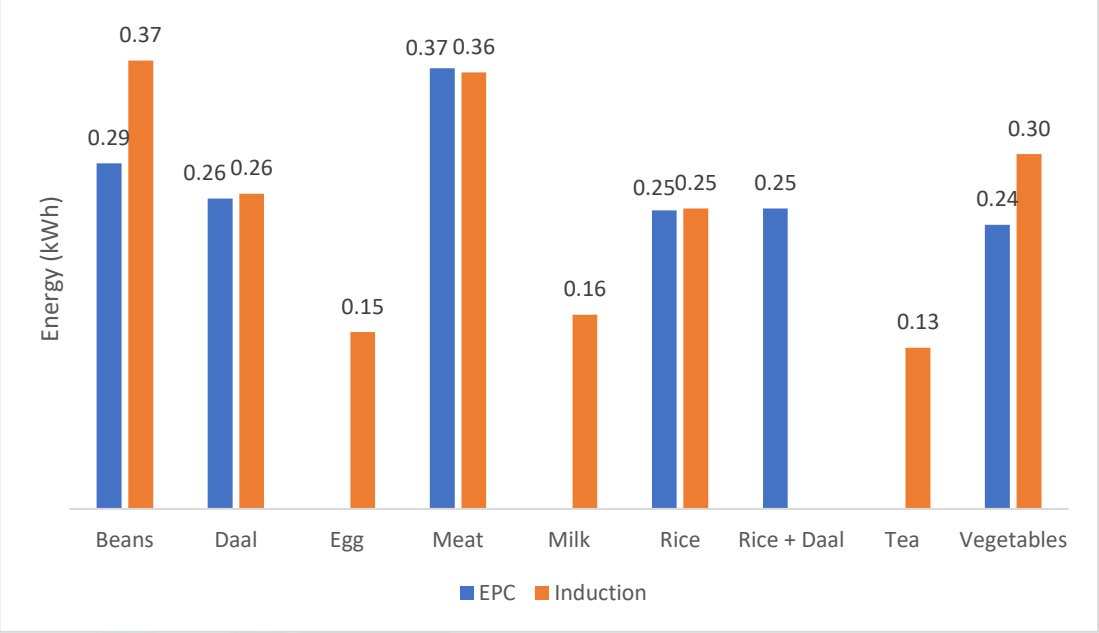


Figure 15: Average electricity required (in kWh) to prepare fresh dishes in endline phase

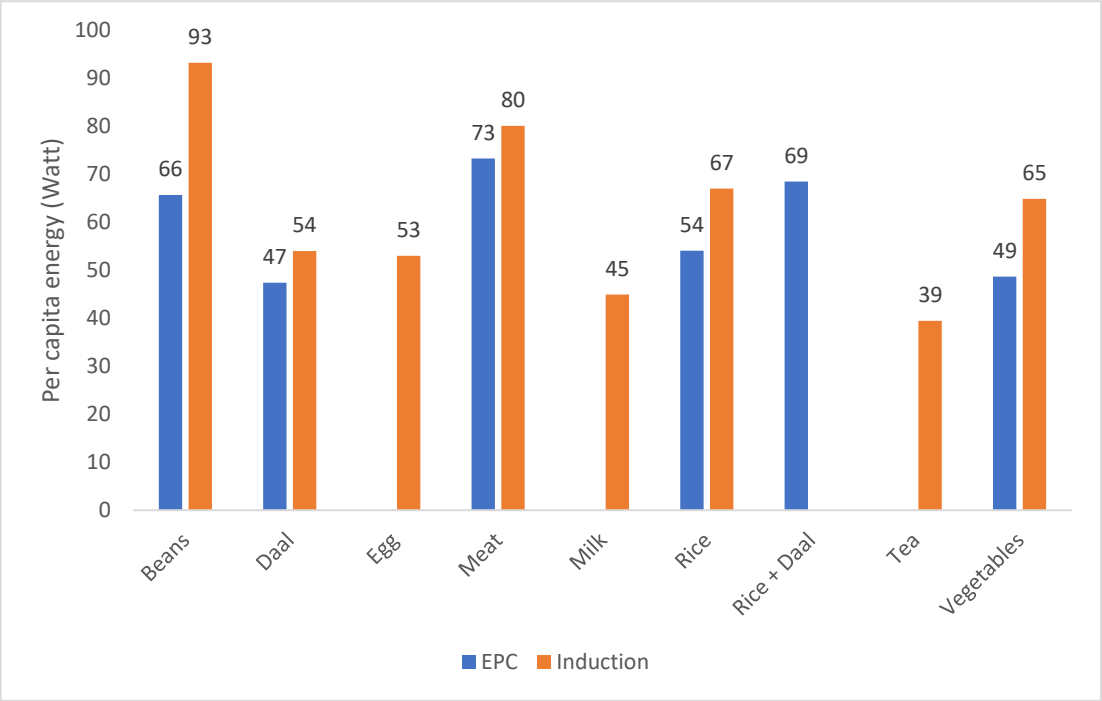
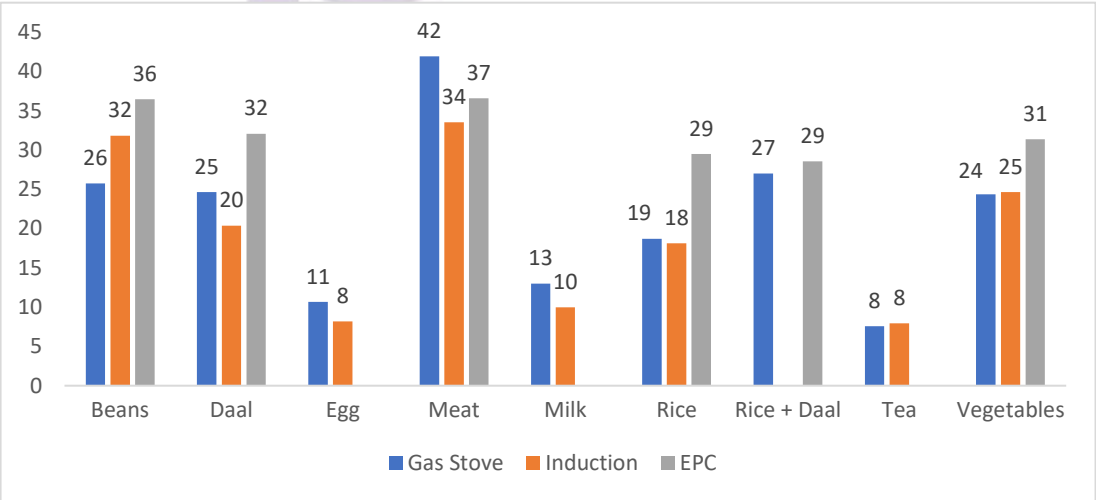


Figure 16: Average per capita electricity consumed (in watt) to prepare fresh dishes in endline phase

Figure 16 suggests that when we consider the per capita average energy consumption for a particular freshly cooked dish, then EPC turns out to be the more efficient cooking device compared to induction cooktop. Figure 16 also suggests that cooking rice and daal together (using separator) in EPC is more efficient than cooking both of the dishes separately in either of the devices.

Figure 17 provides the average cooking time for nine freshly cooked dishes. We have combined the cooking diary data for Transition and Endline Phase to arrive at the average



cooking time for these dishes. According to fig. 17, the cooking time period for EPC was higher than LPG stove and induction in almost all dishes except meat.

Figure 17: Average cooking time for freshly cooked dishes using different cooking stove/appliance

3.5 Preferred dish to cook using different electric devices

The selection of a cooking appliance to cook a particular food by a household depends on several factors like availability of appliance, suitability of appliance for the particular food, convenience in cooking etc. Different cooking methods are suited to different kinds of foods and it also affects the decision of appliance selection.

Table 8: Electric device wise proportion of dishes heated in the endline

Dishes	Total heating events	EPC		Induction		Electric Kettle		Rice cooker	
		Count	%	Count	%	Count	%	Count	%
Vegetables	662	48	7%	417	63%	0	0%	0	0%
Rice	595	555	93%	11	2%	0	0%	9	2%
Tea	549	0	0%	480	87%	0	0%	0	0%
Water	509	0	0%	6	1%	509	98%	0	0%
Milk	258	0	0%	237	92%	0	0%	0	0%
Daal (Pulses)	253	153	60%	76	30%	0	0%	0	0%
Rice+Pulses	95	94	99%	0	0%	0	0%	0	0%
Egg	55	0	0%	36	65%	0	0%	0	0%
Noodles	37	0	0%	32	86%	0	0%	0	0%
Khaja (Snacks)	26	2	8%	14	54%	0	0%	0	0%
Meat	26	3	12%	18	69%	0	0%	0	0%
Beans	23	8	35%	14	61%	0	0%	0	0%
Pickle	20	0	0%	12	60%	0	0%	0	0%
Flat bread	20	0	0%	3	15%	0	0%	0	0%
Dhido	12	1	8%	4	33%	0	0%	0	0%

Table 8 above presents heating records of 15 major dishes in the endline phase and the number of heating events that took using electric devices. The heating records of these 15 dishes constitute more than 97% of the total heating records in the endline phase. Vegetables, rice, tea, water, boiling milk, and daal (pulses) together constitute more than 87% of heating events. In the baseline phase, gas stove was commonly available cooking

stove. Table 8 also reports the percentage of each dish heated using electric devices in the endline phase. Electric devices were used in 70% of events to cook vegetables and induction alone was used in 63% of cases. EPC was the obvious choice for cooking rice. The induction stove share was 87% for preparing tea. An electric kettle was user's best choice for boiling water. The induction cooktop shares in boiling milk was 92%. EPC was used in 60% of events of cooking daal (pulses) and 99% for cooking rice and pulses together, in a single cooking event (using a separator for cooking them together). The program team had demonstrated that this can be done if they had to cook for small number of people say 2 or 3. However, it was completely participant's choice to do so. Please see table 8 for details of the percentage of cooking that took place using the electric device in the endline. Nine participants' household had rice cookers. However, interaction with participants revealed that rice cooked in EPC is more tender and tastier compared to rice cooked in a rice cooker or LPG stove.

3.6 User experience of cooking entirely with electricity

In the exit interview, all of the participants of this study expressed their satisfaction with eCooking devices distributed under this study. 100% of the participants said that eCooking has reduced their cooking costs. Nearly 75% of the respondents were of the opinion that learning to operate EPC, induction and electric kettle was very easy (Figure 18).

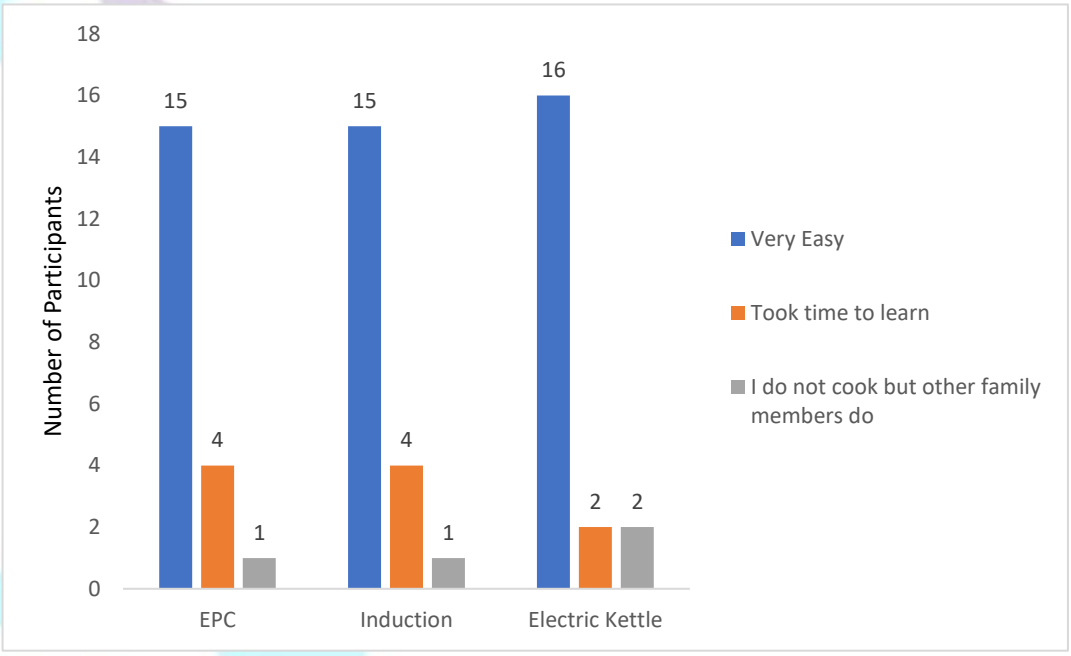


Figure 18: Response of participants regarding the ease of operating eCooking devices

Exit survey findings suggest that people experienced a change in their method of food preparation. The users found that cooking with EPC took less supervision and monitoring than cooking on gas. They found that the taste of rice cooked in an EPC was much tender and tastier than that prepared in a pressure cooker using LPG stove. Among the three appliances provided, participants found EPC to be fairly simple and user-friendly. The training made it easier for the users to use these devices. The users had also experienced EPC functioning as a hot case which keeps the meals warm for a long time. People preferred EPC to prepare multiple meals, such as rice, pulses, vegetables, and rice and pulses together using separate utensils as a separator. Additionally, 10% of the users realized that the EPC made no noise during cooking, indicating this appliance was noise free. Overall, the experience of using EPC was quite positive.

In the exit survey, 25% of the participants said that an induction cooktop took less time to prepare meals than cooking on LPG stove. 15% of the surveyed participants stated that induction cooktop consumed more electricity than EPC. Some participants (20%) reported learning to cook on induction required a longer duration of time.

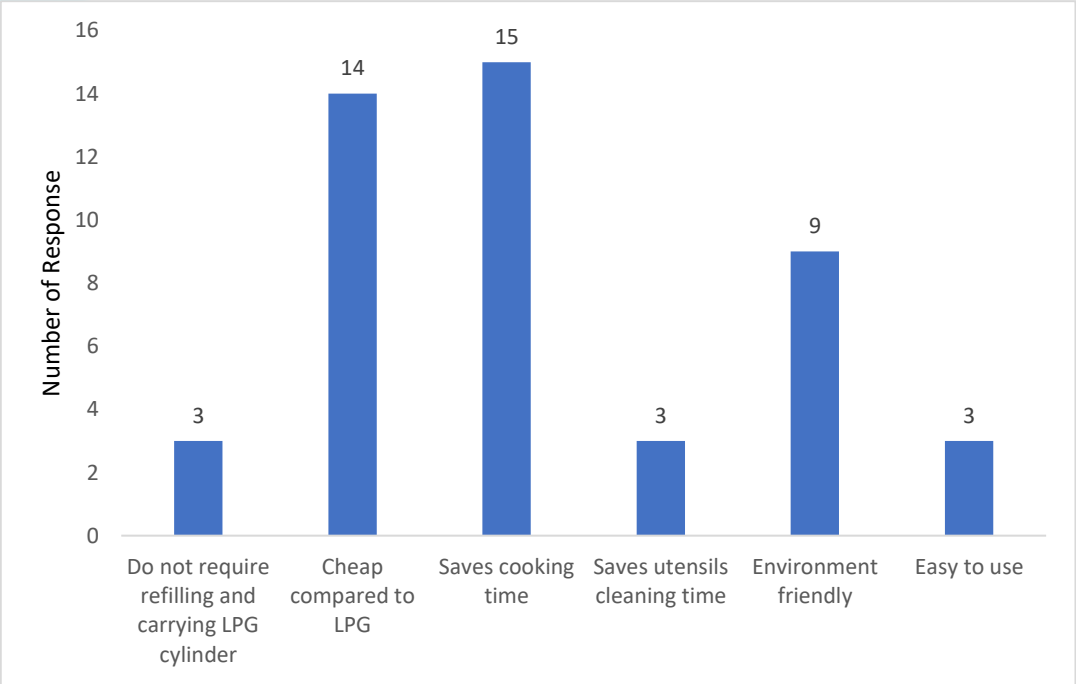


Figure 19: Participants opinion for benefits of eCooking

Figure 19 presents the participants' view regarding the benefits of eCooking, during the exit interview. 70% of the participants feel that eCooking is cheaper than cooking on LPG

stove; 75% of participants believed eCooking saved cooking time; 45% of participants understand that eCooking devices are environment friendly.

Users did not experience any safety concerns, such as electrocution or other minor injuries, when using them. The users of these appliances have benefited immensely since using these appliances has given them more free time, which has enabled them to perform other household chores, engage in kitchen gardening and farming activities.

3.7 Barriers preventing people from cooking entirely with electricity

The absence of a reliable electricity supply and power outages were seen as the major obstacles preventing people from exclusively switching to electricity for cooking. 75% of the users reported that the electricity had gone for 1-2 times a week for a minimum of 15 minutes. The power outage reportedly had an impact on the cooking process for 55% of the users.

Low voltage was also highlighted as a concern that has hindered the users to cook entirely with electricity as this has increased their time and labour of cooking. Some users reported that cooking rice in an EPC at low voltage results in hard, insipid rice. Thus, improving the electricity supply is one of the steps that will improve users' transition to full e-cooking. Another substantial difficulty reported was the lack of technical knowledge on the use of electric appliances. 5% of the participants held the opinion that although someone who has received training can easily operate these devices, other family members and new guests who are not accustomed performing technical functions may not be able to handle it conveniently. They will require assistance in doing so.

Another significant issue that has prevented people from accepting these devices was taste concerns. Few users were found to have ambivalent views on it. Many of the users' family members believed that the food cooked on these devices would taste unpleasant and that their families would not enjoy it. A few perceptual difficulties were also noted during this study regarding the size of eCooking appliances. Some users, particularly those who were single or with a small family size were reluctant to use EPC since they needed less cooking and believed it will consume more electricity. Likewise, another barrier was the perception of electronic equipment as being less reliable, requiring more frequent repairs, and possibility of breaking down at some point.

3.8 Difficulties when cooking entirely with electricity and how to overcome

The electrical outage was considered the major difficulty for people when cooking with electricity, necessitating the need for fuel stacking. Overloading, transformer explosions and grid power loss during repairs were the reported causes of power outages. 55% of the users found it difficult to cook their meals in such a situation. Most of the time, electricity comes within a few minutes, so the users waited until then, but occasionally they used LPG as a backup for cooking in such a situation. Even though LPG was expensive and challenging for households to transport and refill, stacking of LPG with eCooking devices continued for cooking mainly during power outages. However, 35% participants detested using LPG because they felt total time- for cooking and cleaning utensils combined were high compared to eCooking devices. Another issue that led customers to utilize gas for cooking was the lack of induction-compatible cookware. 25% of consumers reported lack of inner pots and separators as a difficulty when preparing various meals using EPC. Different bowls have been used as separators to cook more than one dish in one go in EPC. Cooking meals in large quantities and simultaneously cooking several dishes was seen as another difficulty for 5% of the users. With the combined use of LPG stoves and eCooking appliances, they were able to solve the need for multiple cooking of dishes simultaneously.

4. Conclusion

Achieving sustainable cooking is one of the great challenges. Given the huge potential (tapped\untapped) for hydroelectricity production e-cooking could be a choice for Nepal. To this aspect, the report is an attempt to understand the energy implications at the household level of cooking entirely with electricity in Nepal. The study has explored the multiple aspects of e-cooking such as the required electricity, savings of traditional cooking energy, the cost implication of transition, etc. Further, it has also nuanced the energy required and preferred electric appliances to cook different regularly cooked Nepalese dishes. In the end, user feedback was collected to understand their real-life experience, the barrier to transitioning to e-cooking, and the difficulties faced by them while e-cooking ways to overcome those difficulties through personal interviews.

Cooking is not the only household activity that requires electricity. However, understanding the electricity requirements for e-cooking at the household level is important for making it a viable clean energy option for cooking. The study estimates that the average monthly electricity requirement by an urban Nepalese household to cook entirely with electricity ranges between 52.5 kWh to 55.1 kWh.

It was found that eCooking will replace/reduce the usage of traditional cooking fuels like LPG and biomass. eCooking appliances also have higher energy efficiency than traditional fuel stoves. Hence, improvements in energy efficiency would reduce the total amount of energy required to cook a dish. In the absence of a well-established benchmark for the comparative energy efficiency value of e-cooking appliances to traditional cooking appliances, two scenarios were analysed by considering energy efficiency gain of 1.5 times and 2 times for e-cooking appliances over traditional fuel stoves. Net weekly saving of traditional fuel in scenario 1 was estimated to be 51.4 MJ of LPG per household. Similarly, in scenario 2, it was estimated to be 53.6 MJ per household.

We calculated the cost of cooking Nepalese dishes with electricity using a range of cooking appliances (EPC, Induction, and Electric Kettle) and an LPG stove to have a snapshot of their relative cost competitiveness. As can be seen, the costs of cooking with electricity are now well within the range of cost competitiveness of other available and widely prevalent cooking clean cooking alternatives LPG stoves.

A new generation of highly efficient e-cooking appliances is now available that can drastically lower costs by reducing the amount of electricity required to cook. To this aspect, this study examined the electricity required to cook individual dishes, and household preference for the e-cooking appliance to cook a particular dish is of interest for understanding the suitability of e-cooking appliances to the local dishes. Induction is the preferred e-cooking appliance used by households for the cooking majority of dishes. EPC is the preferred e-cooking appliance for staple dishes (rice and daal). An electric kettle is an obvious choice for water boiling.

Exit interview found that induction is the more versatile e-cooking appliance used more frequently for cooking dishes by households than EPC. Cooking with EPC requires less supervision and user friendly. Households were satisfied with the overall performance of e-cooking appliances. They feel that e-cooking appliance stacking is required to meet cooking needs. Cooking with a single e-cooking appliance is time-consuming and may not fit the needs of the majority of households. Capacity, availability, reliability, and quality of electricity supply are the major impediments to cooking entirely with electricity in Nepalese households.

Today, electricity has become the primary energy source for lighting, cooling, and many other household energy needs. People are familiar and comfortable with the use of different electrical appliances, and it would not take much effort and time to motivate them to shift to electric cooking if major barriers to adoption are addressed. However, improving electricity supply remains an area of concern for households to fully switch to eCooking.

REFERENCES

1.Coley, W., Eales, A., Batchelor, S., Leary, J., & Galloway, S. (2021). Global Market Assessment for Electric Cooking *https://mecs.org.uk/wp-content/uploads/2021/07/Global-Market-Assessment-for-Electric-Cooking.pdf*

2.Tallier, B. M., Troncoso, K., Sieff, R. (2022). Nepal eCooking Market Assessment *https://mecs.org.uk/wp-content/uploads/2022/02/MECS-EnDev-Nepal-eCooking-Market-Assessment.pdf*

3.Duty cuts expected to boost sales of Home Appliances. The Kathmandu Post. The Kathmandu Post. Retrieved from https://kathmandupost.com/money/2021/06/03/duty-cuts-expected-to-boost-sales-of-home-appliances

4.Testing electric cooker adoption in socio-economic and cultural context of Nepal *https://mecs.org.uk/wp-content/uploads/2022/04/Testing-electric-pressure-cooker-adoption-in-socio-economic-and-cultural-context-of-Nepal.pdf*

5.Understanding the Suitability of Electric Pressure Cookers in Nepali Households *https://mecs.org.uk/wp-content/uploads/2022/02/Understanding-the-Suitability-of-Electric-Pressure-Cookers-in-Nepali-Households.pdf*

6.Leary, J., Leach, M., Batchelor, S., Scott, N., & Brown, E. (2021). Battery-supported eCooking: A transformative opportunity for 2.6 billion people who still cook with biomass. Energy Policy, 159, 112619. *https://doi.org/10.1016/j.enpol.2021.112619*