Cooking Diaries Study Performed in the Rural Areas of Hai District, Kilimanjaro Region Tanzania

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TaTEDO

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3 Executive Summary

The use of biomass fuels for cooking is the daily pattern for 90 percent of the population in Tanzania. This pervasive use of biomass fuels including wood, coal, straw, dung and traditional cookstoves has resulted into high levels of household air pollution, extensive daily drudgery required to collect fuels, and serious health impacts.

According to an eCook study performed by TaTEDO, GAMOS, University of Surrey and, Loughborough University in 2018, it was noted that cooking with electricity is now competitive or even cheaper than cooking with LPG, kerosene, or charcoal in urban, peri-urban and rural settings (Batchelor et al. 2018). TaTEDO and the University of Loughborough through MECS programme have perpetuated the concept of eCook by doing this cooking diary study in Kilimanjaro Region.

The objective of the cooking dairy study is to assess the existing cooking practices and find out means of rapidly accelerating the transition to more efficient and clean cooking by proposing the scenario for introducing and scaling up modern cooking services. The cooking diary study seeks to firstly record exactly what people in households cook and when and how cooking is normally done in households and ask them to undertake the transition to new practices of cooking with electricity for the remaining duration of the study.

The area selected for the cooking diary study was the rural areas of Hai District in Kilimanjaro Region, Tanzania, populated by those belonging to the Chagga tribe. Modern energy cooking services are new to the Kilimanjaro Region.

The study was split into two phases. The first phase was the baseline survey phase, which commenced with the initial workshop. The first phase focused on existing traditional cooking practices. This was followed by a transition workshop which started the second phase led to cooking with electricity by using Electric Pressure Cookers (EPCs) – participants were asked to cook as much as possible on the EPCs. After eight days of cooking using EPCs, the third session of the participant workshop was followed by an exit survey which was conducted to get participants' views on how to use the appliances and how the new practices of cooking will impact their lives.

The comparative analysis was done for both phase 1 and phase 2 of the cooking diary survey to assess energy consumption by households. Energy carriers (fuels) used in rural areas of Hai District of Kilimanjaro Region by households are charcoal, firewood, LPG, maize cobs and wood sawmill wastes. Firewood is the main fuel for cooking used by more than 62% of all households in the study area. The LPG is the new fuel for cooking used by almost 15% of households. This is followed by maize cobs and sawmills wastes which are used by almost 14% of households. Charcoal is only used by 9% of households in the study area. The use of electricity is an expensive expenditure for these households and some of those households have practised cooking by electricity but for them was impossible and unaffordable. The introduction of EPCs in households of rural areas of Hai District, Kilimanjaro shifted a large number of households to the use of electricity (92%). There were some households used firewood (4%), LPG (1%) and other fuels (bio-wastes)(3%) due to foods that could not be cooked in the EPC. Households enjoyed the fastness, easiness, affordability and safety of EPCs during phase 2. EPCs were used to prepare many foods but not those that required frying (e.g. eggs, chapati and maandazi).

The type of foods cooked were categorised into breakfast, lunch or dinner. Foods for breakfast in rural areas of Hai District, Kilimanjaro are loaves of bread, dough, porridge, sweet potatoes, and roasted banana/dessert. Other foods were milk, tea, coffee and cocoa are also used for breakfast. The staple food is banana but also other foodstuff cooked for lunch and dinner are pasta, rice, sweet potatoes, beef, chicken, ugali, beans, makande, mtori, pilau, meat, and vegetables. Other foods which are rarely cooked are ngararimu, kyuumbwe, nyan, mlaso, kichanganya, vipere, vikwa and viyee. Some of the breakfast foods types such as bread and dough are not cooked in households but bought as bites from nearby vendors. All these foodstuffs were cooked in all phases but participants felt palatability and increased taste for rice and banana cooked in EPCs during phase 2. All hard and simple foodstuffs were

easily cooked in phase 2 due to appliances that simplified work and lessened time for cooking. The frequency of cooking some foods increased in phase 2.

The cooking appliances used to cook foods by households were also assessed by the study. This shows that more than 45% of foods were cooked with firewood stoves. The firewood stoves were used in both phases 1 and 2 but two fuels (firewood and bio-wastes) were used in this stove. The firewood stoves in phase 2 were used for heating water for bathing and milking.

The study also assessed other equipment used in the kitchen for cooking. The assessed equipment were cooking pots by their sizes, frying pans and lids for covering pots. Uses of these equipment have effects on the energy consumption in households whenever a user is cooking. About 67% of food is cooked in medium size pots. Light foods like tea, milk, baby foods, etc are cooked by using small pots. The large pots and medium pots are used for boiling water for bathing, milking, etc.

There are different methods used for cooking foods by households in rural areas of Hai District in the Kilimanjaro Region. The assessment shows that boiling is by far the most common cooking method during phase 1. This was outweighed by pressure cooking in phase 2 when the EPC was introduced in those households.

An important question that requires an answer is what compels the prevalence of multiple fuels used by households. During phase 1 of the study, fuels that were frequently used in the selected households were firewood, charcoal, bio-wastes and LPG. The frequency of stacking bio-wastes, firewood, charcoal and LPG was 28%. The frequency of using firewood, charcoal and LPG was 16% while firewood/charcoal and bio-wastes was 20%. The frequency of using single fuel was observed for firewood and charcoal which is 35.5%. None of the households used LPG and Bio-wastes as the only fuels for cooking. These fuels are stacked with firewood or charcoal. The reason for fuel stacking is to find combination fuels that are affordable by the households and at the same time save time for other business and productive activities.

The behaviour of fuel stacking by households in phase 2 was tremendously reduced by introducing EPC in households because households were asked to use them as much as possible, and they were able to transition most of their cooking. During phase 2, the energy carriers which were frequently used with electricity were biomass (firewood, charcoal) and LPG. A frequency of 17% was observed for biomass and electricity while the rate for fuel stacking for LPG and electricity was 7%. There was no fuel staking between biomass and LPG.

The average energy used for cooking per day in households in phase 1 was 0.44Kg for multiple fuels which is equivalent to 17.55MJ while the average energy use in phase 2 tumbled down to 1.74 kWh which is equivalent to 6.26 MJ. There was a significant saving of energy compared to the use of charcoal, firewood and LPG.

The time taken to cook different food types using Charcoal, Firewood and LPG in Phase 1 (Existing Cooking Practices) were compared to times used during electric cooking by using EPCs. Makande and beans are heavy common foods that have been used long times during existing cooking practices, followed by Chapati. The times for other foods were less than one hour. The use of EPC has reduced cooking times for all foods to less than an hour. Despite the differences between each household, there are significant shifts of times of starting to cook for all meals (breakfasts, lunches and dinners). This is attributed to assurances of putting food on the table in a short time due to the reduced times caused by cooking with EPCs.

Water heating is most of the time not considered as an event that uses much energy although most of the participants cannot complete a day without heating water for different purposes such as drinking, tea, bathing (babies and family members), washing, etc. Most of the heating events are occurring during breakfast due to the boiling of tea, milk, coffee, etc. This is followed by heating water during dinner and water for bathing before they go to the bed to sleep.

During the exit survey, all participants accepted that with the use of EPC it is possible to cook by using electricity and that electric cooking is now affordable. This is 100% acceptance from all participants. The only challenge is the initial costs of buying the EPC. All participants also accepted that cooking with the EPC is safer than cooking with firewood, charcoal and LPG stoves. Almost 68% of responses from participants showed that it is not difficult to learn cooking by EPC. All participants accepted that they would buy EPC if they saw one in the shop or supermarket. The reason is its ability for saving electricity and household cooking energy budgets.

During the evaluation of the cooking diary survey, participants said they started with doubt on whether they could be able to use electricity to cook in their households. However, at the end of phase 2, all participants were enthusiastic to continue with cooking with electricity using EPCs.

The cooking diaries study in the rural areas of Hai District in Kilimanjaro Region, Tanzania has shown that cooking with electricity is well-matched with Tanzanian cuisine and that modern energy-efficient appliances by using EPCs are highly advantageous to cooking practices in households. In particular, the EPC was observed to be the future alternative to current cooking appliances in households.

4 Abbreviations

AC	Alternating Current
DFID	Department of Foreign and International Development
ICS	Improved Cook Stoves
IRENA	International Renewable Energy Agency
LBNL	Lawrence Berkeley National Laboratory
LPG	Liquefied Petroleum Gas
ME	Ministry of Energy
MECS	Modern Energy Cooking Services
MFIs	Micro-Financial Institutions
PV	Photo Voltaic
REA	Rural Energy Agency
SDGs	Sustainable Development Goals
SE4ALL	Sustainable Energy for All
SPPA	Small Power Purchase Agreements
TANESCO	Tanzania Electric Supply Company
TaTEDO	Centre for Sustainable Energy Services
UKAID	United Kingdom Agency for International Development
WHO	World Health Organization

5 Introduction

5.1 Country Energy Overview

The United Republic of Tanzania in Eastern Africa has a total area of 945,087 km2. The country has a tropical type of climate which is divided into four main climatic zones notably: the hot humid coastal plain; the semi-arid zone of the central plateau; the high-moist lake regions and the temperate highland areas. The Government of Tanzania is composed of 26 administrative regions, 98 districts, 114 councils and 12,317 villages. Almost about two-fifths of the country's population is engaged in agricultural production. The major food crops are corn (maize), rice, sorghum, millet, bananas, cassava (manioc), sweet potatoes, barley, potatoes, and wheat (NBS and OCGS 2021).

The population of Tanzania based on interpolation of United Nations data stands at 63.46 million inhabitants in the year 2022. According to the Energy Access and Use Situation Report (2020) 78.4% of the population have access to electricity overall (69.8% in rural areas). However, only 37.7% of households are connected to electricity and there is a large disparity in connectivity between urban areas, with 73.2% connected to electricity compared to rural areas where only 24.5% of households are connected (NBS and REA 2020). There are also large differences with the distribution of access to electricity across regions in Tanzania. The population of Dar es Salaam all have access to electricity (100%), and other regions such as Kilimanjaro (93.6%), Mwanza (89.9%), Mbeya (89.0%), Mara (87.7%), Coast (85.8%), and Geita (84.4%) have a high percentage of the population connected to electricity (NBS and REA 2020).

Rural Areas of Hai District, Kilimanjaro Region

Tanzania has a variety of potential energy resources, such as biomass fuels, hydropower, natural gas, coal, uranium, wind, geothermal and solar which are yet to be fully exploited. The total primary energy use pattern is dominated by biomass fuel and has almost doubled in the last decade. Cooking energy data shows that 63.5% of households in Tanzania are using firewood as the main source of energy for cooking, followed by charcoal (26.2%), Liquefied Petroleum Gas (5.1%) and electricity (3%) (NBS and REA 2020). About 76.6% are mainly using electricity for lighting (ibid).

The Energy Access and Use Situation Report (2020) stipulates that 26 million m3 of firewood is consumed in rural areas, and of this, 24 million m3 is used for household cooking and 2.03 million m3 for rural small and medium-sized enterprises (ibid). 14.4 million m3 is used as charcoal, mainly in urban areas (ibid). In 2012, the majority of biomass was used in households (90%), and only 4% of the biomass consumed across Tanzania was sustainable (Ministry of Energy and Minerals 2015b). The high proportion of household energy consumption is explained by the use of inefficient stoves for cooking with firewood and charcoal. The remaining (10%) is used by home-based enterprises and commercial, institutional and industrial sectors. The government is struggling with added pressure on energy consumption as the country's economy diversifies and shifts away from agriculture, making the low access rate and other supply limitations obstacles to economic growth (IRENA 2017).

The Renewables Readiness Assessment for Tanzania, published by IRENA in 2017 elaborates on the development of the electricity sector in Tanzania (IRENA 2017):

Electricity is mainly generated from hydropower, oil and natural gas. Costly oil products account for around one-fifth of power generation and are mainly required for off-grid applications and emergency on-grid power supply. The electrical supply varies in times of drought and is highly dependent on hydropower generation, leading to rolling blackouts. What is more, a quarter of power produced is lost due to the state of the grid infrastructure. The unreliability of power supply has had a negative impact on the development of Tanzanian industry. Although Tanzania has excellent wind, solar, geothermal and biomass resources for power production, only 4.85% of non-hydropower renewable electricity was considered in the Electricity Industry Reform Roadmap to 2025.

The country's abundant renewable energy potential offers the possibility to overcome some of the challenges faced by the energy and power sector in a cost-effective way. This would lead Tanzania towards economic growth that is sustainable.

A renewable energy zoning study carried out by the International Renewable Energy Agency (IRENA) and the Lawrence Berkeley National Laboratory (LBNL) in 2015 found that the oil-based power in Tanzania can be displaced by wind power due to the high correlation of wind resources. According to this study, an examination of the characteristics of the least-cost energy system for Tanzania found that utility-scale for solar PV and wind projects could reach 3.7 gigawatts (GW) and 1.9 GW by 2030, alongside 694 megawatts (MW) of gas-fuelled power plant investment already in the pipeline. The report estimated that the overall share of renewable in electricity production, including large hydropower, could reach 78% by 2030. This requires investments of USD 11.4 billion in generation and USD 6.7 billion in transmission and distribution investment between 2013 and 2030. The average generation cost would fall to rate of 17% between 2013 and 2030. This calls for a revision of the existing electricity master plan as well as a roadmap to realise the desired least-cost power system investment strategy.

On the policy and regulatory framework side, the draft Electricity Systems Operations Act 2016, under approval, gives priority for dispatch to the electricity generated from renewable energy sources and indigenous sources. However, this act does not specify guidelines for the power forecast period. Despite the existence of feed-in tariffs and small power purchase agreements (SPPAs) for grid-connected projects, renewable-based power generation is unattractive to private investors. This is due to the weak financial position of TANESCO, the sole off-taker, and the government's inability to guarantee payment of TANESCO defaults.

5.2 Context of the Potential Landscape Change by Modern Cooking Services

The use of biomass (or solid bio-fuels) for cooking is the daily pattern for 85% of the population in Tanzania (Ministry of Energy and Minerals 2015a). This pervasive use of solid fuels including wood, coal, straw, and dung and traditional cookstoves results in high levels of household air pollution, extensive daily drudgery required to collect fuels, and serious health impacts. J. Leary et al (2019) note: '*Cooking is mainly done on traditional, low-efficiency stoves that use biomass fuels that are produced locally through inefficient, informal and uncontrolled value chains and with basic, low-yield technologies'* (Leary et al. 2019). Extensive and inefficient use of those fuels combined with unsustainable harvesting practices is the single largest cause of depletion of natural forests in the country. The adverse socio-economic effects of the current practices are partly caused by the lack of access to sustainable cooking solutions, a poverty trap that creates high barriers to economic development.

Alternative fuels and appliances that are suitable for domestic clean cooking are available but have been limited by acceptability from the community because of unawareness of those cooking appliances. The different alternatives such as LPG, ICS, kerosene and biogas represent different improvement potentials and are important parts of the solution. LPG represents lower long-term average cooking costs for households than ICS, but it has logistical challenges; dependence on the import of LPG influences the level of energy security of this option and requires higher investments for users. Toby D. Couture and David Jacobs in their report 'Beyond Fire: how to achieve electric cooking (2019)' outline some of the challenges of relying on LPG, including high price volatility, greater geopolitical and related risks, and supply chain challenges. They conclude that although '*LPG may be seen as a transitional fuel; it is arguably not, however, a long-term solution to challenge the achievement of sustainable cooking'* (Jacobs and Couture 2019).

Electricity is one of the cleanest cooking solutions and if used in efficient appliances will be affordable to most people, even poor segments in the community, if financing is carefully considered. The challenge at the moment is low awareness of the type of modern energy appliances and services as a barrier to efficient cooking and appropriate business models for reaching the majority of the population in the country.

5.3 Introduction of Modern Cooking Services

Modern energy, particularly electricity, plays a key role in rural development. Concerning the country's goal of achieving a small and middle industrialized economy, access to affordable, reliable and safe electricity can greatly improve food, education, and health services, and improve opportunities for income generation.

Increasing the pace of electricity connection, especially in rural areas, is one of the fundamental principles of the Rural Energy Agency (REA). The 2020 Energy Access Situation Survey results show a significant improvement in electricity connection at the household level in both rural and urban areas of the Tanzania Mainland since 2011 (NBS and REA 2020).

The National Energy Policy is focusing on a transition to modern cooking fuels and technologies, moving away from the use of biomass for cooking. The policy includes a reference to cooking and biomass consumption under the Electricity Sub-sector and only addresses an ambition for transition to modern fuels. Specifically, the relevant objective is to improve the quality of life through the use of modern fuels and the associated policy statements include; i) enhancing fuel switch from wood fuel to modern energy and (ii) facilitating the adoption of appropriate cooking appliances to promote alternatives of woodfuel (Ministry of Energy and Minerals 2015a).

J.Leary et al in the Policy and National Markets Review for eCook in Tanzania (2019) explore the various incentives the government of Tanzania has provided, such as tax relief and results-based financing, to stimulate the use of LPG in the country. The report elaborates (drawing on (Ministry of Energy and Minerals 2015a)): '*Over the past ten years, the LPG supply for household cooking has increased significantly. The total volume of LPG imported in the financial year 2010/11 was 24,470 MT compared to 69,148 MT in the financial year 2014/15. The trend shows that the LPG market is growing rapidly, especially in urban centres'* (Leary et al. 2019).

5.4 Modern Cooking Services in Tanzania

Access to affordable, reliable, safe and sustainable energy services are increasingly recognised as crucial attributes for the success of many development sectors. Access through distributed energy solutions powered by renewable energy sources is often the most viable and cost effective for communities living in poverty. Access to affordable and reliable cooking energy is part of SDG 7 and

SEforALL Initiatives and the aim is to increase the segment of the population with primary reliance on clean cooking appliances with low emission targets and specific fuels recommendations.

According to an eCook study performed by TaTEDO, GAMOS, University of Surrey and Loughborough University in 2018, it was noted that cooking with electricity is now competitive or even cheaper than cooking with LPG, kerosene, or charcoal in urban, peri-urban and rural settings (Batchelor et al. 2018). The positive findings from the eCook Study raised confidence for TaTEDO and partners to continue to initiate efforts towards developing sustainable delivery and business models for scaling up uptake of efficient eCook appliances. Initial efforts on eCook promotion, awareness raising and capacity building to different stakeholders (end users, development partners, Members of Parliament, Local Government Authorities, Civil Society Organizations, etc) has been effective with slowly increasing demand for electric pressure cookers (EPCs) and increased interest from government about the potential of eCooking. More than 3,000 households in the country are using EPCs. Various pilot projects have also investigate eCooking viability on minigrids, finding that even on minigrids with high tariffs eCooking is still cheaper than other paid-for fuels for some dishes (Inston and Scott 2022).

TaTEDO has also implemented a project on the Approach to Designing Delivery Models of Energy Cooking Services in Tanzania (Shuma et al. 2022). The project aim was to assess and understand the entire market system of modern energy cooking appliances (specifically EPCs) in order to propose an approach for designing sustainable delivery and business models for scaling up their uptake in Tanzania. The project was implemented in urban and peri-urban areas of Dar es Salaam Region (Ubungo and Kinondoni districts) and a rural area of Gairo District in Morogoro Region where PowerGen Company is operating a Solar PV Mini-Grid power plant.

The research findings from the project indicate that the target markets for EPCs are households and small food business enterprises in both rural and urban areas. The aggregate demand of EPCs is still very low in Tanzania, and the project documented the challenges and barriers to scaled uptake. The factors which were observed and considered to influence the demand of EPCs are awareness of appliance, price of appliance, seasonality of income, availability and quality of the appliance and income level of customers which determines affordability and prices of substitutes/compliments.

The end users of EPCs who will benefit from modern energy cooking services are categorized into various groups based on their income. These are 1) Low Income Customers, 2) Medium Income Customers and 3) High Income Customers. The segments with most uptake potential are high and medium income segments and 40% of the low income customers, especially business people and individual households with regular monthly income.

The support services required for facilitating access to EPCs: awareness campaigns and promotion of EPCs, capacity building trainings for use, financial support to enable affordability to end users and investment and working capital for importers, distributors and retailers and after sale services of electric cooking appliances.

The enabling environment will be brought about by supportive policies of energy, trade, SMEs, micro-finance, feed-in-tariffs, fiscal and monetary issues and related strategies, programmes and institutional and legal frameworks. These documents among others support the delivery of modern energy cooking services in Tanzania.

This cooking diaries study adds to the body of evidence about cooking practices in Tanzania, gathering data on time and energy used to cook traditionally to cook with energy efficient electric cooking appliances.

6 Objective

The objective of the cooking dairy study is to assess the existing cooking practices and find out means of rapidly accelerating the transition to more efficient and clean cooking by proposing the scenario for introducing and scaling up modern cooking services.

The cooking diary study seeks to firstly record exactly what people in households cook and when and how cooking is normally done in households and ask them to undertake the transition to new practices of cooking with electricity for the remaining duration of the study.

7 Area of the Study

The area selected for the cooking diary study was the rural areas of Hai District in Kilimanjaro Region, Tanzania. Hai District is one of the seven districts of the Kilimanjaro Region. It is bordered to the south and west by the Arusha Region, to the west by the Siha District, and to the east by the Moshi Urban District and Moshi Rural District and the Rombo District. The District lies between Latitudes 20 50` and 30 29` south of Equator and between Longitudes 300 30` and 370 10` east of Greenwich.

Hai District Council is constituted by three Divisions, 17 Wards, 62 Villages and 294 sub-villages. One of these wards is Machame Kaskazini (North Machame Ward) where the cooking diary study was undertaken. According to the 2012 National Population Census results, the district had a total population of 210,533 of which females were 108,076 and males were 102,457. The average population density was 130 people per square kilometres; at the Upper Zone (Highland Area) the number of persons per km2 exceeds 650 people. The population is growing at the rate of 1.9 per year. The District covers an area of 1,011 square kilometres (101,100 Ha). A total of 46,506Ha is arable land; 27,297Ha is suitable for livestock; 14,154Ha is covered by forest; and 13,143Ha is non-arable land which is covered by rocks, hills and gullies.

Hai District Council is at an altitude of 700m to 1700m above sea level. The district is characterized by mountainous topography on the Northern part which forms the Kilimanjaro Mountain while moving towards the south are the Lowlands.

The district receives short and long rains. The rains start in October and reach the peak in December and end in January. The long rains start in March and end in June. The average temperature ranges between 25OC and 32OC in hot months. The conducive climate condition (rains and constant temperature) contributes to the high production of crops based on three main agro-ecological zones.

Soil condition for the Hai District council is favourable for the production of food and cash crops like bananas, maize, cotton, paddy, cassava, beans, sweet potatoes, groundnuts, coffee, sunflower, fruits and vegetables. The economy of the Hai District Council is mainly dependent on the agriculture sector than 80% of the district population largely depends on agriculture activities, whereby the land under cultivation is 108,389Ha which is 87.3% of the total arable land. Hai district is endowed with various

resources such as very fertile land, forests, livestock and labour as human resources.

The six most widely grown crops in the district are maize, common bean, coffee, banana, paddy (rice) and sunflower. Among the animals domesticated in the district include; cattle, goats, sheep and chickens. Production of these crops accounts for over 46% of the Hai District cropland area and more than 82% of food production, grown by more than 80% of the small scale farmers/residents whose primary source of livelihood is agriculture. Maize is now the staple food of the impoverished majority of the Tanzanian population, whereas the small middle class and the tiny upper class consume rice and wheat.

The specific area selected was in the North Machame Ward the villages of Foo, Wari Ndoo and Wari Sinde to offer a deeper exploration into the unique cooking practices of individual households, paired with quantitative measurements of energy consumption. The area occupied by Chagga Tribe with a culture of planting a variety of food crops, including bananas, maize, beans, and roots. They also keep cattle, goats, and sheep. Due to limited land holdings and grazing areas, most Chagga people today are forced to purchase other foodstuffs such as rice, pasta, sugar and others from shops and meat from butchers. Foodstuffs cooked can be divided into five groups according to their compatibility with efficient electric cooking appliances and the potential energy and time savings. These are 'long heavy', 'moderate-light', 'boiled', 'simple fry, and deep fry foods.

8 Methodology

The cooking diary study was designed to deeper explore the unique cooking practices of individual households. A total of 12 households were selected for this study in the rural areas of Hai District, Kilimanjaro based on the fuels used for cooking and their willingness to record quality data for the whole duration of the study.

8.1 The Cooking Diary Methodology

The cooking diary methodology is narrating on how the study was conducted and people who were involved in the study from different places in the city. The participants, facilitators and approach of the study are as discussed in the heading hereunder:

8.1.1 Participants and Facilitators

The study was supported by the Local Government in Hai District, Kilimanjaro Region through the Community Development Officers and partners in rural areas of Hai District such as MFIs, Women Groups, Entrepreneurs, etc. The study team (comprised of three TaTEDO staff and experienced enumerators) mobilized representatives of sampled households categorized in low, medium and high income which will participate in the cooking diary survey. The participants from households were selected based on previous interventions in the field by linking with participants from capacity building training sessions.

The households were sampled based on their levels of income and were divided into three categories of high (4), medium (4) and low (4) income households. The study began with a registration survey designed to capture basic information on who they are cooking for, the appliances they use and why. The first part of the study was used to collect data for existing cooking practices (on how households were cooking). This was followed by transition workshop which trained participants on how to use EPCs for preparing meals. The second part of the study, the households were asked to solely use electricity for cooking. As part of the study, they were asked to cook with efficient electric appliances which were EPCs.

The survey finished with an exit survey, asking about their experience with cooking with electricity. Participants were also invited to share their energy-efficient cooking practices.

8.1.2 Energy Measuring Equipment

During the Cooking Diary Study, some equipment were used to weigh or measure firewood, charcoal and LPG. These fuels were weighed in metric kilogrammes and some coefficients were used to convert them into Mega Joules. Smart-phones were used to capture data from participants through enumerators. Other equipment were for recording data such as pens and exercise books. The following are some of the equipment used for measuring energy in the selected households:

Equipment	Description
	The Electronic Weighing Scale is a portable hanging scale designed to measure up to 40 Kgs. It has clear LCD display and big fonts, it's easy to identify the readings. Users can switch between pounds, ounces, and kilograms with the unit button. Use the "tare" button to reset the scale to zero when measuring content in a container. The weighing scale was used to weigh firewood, charcoal and LPG cylinder before and after cooking during the phase 1 and phase 2 of the cooking diary survey.
	The household energy meter is used for measuring electricity. This is single phase two wire active energy meters used for domestic measuring of electricity in households. The meter has novel design, rational structure, and it can display total energy consumption by drum wheel mechanical register. The meter was used to measure energy when EPCs were used for cooking in phase 2 of the cooking diary survey. Two wires were connected to the meter and one cable to the EPC for measuring amount of electricity used for cooking.

8.1.3 Approach

The study was split into two phases. The first phase focused on existing traditional cooking practices whereas the second phase focused on cooking with electricity by using EPCs. The workshops were organized with participants from households involved in the study. In the first workshop, participants were introduced to TaTEDO, the project and the aim of the survey. In the same workshop, participants were introduced to cooking diary and trained on how to fill forms/record cooking information which continued with practical part at their households on the next day. Therefore, participants were required to practice on how to fill the required information in the forms and they were asked to stay at home and keep cooking records for the whole day. Enumerators and TaTEDO staff visited them to check whether they have managed to fill forms correctly. The first part of field activities of data collection on existing cooking practices started after training and continued for seven days.

The first part was follow by transition workshop of assessing the challenges of the first part of the study and training participants on how to use electricity and electric appliances. In this phase data were recorded for a period of seven days. Everyday data collection forms were verified to ensure minimal errors from the field.

After eight days of cooking using electric appliances, the third session of participant workshop followed by exit survey which was conducted to get participants' views on how to use the appliances and how the new practices of cooking will impact on their lives.

9 Cooking Diaries in Rural Areas of Hai District, Kilimanjaro Region, Tanzania

Cooking is very much embedded in culture and due to cultural resistance to clean cooking solutions; it has been difficult to adopt clean solutions. These cultures are linked to the cooking habits, traditions, cultural appropriateness of the device, and perceptions about the taste of food. Since most of these barriers are deeply tradition-based and location-specific, it is making it difficult to drive large-scale substitution in the market, while also limiting the potential scalability of alternatives.

The cooking diary survey was conducted in North Machame Ward the villages of Foo, Wari Ndoo, and Wari Sinde, located in Hai District, Kilimanjaro Region, Tanzania in order to offer a deeper exploration into the unique cooking practices of individual households, paired with quantitative measurements of energy consumption. The Modern Energy Cooking Services are new cooking practices in the Kilimanjaro Region that deliberately tries to find out how to transform traditional cooking practices to new practices of using modern clean cooking solutions. In so doing, MECS will change the lifestyles of several people in households and across several government agencies, business sector, development partners, and private sector and may change the shape of how energy for cooking is supplied and demanded. Shifting from biomass-based cooking will result in a potential loss of jobs in the charcoal and wood industry. The private sector and business entrepreneurs will make a profit from offering modern energy cooking services. The household payments for cooking energy will be redirected from biomass fuels to modern energy services.

10 Results

10.1 Typical Foods for People in Rural Highlands of Hai District

The rural area selected for the Cooking Dairy Study is populated by Chagga ethnic groups with the culture of planting a variety of food crops, including bananas, maize, beans, and roots. They also keep cattle, goats, and sheep. Due to limited land holdings and grazing areas, most Chagga people today are forced to purchase other foodstuffs such as rice, pasta, sugar, and others from shops and meat from butchers. The Chagga are known for their sense of enterprise and strong work ethic. The staple food of the Chagga people is banana, which is also used to make beer of mbege, their main beverage.

The ethnicity of people also indicates the different types of food cooked and consumed in the Hai District. Foodstuffs cooked can be divided into five groups according to their compatibility with efficient electric cooking appliances and the potential energy and time savings. These are 'long heavy', 'moderate-light', 'boiled', 'simple fry, and deep fry foods. According to the Cooking Diaries study, the following are foodstuff consumed in rural areas of Hai District:

Table 1: Food Consumed in Hai District, Kilimanjaro Region

Food Type	Description
Heavy Foods	
Kande	The dish is cooked by combining pealed maize with beans which are sometimes soaked overnight and then cooked until they become soft and then cooked by oil, tomatoes and onion. There two types of Makande. One is mixed with vegetables and another flavoured with ginger, cumin and cardamom.
Legume Grains	Grain legumes are used in Hai District are beans , pigeon peas and kunde. Beans and pigeon peas are mostly obtained in the district. These grains are boiled and beans stew is made for eating with other starchy foods i.e. Ugali, rice, etc.
Kiburu	Kiburu is soup of boiled beans or kunde mixed with banana stirred with wooden traditional blander. Bicarbonate soda is added during cooking to accelerate cooking process
Kichanganya	Kichanganya is dish made as mixture of bananas and beans as the main ingredients.
Ngararimu	Ngararimu is maize grains which are not pealed cooked with beans. Bicarbonate soda is added during cooking to accelerate cooking process and pealing the outer coat of maize grain,
Moderate Light Foods	
Rice	Rice or Wali is a starchy food consisting of rice cooked in a combination of coconut milk/oil and water, mixed with salt. It is usually served as an accompaniment to various curries or chicken, fish, and meat dishes.
Pilau	A combination of meat stew and rice. May use meat stew/stock pre-cooked on a previous occasion, or may cook the meat especially for this dish. May involve some frying of onions too. Sometimes potato is even thrown in!
Ndizi, Machalari	Ndizi Machalari is a dish using bananas and meat as the main ingredients.
Ugali	Ugali is a stiff porridge made from maize flour (corn meal). This dish is usually served with whatever meat is available, mashed vegetables, stews, or sour milk.
Tuber and Roots	These are sweet/irish potatoes,
Mangolo	Mangolo are mashed dry banana cooked by mixing with boiled beans
Simple Fried Foods	
Vegetables	These are usually prepared with leafy vegetables such as amaranth cabbages, or spinach with added grated coconut, coconut milk, peanut butter, tomatoes, and onions. It is recommended to serve with rice, Ugali and beans on the side in order to make a satisfying main course.
Meat	Beef/pork/sheep/fish/vegetable stew –many people will pre-cook (boil) meat in bulk and wet fry portions throughout the week. Chicken/fish/vegetable generally cooked for a lot less time than meat, but difficult to separate out without going through the quantity field one by one.
Eggs	Could be boiled, fried or omelette. If omelette, can often be combined with potatoes (chips mayai), which may need deep frying first.
Boiled Foods	
Milk	Boiled milk is consumed as breakfast especially for people who are coming from livestock keeping families. Milk is mostly used for feeding children less than five years of age.
Tea	These are boiled food consumed with snacks as breakfast and occasionally can be consumed in the afternoon and evening.
Porridge	Porridge is a food commonly eaten as a breakfast cereal dish, made by boiling ground starchy grains in water and milk. It is often cooked or served with added flavourings such as sugar, honey, lemon juice, margarine, black pepper to add taste
Mlaso	Mlaso is traditional boiled coagulated animal blood (goat/cattle) mixed with milk.
Mtori	These are light and simple soup from boil meat bones in water mixed with mashed banana, mostly used as breakfast. It can also used as drink in afternoon and evening. Soup can be boiled from different types of meat such as beef, pork, goat, etc.
Kisusio	These are light and simple white soup from boil meat bones in water mixed with animal blood. It can also used as drink in afternoon and evening. Kisusio can be boiled from different types of meat such as beef, goats, sheep, etc.

Soup	These are light and simple white soup from boil meat bones in water, mostly used as breakfast. It can also used as drink in afternoon and evening. Soup can be boiled from different types of meat such as beef, chicken, pork, etc.
Kitawa	Kitawa is mashed banana mixed with milk eaten in the afternoon for quenching thirsty
Deep Fried Food	
French Fries (Chipsi)	Chipsi (French Fries) is a staple street food made of sliced Irish potatoes fried in combination with eggs. It is typically served with kachumbari sauce on the side, consisting of tomatoes, chilli peppers, and onions.
Dough (Maandazi)	These are dough shaped into triangles, circles, or ovals, made with sugar, wheat flour, water, yeast, additionally enriched with ingredients such as ground peanuts or almonds. Maandazi are usually served for breakfast with tea.
Dessert	Banana like food deep fried when ripe or unripe and eaten with tea, milk, coffee, cocoa,etc

10.2 Overview of Data

10.2.1 Overview of Participating Households

The cooking diary study was explored deeper into the unique cooking practices of individual households. A total of 12 households that were selected to participate in the study in Hai District, were used to prepare meals during cooking diary workshops, trained on how to weigh and measure fuels and record high-quality data for the duration of the study.

The identified enumerators were recruited to undertake cooking diary information collection by using the Kobo software. Priority was given to individuals who could easily be trained and own smart-phones.

10.2.2 Overview of the Data from Cooking Diaries Survey

The cooking diaries data were recorded from participants from paper records kept by participants and those data were copied to digital form using Kobo Collect Software. Data from each cooking and heating event was entered into separate data forms by enumerators using smart-phones. Although each record related to distinct times of the day, they could cover multiple heating events e.g. an early morning record could include breakfast, preparing food for a baby, and heating water.

10.2.2.1 Heating Events

Heating Events in most of the time is not considered as stuff which is using much energy although most of the participants cannot complete a day without heating for different purposes such as lunch, breakfast, water heating, food for babies, etc.

Table 2: Number of Heating Events[1]

Heating Events	Phase 1		Phase 2	
	Frequency	Percent	Frequency	Percent
Breakfast	52	19.33	39	16.32
Food for Baby	14	5.20	16	6.69
Lunch	38	14.13	37	15.48
Dinner	99	36.80	61	25.52
Water Heating(Bath)	48	17.84	75	31.38
Missing Cases	18	6.69	11	4.60
Total	269	100	239	100

[1] N.B. multiple heating events in each record means that total sums to more than 100%.

Most of the heating events in phase 1 were occurring for dinner and breakfast due to the boiling of tea, milk, coffee, etc. This is followed by heating water for bath before they go to the bed to sleep. Water heating during lunch is nominal and mostly for households with babies or for washing hands. Heating events during the second phase changed frequency of water heating water heating increased. The frequencies were high for water heating and dinner , moderate for lunch and breakfast and low for cooking baby foods.

10.2.2.2 Zero Energy Meals

Zero Energy meals simply mean no heat, which implies the stove or cooker was kept off or food that was eaten in the household was bought from vendors or that have already been cooked and was not warmed such as bites, loaves of bread, etc or food which was bought but is eaten without cooking such as fruits, juice, vegetable salads (kachumbari), etc.

Table 3: Zero Energy Meals

Food Type	Frequencies	Percent
Fruits (Lunch and Dinner)	80	44.69
Bites (Breakfast)	83	46.37
Raw Food (Lunch and Dinner)	13	7.26
Did Not Eat at Home	3	1.68
Total	179	100.00

The culture of eating from vendors is limited to people who are coming from distant places for treatment in the hospital and business activities but not for local people in the selected rural villages.

Most of the missing cases are instances in which no food was eaten in the households (especially families which did not eat at home due kind of business they are doing in near towns), which narrowed down cases of collected data. Some zero energy meals such as fruits and raw food) are eaten in households during lunch and dinner. Traditionally, every breakfast is eaten with bites (dough, doughnuts, bread, etc) which are bought from vendors. Those cases did not affect cases of collected data, because these foodstuffs were part of meals.

10.3 Energy Consumptions

The fuels used in the study areas are firewood, charcoal and LPG. Electricity is used in high income households for light food. For each of the four fuels, energy consumptions have been calculated from assumed fuel consumptions (based on the before and after readings) and the calorific values given in table 4.

Table 4: Calorific Values (Conversion Efficiencies)[2]

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

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

These values were used to convert cooking fuels and energy as may be required by this study. Some data for firewood, charcoal and LPG were weighed by weighing scales in metric units (Kilograms). There is a need to convert these data by using the above conversions coefficients.

10.3.1 Mix of Fuels (Fuel Stacking)

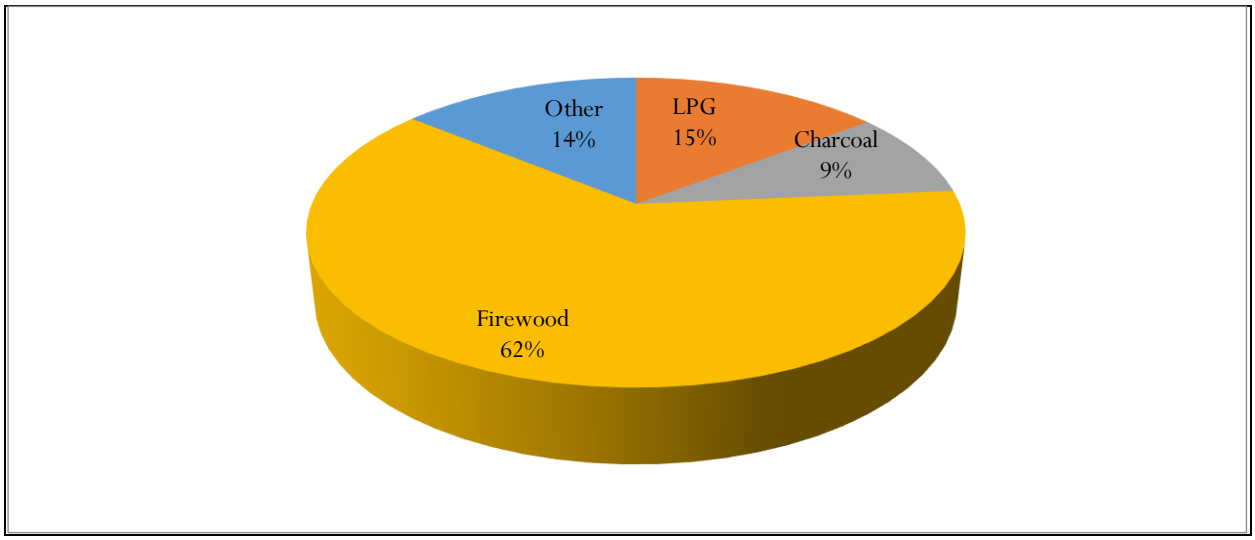
The mix of fuels used in Kilimanjaro for phase 1 is presented in table 5. This shows that firewood accounts for the majority of energy consumed in households in rural areas of the Hai District. This is followed by LPG and other fuels. Other fuels in this case mean maize cobs and wood sawmill remains. Charcoal is used by a few households for businesspersons who can buy it from nearby towns. Electricity is occasionally used by a few households for warming foods and cooking light foods.

Table 5: Use of Fuels by Participants (Phase 1)

Participants	Electricity	LPG	Charcoal	Firewood	Others
Elinaike Masawe			x	x	
Dorcas Nkya				x	
Vicky Mushi				x	x
Nancy Kidin		x		x	x
Ndumieshi Mushi				x	
Rehema Shoo		x	x		
Aisa Lema		x		x	x
Doroth Swai		x		x	x
Lipina Kombe				x	
Olga Shoo				x	
Batuli Kimaro		x		x	
Jenifer Mushi			x		x

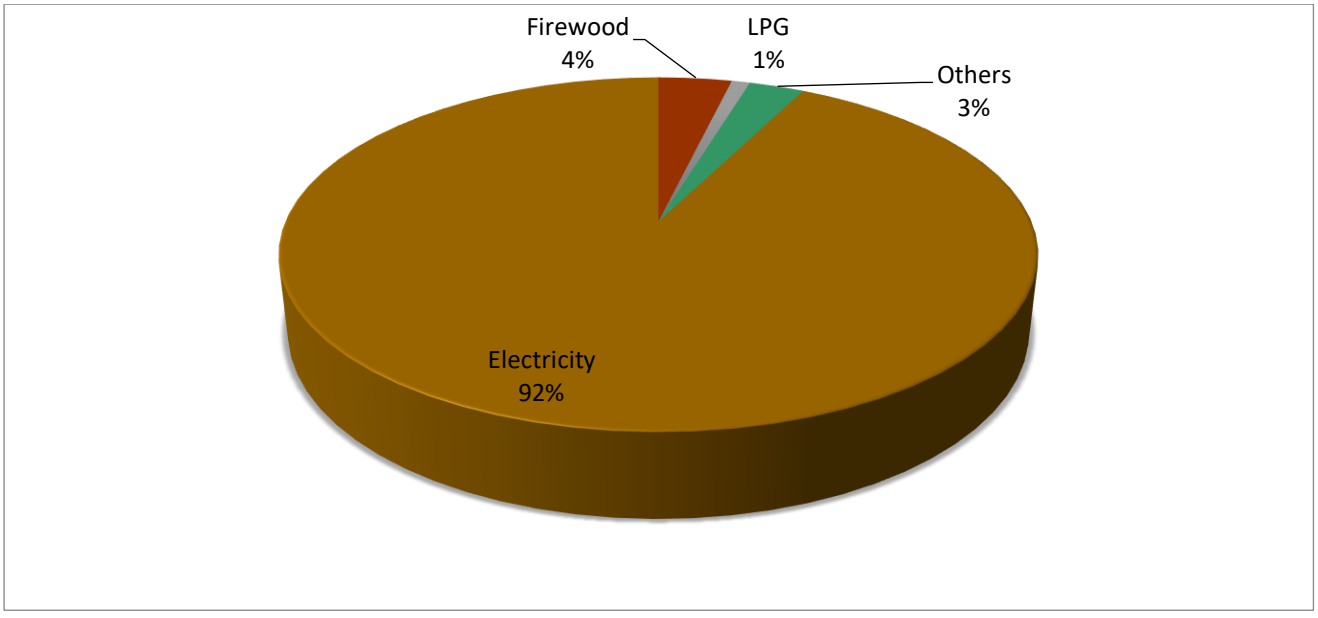
Chart 1 shows cooking energy used by households. Although most households are using firewood, the rate of using LPG (14%) and other fuels (maize cobs and sawmill remains) (14%) were the same although sawmill remains is sourced from a few places. Charcoal is used occasionally by a few households which can afford to buy these fuels.

Chart 1: Traditional Fuels Used by Households in Rural Hai District, Kilimanjaro (Phase 1)



The experiences from some participants (chart 1) indicate that a large number of households were using firewood as fuel for cooking. The pattern has changed to most of them and they are switching gradually to the use of LPG. The use of electricity is an expensive expenditure for these households and some of those households have practised cooking by electricity but for them was impossible and unaffordable.

Chart 2: Energy Used by Households after Introducing EPCs in Rural Hai District, Kilimanjaro (Phase 2)



The introduction of EPCs in households of rural areas of Hai District, Kilimanjaro shifted a large number of households to the use of electricity (92%). There were some households used firewood(4%), LPG (1%) and other fuels (bio-wastes)(3%). These fuels were used because there

were some foods which could not be cooked in EPCs. These were foods which their recipes have bicarbonate soda. Some households also restricted the use of EPCs to one person only but the problem was solved by enumerators during their visits to those households.

10.3.2 Energy Consumption by Households

The comparative analysis was done for both phase 1 and phase 2 of the cooking diary survey to assess energy consumption by households. Energy carriers (fuels) used in rural areas of Hai District of Kilimanjaro Region by households are charcoal, firewood, LPG, maize cobs and wood sawmill wastes. Firewood is the main fuel for cooking used by more than 62% of all households in the study area. The LPG is the new fuel for cooking used by almost 15% of households. These are followed by the use of maize cobs and sawmill wastes which are utilized by almost 14% of households. Charcoal is only used by 9% of households in the study area.

Table 6: Energy Consumption by Households (Phase 1) (MJ)

S. No.	Names	Charcoal			Firewood			LPG			Others		
		Median	Mean	N	Median	Mean	N	Median	Mean	N	Median	Mean	N
1	Elinaike Masawe	39.5	39.5	2	55.5	65.0	4	0	0	0	0	0	0
2	Dorcas Nkya	0.0	0.0	0	63.4	64.4	14	0	0	0	0	0	0
3	Vicky Mushi	0.0	0.0	0	38.6	41.8	19	0	0	0	32.9	32.9	2
4	Nancy Kidin	0.0	0.0	0	47.7	49.3	4	24.6	24.6	2	39.8	39.8	2
5	Ndumieshi Mushi	0.0	0.0	0	47.4	43.4	16	0.0	0.0	0	0.0	0.0	0
6	Rehema Shoo	30.8	30.5	5	0.0	0.0	0	66.3	83.3	8	0.0	0.0	0
7	Aisa Lema	0.0	0.0	0	33.4	33.4	1	59.1	64.5	4	60.1	60.4	12
8	Dorothy Swai	0.0	0.0	0	43.6	51.2	13	122.8	144.3	13	31.3	31.3	2
9	Lipina Kombe	0.0	0.0	0	49.3	52.8	18	0.0	0.0	0	0.0	0.0	0
10	Olga Shoo	0.0	0.0	0	40.7	51.4	12	0.0	0.0	0	0.0	0.0	0
11	Batuli Kimaro	0.0	0.0	0	52.6	45.6	9	1.3	1.3	2	0.0	0.0	0
12	Jenifer Mushi	30.5	32.6	12	0.0	0.0	0	0.0	0.0	0	39.8	46.0	5

According to the findings of phase 1 of the cooking diary survey in table 6, the average charcoal consumption by households is 0.29 Kg (equivalent to 8.67 MJ per household) (range of 0 to 39.5 MJ) while average LPG consumption by households is 0.59 Kg (equivalent to 26.43 MJ per household) (range of 0 to 144.3) per day. The households using firewood are consuming an average of 2.61 Kg (equivalent to 41.5 MJ per household)(range of 0 to 65 MJ). The average consumption of other fuels (maize cobs/sawmill waste) per household is 1.10 Kg (equivalent to 17.5 MJ per household). The frequency of using firewood by households is still high in Kilimanjaro. Almost a reasonable number of households has shifted to the use of LPG but has not outweighed the use of firewood for cooking. Firewood is bought from vendors or collected from family farms and surrounding forests and river valleys.

There was no any case of cooking by using kerosene in phase 1. Cooking with electricity is negligible and only rich families are cooking by using hot plates. We did not get any participant cooking with electricity, although some participants declared that they have previously tried to use those energy carriers but they were expensive and were not affordable to them.

The rates of using firewood and LPG in phase 2 were reduced to 4% and 1%, respectively. None of the households used charcoal for cooking. The rate of energy consumption in phase 2 shifted to the use of electricity by almost all households after introducing EPCs to the participants. The rates of electricity varied from one household to another due to cooking requirements in their families.

Table 7: Energy Consumption by Households (Phase 2) (MJ)

S. No.	Names	Charcoal			Firewood			LPG			Electricity		
		Median	Mean	N	Median	Mean	N	Median	Mean	N	Median	Mean	N
1	Elinaike Masawe	0	0	0	0	0	0	0	0	0	4.5	4.5	8.0
2	Dorcas Nkya	0	0	0	0	0	0	0	0	0	4.3	3.8	6.0
3	Vicky Mushi	0	0	0	0	0	0	0	0	0	4.0	4.1	10.0
4	Nancy Kidin	0	0	0	0	0	0	0	0	0	4.0	4.2	7.0
5	Ndumieshi Mushi	0	0	0	0	0	0	0	0	0	5.0	5.8	11.0
6	Rehema Shoo	0	0	0	0	0	0	50.2	50.2	1	5.2	4.8	6.0
7	Aisa Lema	0	0	0	0	0	0	0	0	0	4.0	4.1	11.0
8	Dorothy Swai	0	0	0	0	0	0	0	0	0	4.5	4.6	8.0
9	Lipina Kombe	0	0	0	0	0	0	0	0	0	4.3	4.3	7.0
10	Olga Shoo	0	0	0	0	0	0	0	0	0	4.0	4.1	11.0
11	Batuli Kimaro	0	0	0	35.1	35.1	2	0	0	0	5.1	5.1	6.0
12	Jenifer Mushi	0	0	0	29.3	29.3	2	0	0	0	4.3	4.0	8.0

The energy consumption rates by households dropped down for firewood and LPG in phase 2 and almost 100 percent of households shifted to the use of electricity. The findings show that average firewood consumption was 0.34 Kg (equivalent to 5.41 MJ per household). The LPG consumption for households was reduced to 0.09 Kg (equivalent to 4.18 MJ per household). The average electricity consumption by household was 1.23 Kwh (equivalent to 4.43 MJ per household per day). The rate of using electricity was high in selected households but consumption of electricity was very low compared to charcoal, firewood and LPG. The household energy consumption in the second phase was lowered by 85% compared to the first phase of a survey of traditional cooking practices. The electricity consumption was lower than other energy carriers. This was caused by the high efficiency of cooking appliances (which means EPCs) used for cooking by participants in households during the second phase.

10.3.3 Per Capita Energy Consumptions

It has already been pointed out that energy consumption depends on the number of people that eat cooked meals. Therefore, the per capita energy consumption has been calculated simply by dividing the energy consumption for the heating event by the number of people that consumed the meal. Note that adults and children have been given an equal weighting when calculating per capita consumptions.

There are three five heating events that are practised for household cooking in Kilimanjaro. These are breakfast, lunch, dinner, water heating and baby foods. Water heating and cooking baby foods occurs whenever members of households are in need of them. Water heating is divided into water for bathing, tea, coffee, milk, water for milking, etc. The energy consumption by type of heating event is as shown in the tables below:

Table 8: Per Capita Energy Consumption by Heating Event (MJ/person/event) (single events only) – Phase 1 (Charcoal Only)

Heating event	Frequency	Mean	Median	Std.dev.
Breakfast	5	5.83	2.68	10.12
Lunch	7	12.56	13.16	5.21
Dinner	7	9.27	6.58	6.88
Water Heating	8	14.04	12.26	5.98
Food for Babies	3	8.97	10.76	7.77

According to table 8 above, the frequency of using charcoal in rural areas of Hai District in Kilimanjaro Region is small and charcoal is used by some households in all heating events. The charcoal is mostly used for cooking both lunch, dinner and heating water followed by cooking breakfast and the last one is food for babies. Charcoal in this areas is bought from nearby urban centres of Moshi and Bomang'ome.

Table 9: Per capita energy consumption by heating event (MJ/person/event) (single events only) – Phase 1 Firewood only

Heating event	Frequency	Mean	Median	Std.dev.
Breakfast	40	14.79	13.67	8.90
Lunch	22	32.28	26.08	17.17
Dinner	43	23.69	20.99	14.63
Water Heating	12	19.08	20.51	11.45
Food for Babies	8	16.22	14.63	7.79

Firewood in the main fuel used for cooking in rural areas of Hai District in Kilimanjaro region. The frequency of using firewood was higher for all heating events. The breakfast is the heating event with high frequency of using firewood, followed by cooking dinner. Use of this fuel is moderate for lunch because in the afternoon most of the people are at the work places. They do not cook at home; some who are left at home are the one cooking by this fuel. Food for babies was the least in terms of frequencies of cooking by using firewood.

Table 10: Per capita energy consumption by heating event (MJ/person/event) (single events only) – Phase 1 LPG only

Heating event	Frequency	Mean	Median	Std.dev.
Breakfast	7	1.34	0.45	2.23
Lunch	9	12.99	12.99	10.30
Dinner	49	67.20	59.58	38.98
Water Heating	28	51.97	54.66	27.33
Food for Babies	3	0.90	0.45	0.45

The rate of LPG consumption per person is higher for dinner, followed by water heating. The fuel was used 49 times for cooking dinner followed by water heating. Lunch, breakfast and food for babies scored low in terms of frequencies of cooking by using LPG. The rate of using and amount of LPG were high for cooking dinner and water heating in households.

The per-capita energy consumption for different heating events are also presented in the charts 3-5 below:

Chart 6: Per capita Energy Consumptions for Different Heating Events (Phase 1) (Median-Single Events Only)

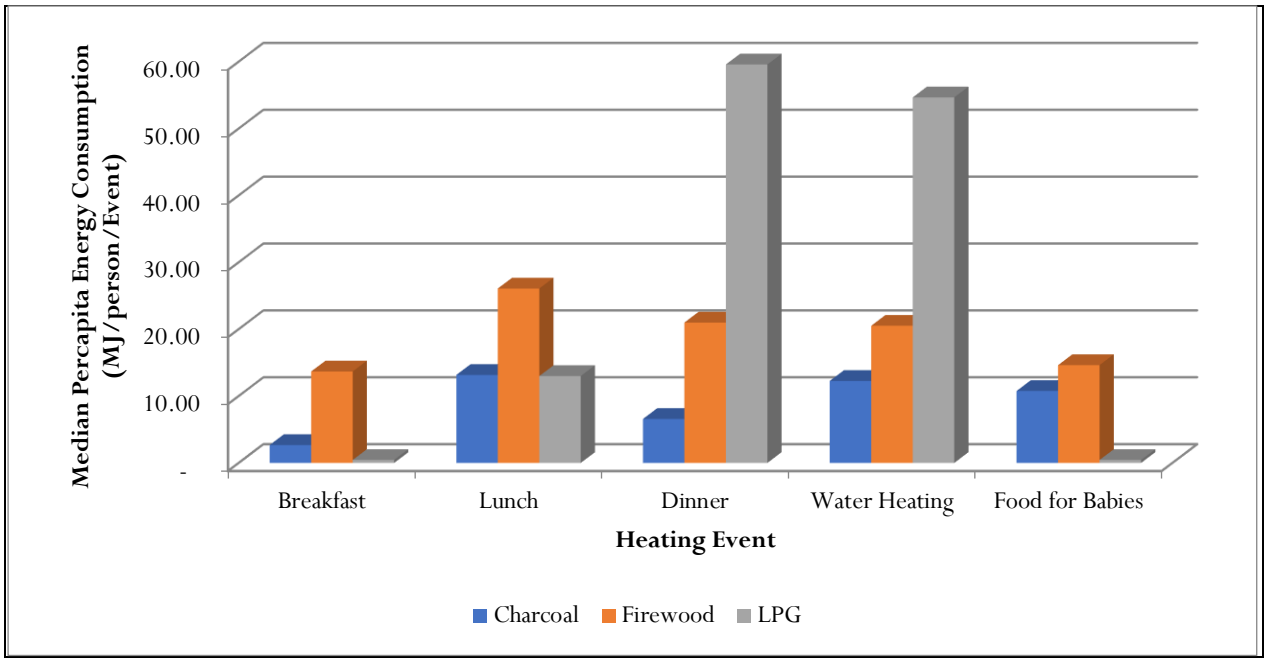
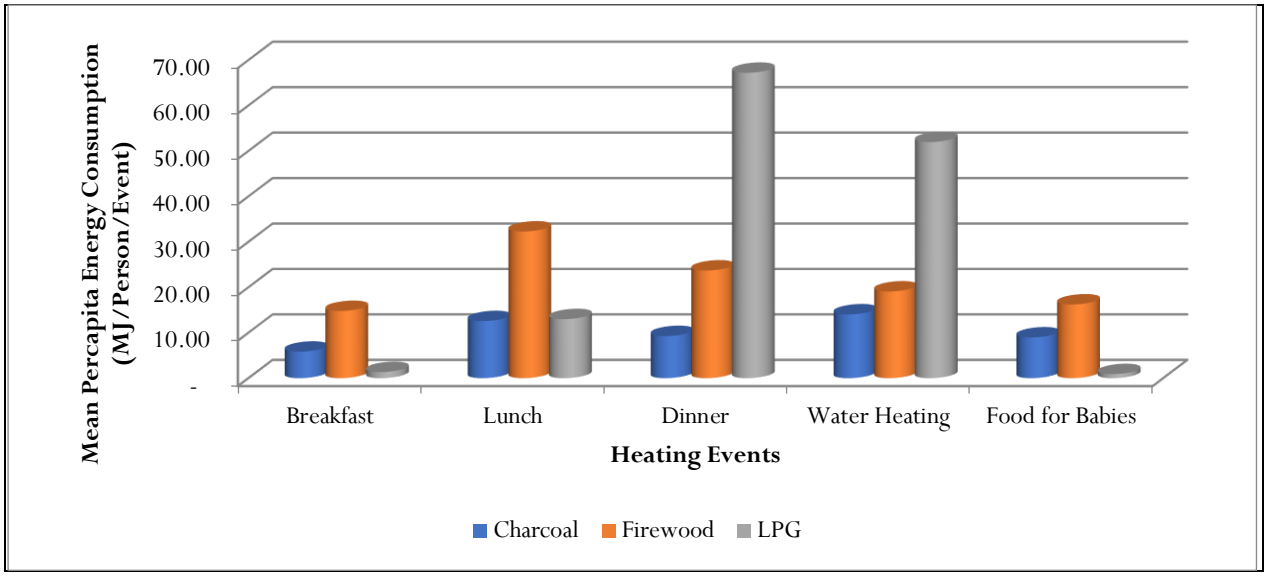
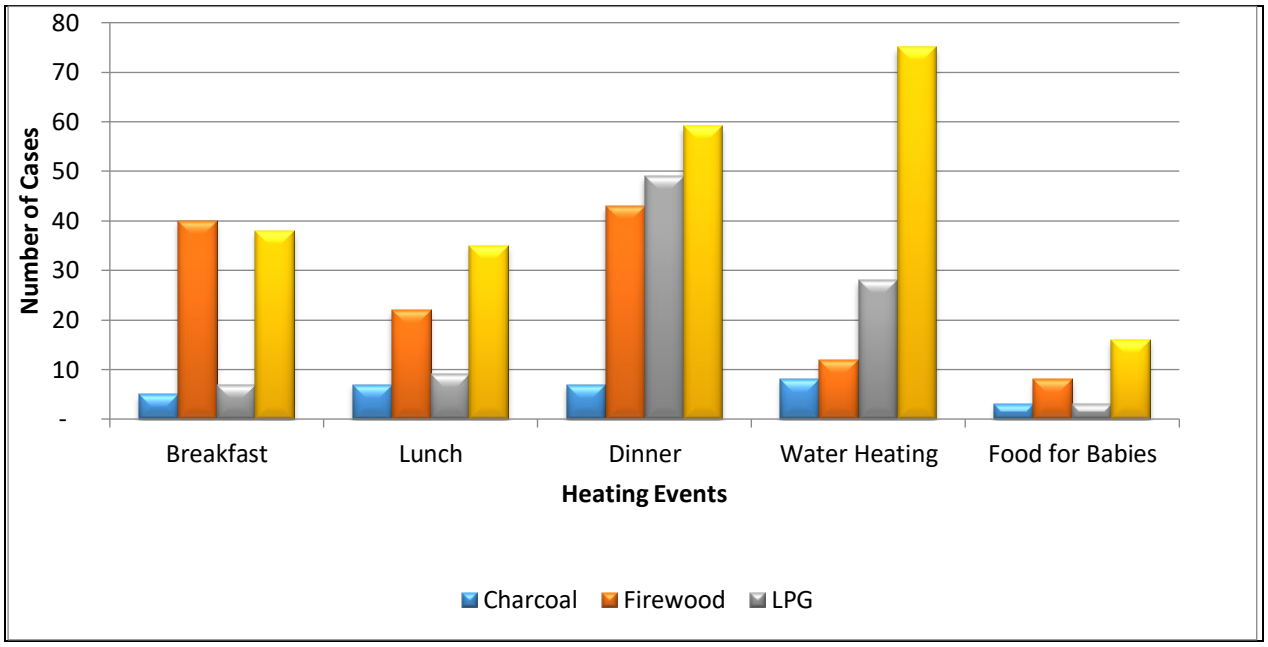


Chart 7: Per Capita Mean Energy Consumptions for Different Heating Events (Phase 1) (Mean-Single Events Only)



The energy consumption records in Phase 1 shows that dinner consumed the larger amount of energy than others, closely followed by water heating. The energy consumptions for each type of heating event show variations due to the overall conversion efficiencies and amount of energy used in relation to different fuels. The energy consumption for dinner is high because it is time of the day when all members of the families are eating their meal at home and food is cooked for the whole family. Foods for babies are cooked occasionally for households with babies. The firewood is used in all heating events. Use of firewood implies that more amount of energy from this fuel is used in rural areas of the study area compared to other cooking fuels (LPG, Charcoal and Bio-wastes). The large amount of LPG is used in the evening for cooking dinner due to weather and easiness of using it in the evening. Water heating is done by using firewood and in some households by LPG.

Chart 5: Choice of Fuels for Heating Events (Phase 1)



The charts above are for different heating events with multiple fuels where fuel stacking is practised. The Firewood and LPG was ranked as the main fuel used for cooking across all heating events. The last fuel used for cooking is charcoal. Firewood and LPG are mostly used for cooking breakfast and dinner and moderate in the afternoon for cooking dinner and water heating. Different participants use different fuels, so per capita energy consumption values will depend on the fuel which is being used.

Firewood ranked first as the main fuel used for cooking by households. This is followed by LPG and the last one is charcoal. During Phase 1, it was observed that firewood and LPG had alternating uses by households but charcoal is used by a few households who can obtain them from vendors in the near towns of Bomang'ombe and Moshi. Per-capita use of energy for cooking indicates that cooking with firewood uses 16.8 times of per capita energy as much energy as cooking with charcoal, 11.3 times of per capita energy compared to maize cobs/sawmill wastes and 5.2 times of cooking energy per capita compared to LPG.

During the second phase, electricity was a priority cooking energy carrier. The rural areas of the Hai District have been facing some instances of occasional power cuts. The survey was performed around the period of the national election, therefore for the whole period of the survey, there were no power cuts. Therefore, only a few households used other fuels such as firewood and LPG during the second phase.

Table 11: Per-Capita Energy Consumption (Second Phase (Cooking with Electricity (EPC))

S. No.	Names	Charcoal			Firewood			LPG			Electricity		
		Median	Mean	N	Median	Mean	N	Median	Mean	N	Median	Mean	N
1	Elinaike Masawe	0	0	0	0	0	0	0	0	0	0.25	0.25	8
2	Dorcas Nkya	0	0	0	0	0	0	0	0	0	0.20	0.18	6
3	Vicky Mushi	0	0	0	0	0	0	0	0	0	0.28	0.29	10
4	Nancy Kidin	0	0	0	0	0	0	0	0	0	0.18	0.20	7
5	Ndumieshi Mushi	0	0	0	0	0	0	0	0	0	0.23	0.27	11
6	Rehema Shoo	0	0	0	0	0	0	0.56	0.56	1	0.73	0.66	6
7	Aisa Lema	0	0	0	0	0	0	0	0	0	0.22	0.23	11
8	Dorothy Swai	0	0	0	0	0	0	0	0	0	0.31	0.32	8
9	Lipina Kombe	0	0	0	0	0	0	0	0	0	0.40	0.40	7
10	Olga Shoo	0	0	0	0	0	0	0	0	0	0.55	0.58	11
11	Batuli Kimaro	0	0	0	0.44	0.44	2	0	0	0	0.28	0.28	6
12	Jenifer Mushi	0	0	0	0.37	0.37	2	0	0	0	0.24	0.22	8

Totals show that cooking with LPG during the second phase used 23.4 times of energy per capita for cooking compared to energy per-capita from firewood and 21.6 times of energy per capita for cooking compared to electricity. EPC in this phase used a small amount of energy per-capita of about 1.16 MJ/kWh. This was more attractive to involved households because using electricity for cooking was previously impossible due to loads of unaffordable electric units (kWh) used for cooking but the use of EPCs has changed this impossibility into possible and real cooking practice.

10.3.4 Energy Consumption by Heating Events

There are three major heating events for households in rural areas of Hai District, Kilimanjaro Region. These are breakfast, lunch and dinner. Other heating events are water heating and cooking baby foods which occur whenever members of household are in need of them. Water heating is divided into water for bathing, tea, coffee, milk, etc. The energy consumption by heating event is as shown in the tables and chart below:

The energy consumption in Phase 2, shows that energy for households was reduced from a maximum of 180 MJ for households that were using firewood to almost 14 MJ for households switched to the use of electricity (which means the use of an EPC. There were few cases of using LPG and Firewood for cooking in both three events. Most of the households switched to the use of electricity for cooking different types of food. The comparative analysis of the mean of energy from electricity during uses of EPC was 7.2 MJ per household. This is equivalent to an average of 2 kWh of electricity for each household per day. This is also equivalent to about 60 kWh per month for each household.

Table 12: Per Capita Energy Consumption by Heating Event (MJ/person/event) (single events only) – Phase 2 (Charcoal Only)

Heating event	Frequency	Mean	Median	Std.dev.
Breakfast	0	0	0	0
Lunch	0	0	0	0
Dinner	0	0	0	0
Water Heating	0	0	0	0
Food for Babies	0	0	0	0

According to the table above, charcoal was not used by any households after introducing EPCs in those households. The cooking by EPC in other words eliminated use of charcoal in those households. The reason is that charcoal is bought from the distant urban markets but electricity is connected to their households. Therefore, it is easier to use electricity by EPC than charcoal which is expensive and easily available to them.

Table 13: Per-capita Energy Consumption by Heating Event (MJ/person/event) (single events only) – Phase 2 Firewood only

Heating event	Frequency	Mean	Median	Std.dev.
Breakfast	0	0	0	0
Lunch	2	0.44	0.44	0.56
Dinner	2	0.37	0.37	0.25
Water Heating	0	0	0	0
Food for Babies	0	0	0	0

The per-capita energy consumption for firewood during the second phase dropped and use of firewood was only for 4 times in two households only. The use of firewood was a result of cooking Ngararimu (food which its recipe has bi-carbonate soda) and boiling water for milking.

Table 14: Per-capita energy consumption by heating event (MJ/person/event) (single events only) – Phase 2 LPG only

Heating event	Frequency	Mean	Median	Std.dev.
Breakfast	1	0.56	0.56	0.35
Lunch	0	0	0	0
Dinner	0	0	0	0
Water Heating	0	0	0	0
Food for Babies	0	0	0	0

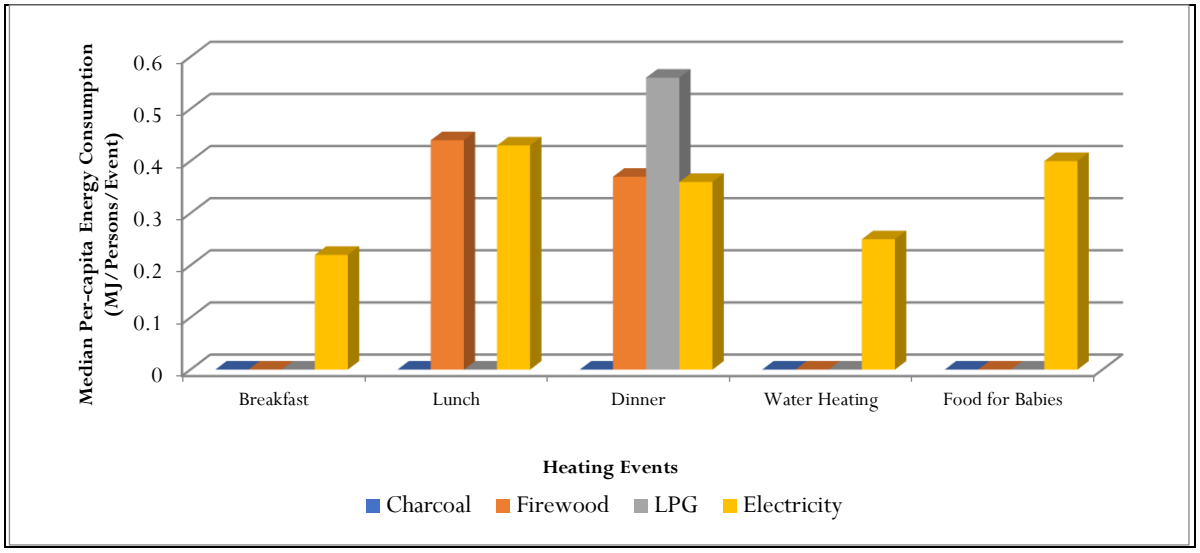
The per-capita energy consumption from LPG was used once during the second phase. The LPG was used during the breakfast for boiling tea since the household run out of electricity due to running out of bill (required paying another bill). All other households did not use LPG for cooking during the second phase.

Table 15: Per capita energy consumption by heating event (MJ/person/event) (single events only) – Phase 2 Electricity only

Heating event	**Frequency**	**Mean**	**Median**	**Std.dev.**
Breakfast	38	1.26	0.22	1.58
Lunch	35	0.50	0.43	0.36
Dinner	59	0.43	0.36	0.36
Water Heating	75	0.86	0.25	1.12
Food for Babies	16	0.54	0.40	0.13

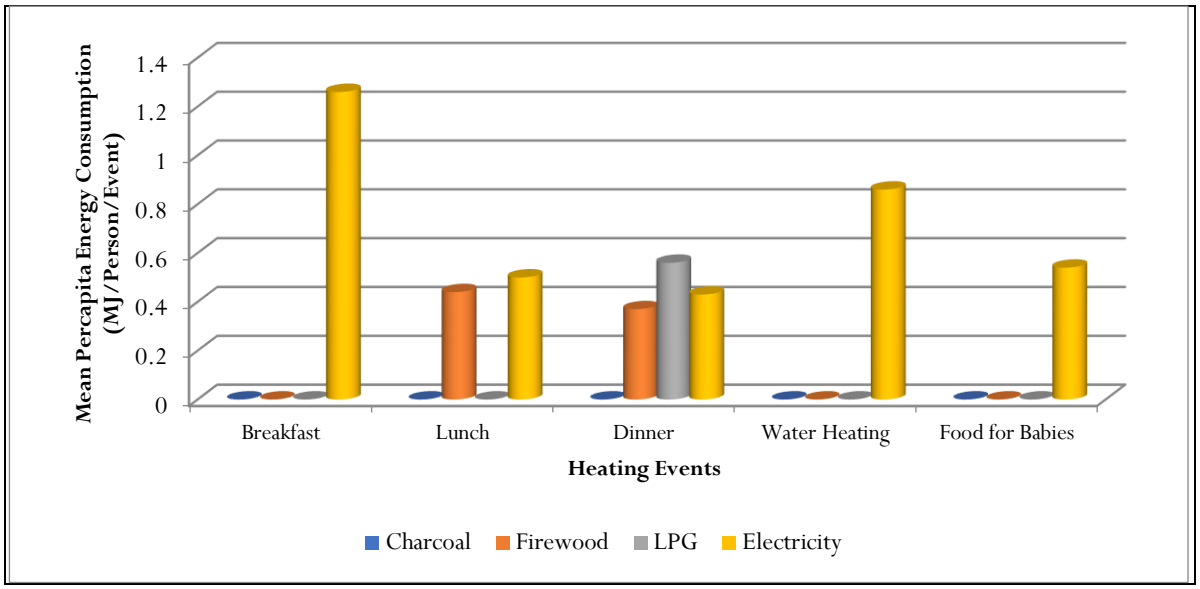
The phase 2 was time for high frequency of cooking by electricity using EPCs in all cooking events. The frequency of using electricity per person increased due to introduction of EPCs in the households which is efficient appliances and clean cooking solution. Although the frequency of cooking with electricity and EPCs was higher in all heating events, the per-capita energy consumption was low compared to the cooking in phase 1.

Chart 6: Median Per capita Energy Consumptions for Different Heating Events (Phase 2-Single Events Only)



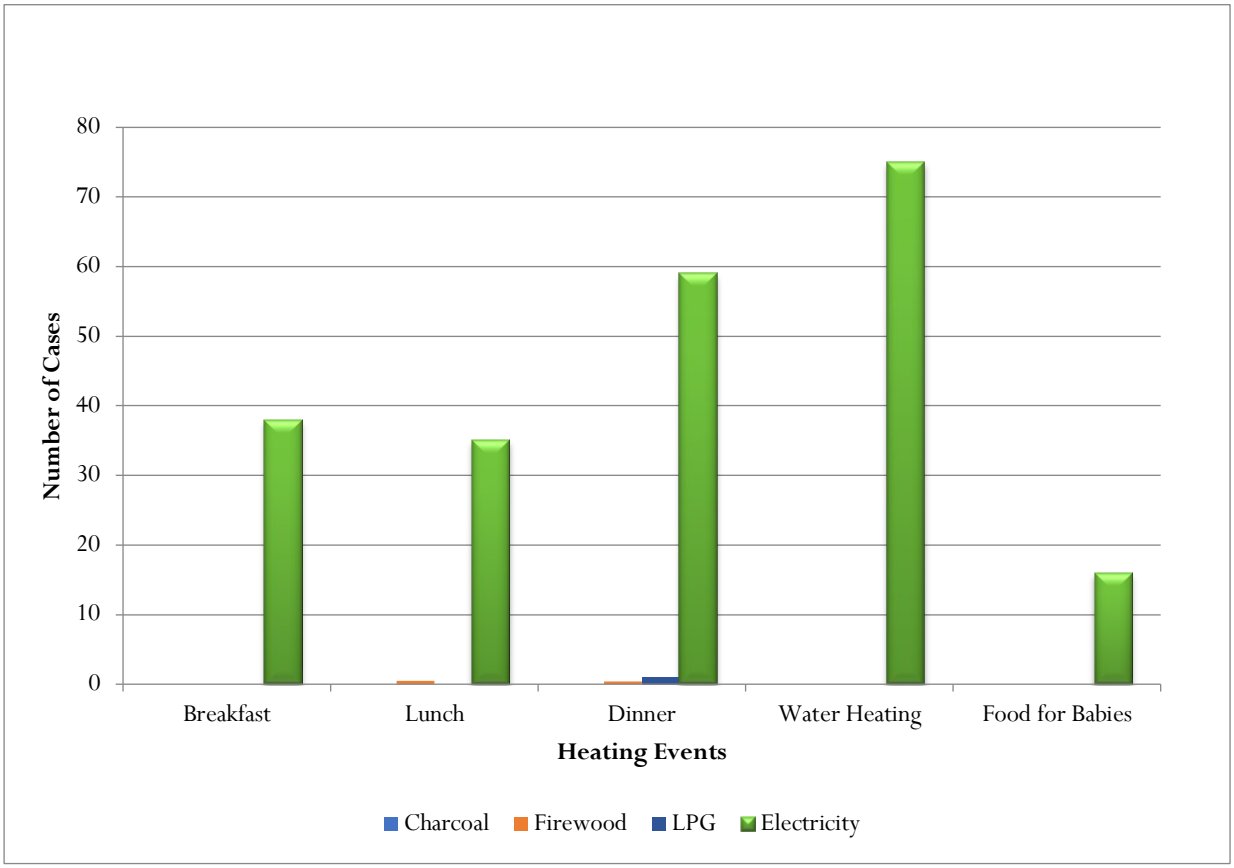
Per-capita median energy consumption shows only three energy carriers used by households during different heating events. All households used electricity in each heating event. None of the household used charcoal in phase 2. There was use of firewood for lunch and dinner and LPG for dinner but it happened for water heating and cooking food which it recipe has bi-carbonate soda.

Chart 7: Per Capita Mean Energy Consumptions for Different Heating Events (Phase 2-Single Events Only)



Per-capita mean also shows cooking with electricity throughout all heating events and households did not use charcoal for cooking in phase 2. Only electricity used during cooking breakfast, food for babies and water heating. There was fuel stacking of electricity with firewood and LPG for some households in the afternoon and evening for cooking lunch and dinner. The energy per person per event ranged from 0 to almost 1.2 MJ.

Chart 8: Choice of Fuels for Heating Events (Phase 2)

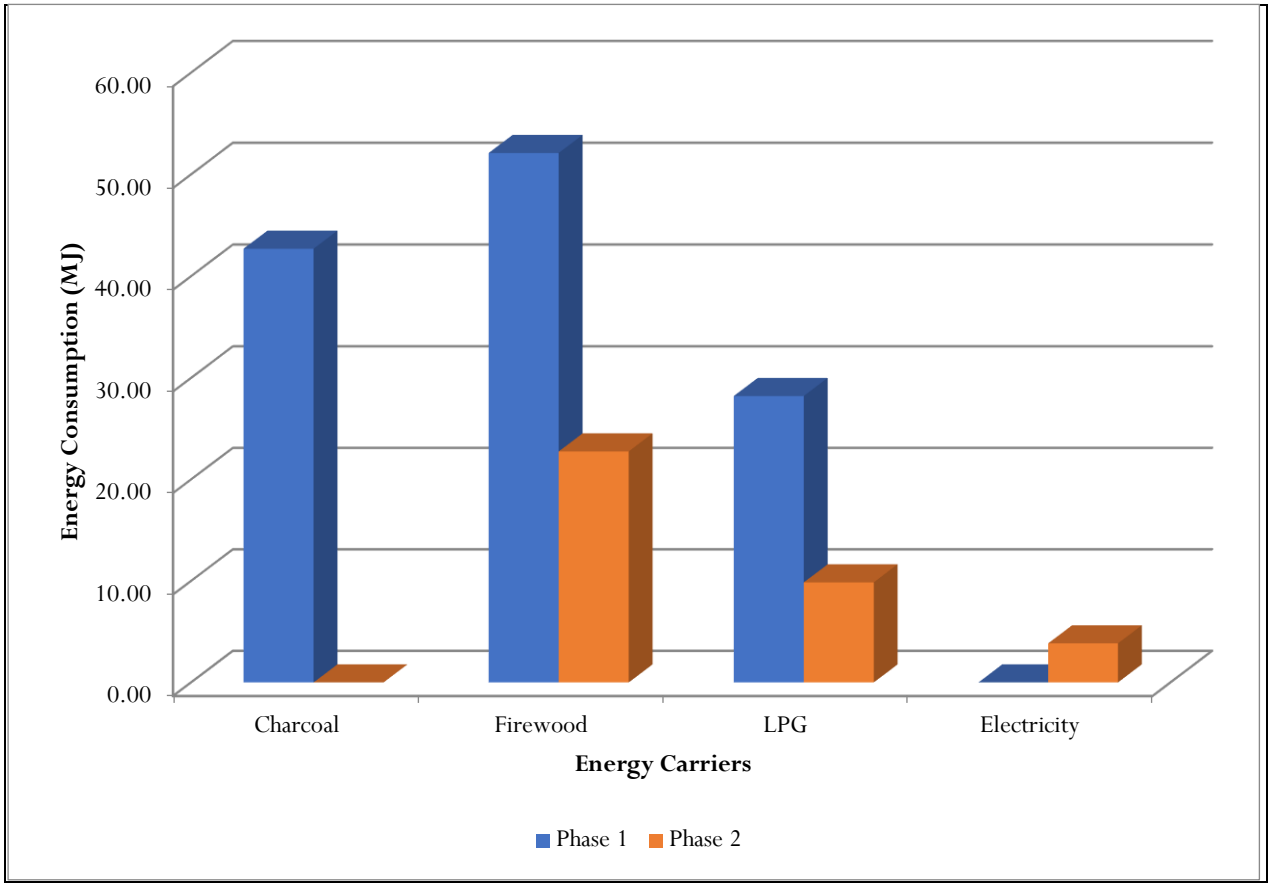


The frequency of energy consumption for each heating events shows that there were more cases of using electricity during water heating, followed by cooking dinners, breakfast and lunch. Food for babies is performed for household with infants (babies), hence there were few cases of this heating event. The number of heating events cases ranged from 0 to 75 but maximum per capita energy consumption was only 1.26 MJ.

10.3.5 Energy Consumption per Day

The total energy consumed per day has been calculated by adding the energy consumption of all heating events for a day. For each heating event, average energy consumption has been calculated for the time period during which the meal was prepared by dividing the energy consumption by the time duration of the heating event (both start and end times for the preparation of the meal were recorded for each heating event). The following chart indicates energy consumption per day for phase 1 and phase 2 from various cooking energy carriers.

Chart 9: Average Energy Consumed per Day (Summed Across all 12 Households)



An analysis of energy consumption per day for phase 1 indicates that household which was using firewood was using more energy, followed by energy from charcoal and LPG. None of the households was using electricity in the first phase. Phase 2 also showed the use of fuels which have more energy such as LPG and firewood for some foods which uses bicarbonate soda and heating of water for bathing. However, households which used electricity solely for lighting started to use it for cooking. The use of efficient cooking appliances made them believe that electricity is affordable and can be used for cooking if is used in efficient devices. The total electricity used per day by households was 3.85 MJ which is lower than the charcoal, firewood and LPG.

10.4 Meals Cooked

10.4.1 Food Types Cooked

Types of food cooked were categorised into breakfast, lunch or dinner events as shown in table 10. Foods for breakfast in rural areas of Hai District, Kilimanjaro are loaves of bread, dough, porridge, sweet potatoes, and roasted banana/dessert. As shown in table 11: milk, tea, coffee and cocoa are also used for breakfast. The staple food is banana but also other foodstuff cooked for lunch and dinner are pasta, rice, sweet potatoes, beef, chicken, ugali, beans, makande, mtori, pilau, meat, and vegetables. Other foods which are rarely cooked are ngararimu, kyuumbwe, Nyan, mlaso, kichanganya, vipere, vikwa and viyee. Some of the breakfast foods types such as bread and dough are not cooked in households but bought as bites from nearby vendors.

Table 16: Type of Food Cooked by Households (Frequencies Across Participants)

Food	Event	Phase 1		Phase 2	
		Frequency	Percent	Frequency	Percent
Bread	Breakfast	3	1.23	2	0.74
Dough	Breakfast	2	0.82	0	0.00
Porridge	Breakfast	7	2.88	6	2.21
Sweet potatoes	Breakfast	21	8.64	16	5.88
Eggs	Breakfast	7	2.88	5	1.84
Banana	Lunch/Dinner	32	13.17	34	12.50
Rice	Lunch/Dinner	15	6.17	24	8.82
Ugali	Lunch/Dinner	10	4.12	13	4.78
Makande	Lunch/Dinner	6	2.47	10	3.68
Meat (Beef/Goat)	Lunch/Dinner	28	11.52	33	12.13
Chicken	Lunch/Dinner	5	2.06	13	4.78
Beans	Lunch/Dinner	12	4.94	27	9.93
Vegetables	Lunch/Dinner	36	14.81	36	13.24
Kiburu	Lunch/Dinner	12	4.94	0	0.00
Mtori	Lunch/Dinner	15	6.17	22	8.09
Ngararimu	Lunch/Dinner	5	2.06	1	0.37
Kichanganya	Lunch/Dinner	10	4.12	11	4.04
Pilau	Lunch/Dinner	17	7.00	19	6.99

Table 17: Type of Hot Drinks (Water Heating)

Water	Event	Phase 1		Phase 2	
		Frequency	Percent	Frequency	Percent
Water for Drinking	Lunch/Dinner	12	11.65	14	12.84
Water for Milking	Breakfast/Lunch/Dinner	26	25.24	27	24.77
Water for Bathing	Breakfast/Lunch/Dinner	25	24.27	26	23.85
Tea/Coffee/Cocoa	Breakfast	24	23.30	24	22.02
Food for Babies/Milk	Breakfast/Babies	16	15.53	18	16.51

The comparative analysis was undertaken for phase 1 and 2 on type of food and hot drinks cooked by participants. Banana ((13.17%), Meat (11.52%), and water in terms of water for milking (25.24%) and tea, coffee and cocoa (23.3%) had high frequency in the breakfast but all these food are consumed with bites (bread, dough, eggs, sweet potatoes and roasted banana). Some households also are taking breakfast with leftovers of food (kiporo) of the previous day. Vegetables were also observed as a foodstuff with high frequency during lunch and dinner. Animal protein consumed by people during lunch and dinner are beef/lamb (11.52%) and mtori soup (6.17%). The animal protein food and vegetables are also appearing in the table to have high frequencies because they are mixed or consumed with rice, banana and ugali. Beans are also mixed in various food such as Pilau, Kichanganya, Ngararimu, Kiburu and makande.

Most of the participants were much interested in the use of EPC after introducing it to them in phase 2. All these foodstuffs were cooked in all phases but participants felt palatability and increased taste for rice and banana cooked in EPCs during phase 2. All hard and simple foodstuffs were easily cooked in phase 2 due to appliances that simplified work and lessened time for cooking. The frequency of cooking some foods increased in phase 2. These were rice, banana, ugali, meat, chicken, beans, mtori, kichanganya and pilau. The hot drinks were almost the same for both phase 1 and phase 2.

10.4.2 Reheating Food

Fresh cooking and reheat of food were part of data collected from households involved in the cooking diary survey in Kilimanjaro. If all dishes in a meal were reheated, then the meal was classified as reheated, if all were freshly cooked, then the meal was classified as fresh. Results for all those records that contained only a single heating event are presented in table 12.

Table 18: Mean of Daily Energy Used for Cooking Fresh Foods or Reheating Food (MJ)

Energy Carrier	Existing Cooking Practices (Phase 1)			Cooking with Electricity(EPC) (Phase 2)		
	Fresh	Reheated	N	Fresh	Reheated	N
Charcoal	72.62	30.24	30	0	0	0
Firewood	308.95	189.36	125	35.42	28.98	4
LPG	188.32	129.78	96	41.14	9.04	1
Electricity	0	0	0	34.5	19.26	223

Reheating food is expected to take less energy than cooking a fresh meal and indeed this was the case for both meals. Less energy was used in phase 2 of cooking with EPCs compared to the energy used in phase 1 in which foods was prepared by using charcoal, firewood and LPG. Most of the households in phase 2 stopped reheating food by using charcoal instead those households reheated by using firewood, LPG and electricity. Only two households used firewood for reheating foods and one household reheated food by using LPG. None of the households used electricity in phase 1 for cooking fresh and reheating food.

Table 19: Frequency of Reheating /Cooking Fresh Food

Item	Dish 1	Dish 2	Dish 3	Dish 4	Total	Percent
Reheated	51	43	21	8	123	24.6
Fresh	249	119	7	9	384	75.4

The breakfast had a higher degree of reheating dishes than lunches and dinners and this was true of both Phase 1 and Phase 2. There was reheating of food during breakfast for foods that remained in the previous day. Reheating was realized during lunches for households with housekeepers in the afternoon when all parents are in their workplaces. However, the frequency of cooking fresh food was 75.4 percent compared to reheating food which was only 24.6 percent.

10.4.3 Energy to Cook Food Types

In this section, the energy required to cook different food types or meals in combinations was identified. Multiple fuels were used to cook dishes in Phase 1. Frequencies of dish 1 to dish 4 were recorded and added for each fuel used to cook those types of dishes. The percentage of each dish for every fuel was determined to assess the magnitude of energy used to cook that type of food.

Table 20: Frequency of Cooking Dishes with Different Fuels

Energy	Food	F, Dish1	F, Dish 2	F, Dish3	F, Dish 4	Total	Percent
Charcoal	Vegetables	1				1	5.56
	Beans	2				2	11.11
	Ugali	2	2			4	22.22
	Rice	1	1			2	11.11
	Soup	1				1	5.56
	Porridge	4				4	22.22
	Makande	1				1	5.56
	Banana (hard)		1			1	5.56
	Beef/Goat		2			2	11.11
						18	100.00
Electricity	Porridge	11				11	8.09
	Beef/Goat	17	5	2		24	17.65
	Makande	12	2			14	10.29
	Banana (hard)	14	12	2	1	29	21.32
	Rice	5	14		2	21	15.44
	Vegetables	5	4			9	6.62

Energy	Food	F, Dish1	F, Dish 2	F, Dish3	F, Dish 4	Total	Percent
	Soup	2				2	1.47
	Beans	5	4	1		10	7.35
	Ugali	2	6	2		10	7.35
	Sweet potatoes/taro root	1				1	0.74
	Fish Stew	3	1			4	2.94
	Chick/Duck Stew	1				1	0.74
						136	100.00
Firewood	Matoke	1				1	0.69
	Banana(hard)	17	6	1		24	16.67
	Beef Goat	4	4			8	5.56
	Vegetables	7	18	1		26	18.06
	Chapati	4				4	2.78
	Ugali	6	8	2		16	11.11
	Beans	4	2	1		7	4.86
	Boiled Potatoes	2		1		3	2.08
	Rice	5	6	1		12	8.33
	Pasta	3				3	2.08
	Porridge	5	1			6	4.17
	Sweet potatoes/taro root	2				2	1.39
	Fish Stew		2			2	1.39
	Soup		1			1	0.69
	Makande	7	1	1		9	6.25
	Others	18		2		20	13.89
						144	100.00
LPG	Bananas (hard)	2	2			4	16.00
	Beans	1				1	4.00
	Beef/Goat	3				3	12.00
	Chapati	1				1	4.00
	Vegetables	1				1	4.00
	Pasta	1				1	4.00

Energy	Food	F, Dish1	F, Dish 2	F, Dish3	F, Dish 4	Total	Percent
	Porridge	6				6	24.00
	Ugali	1	1	1		3	12.00
	Sweet potatoes/taro root	1				1	4.00
	Others	1	2	1		4	16.00
						25	100.00

According to the table 14 above, fuels used in phase 1 which were charcoal, LPG and firewood cooked all types of foods. Firewood is the dominant fuel used by all households. Almost all foods were cooked with firewood. Banana, Rice, Meat (Beef/Goat) and Vegetables as main dishes are cooked with all fuels in the study area. These are followed by Porridge, Ugali and Makande. Meat and vegetables are mixed with other foodstuffs during consumption. The rates of these foods are high because they are consumed by almost all starch foods.

Although firewood is sometimes fetched within the selected study areas but also is bought from other areas while charcoal is totally bought from towns or other places.

Banana as a staple food is also cooked by all fuels but this type of food is cooked well in the LPG and electricity. The reason is requirement of constant heat during cooking of this dish (It does not require heat fluctuation during cooking which can be well maintained by LPG stoves and EPC). Beans and makande are hard foodstuffs, their frequency are not high because beans are half cooked and packed in the refrigerators while makande are rarely cooked by households.

According to the table 14, almost all food in the second phase were cooked by electricity in the EPC. Cooking with electricity using EPCs replaced charcoal, firewood and LPG used in phase 1. The consumption of electricity by households in terms of frequencies of using this energy type is broken down further in chart 10 below.

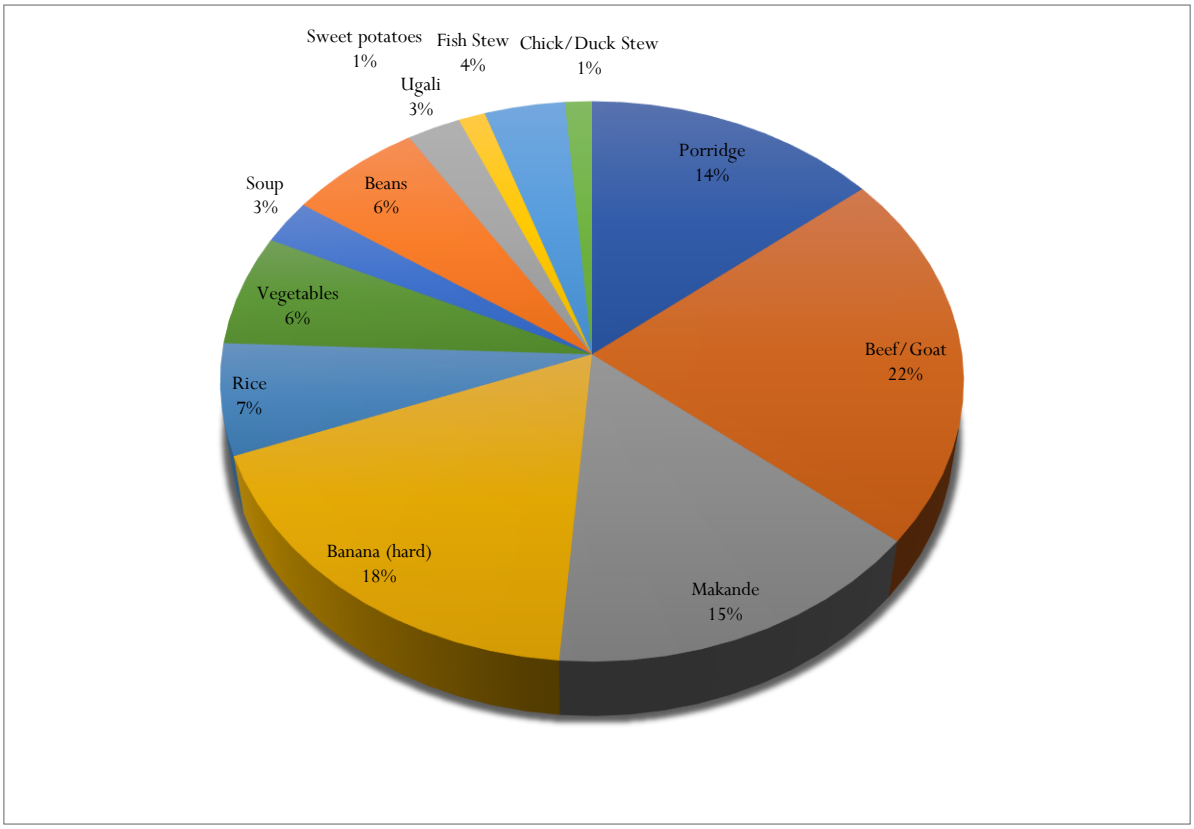


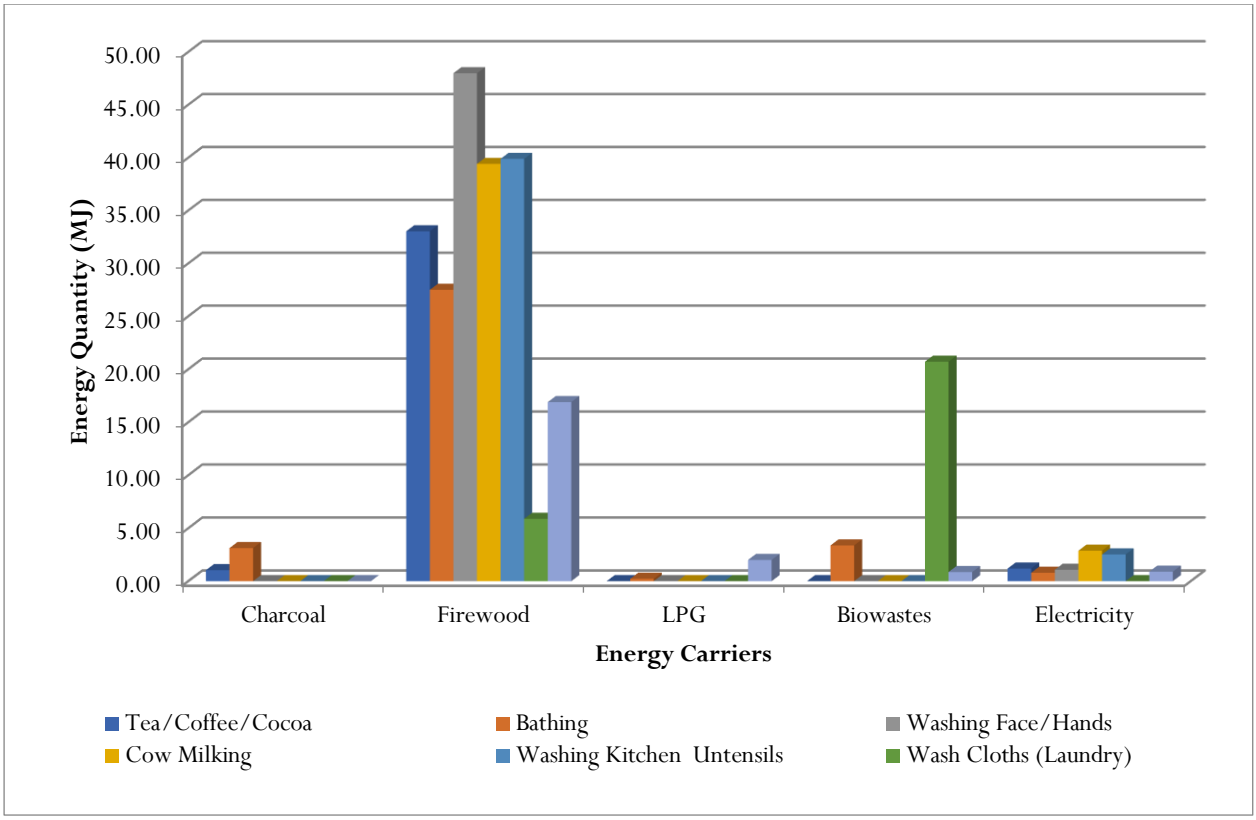
Chart 10: Frequency of Consumption Different Type of Foods Cooked in the Electricity (Phase 2)

The main dish remained to be Meat, followed by Banana, Makande, Porridge, Rice, Vegetables, and Beans. Vegetables, meat and beans were complimentary foodstuffs eaten with starch foods. The rate of cooking beans by electricity increased because of the short time, easiness and affordability of cooking this type of food in the EPCs. The frequency of cooking rice increased in households because of the taste and easiness of cooking this dish compared to other foodstuffs.

10.4.4 Hot Drinks and Water Heating

Hot drinks and water heating are other energy consumption requirements for households. The main hot drinks cooked by all fuels in phase 1 and phase 2 are tea, coffee, cocoa and milk (chart 5). Although these foodstuffs were not further analysed, experiences show that tea and milk are hot drinks mostly consumed in those households compared to cocoa and coffee. Although Kilimanjaro is a coffee-growing area, people are growing it for commercial purposes and only a small amount is consumed in the households. In phase 1, it was realized that firewood is the fuel that is used by several households for cooking hot drinks. This is followed by bio-wastes (complementary of firewood) which is used for water heating whenever hot water is required in a large quantity in those households because of cool weather.

Chart 11: Average Energy Consumption for Water Heating per Day for All Households



Water is also heated for the purpose of bathing, cow milking and washing hands. The main fuel used to heat water for bathing, milking and washing hands is firewood. LPG and Charcoal are rarely used for water heating; only a few households are using them for bathing water for washing kitchen utensils. Water for washing clothes or laundry is boiled by bio-wastes and firewood and not other fuels.

Preparation of hot drinks and heating of water for bathing in phase 2 was done by electricity. According to the chart above, water for cow milking, washing utensils, water washing face/hands, washing kitchen utensils and cow milking were also boiled by EPCs. The energy used for water heating in the aforementioned household requirements is small due to the efficiency of the electric appliances used for boiling water.

10.5 Cooking Appliances

10.5.1 Detail on How Participants Cook

During the study, the following information was recorded and collected from households surveyed by asking the following questions. 1) Cooking appliance used i.e. what type of stove, 2) Type of cooking pot/utensil, 3) How they used the lid and 4) Cooking process used e.g. fry, boil, bake etc.

The cooking appliances used to cook foods by households are presented on table15. Note that any single record can contain information up to four foods, so the table includes each separate food–appliance combination. This shows that more than 45% of foods were cooked with firewood stoves. The firewood stoves were used in both phases 1 and 2 but two fuels (firewood and bio-wastes) were used in this stove. The firewood stoves in phase 2 were used to heat water for bathing and milking. During phase 2, almost all households (100%) used EPCs to cook food but if compared

to phase 1, the rate of households using EPCs is 42.4%. Charcoal stoves (5.3%) and LPG stoves (6.9%) were also used by those households during phase 1.

Table 21: Cooking Appliances Used by Households

Appliance	Frequency	Mean	Median	Percent
Charcoal Stove	20	1.7	1	5.3
LPG Stove	26	2.2	1	6.9
Firewood Stove	171	14.3	4	45.4
EPCs	160	13.3	3	42.4

10.5.2 Kitchen Equipment Used During Cooking

The study also assessed other equipment used in the kitchen for cooking. The assessed equipment were cooking pots by their sizes, frying pans and lids for covering pots. Uses of these equipment have effects on the energy consumption in households whenever a user is cooking. The following table 16 shows kitchen equipment used in rural areas of Hai District, Kilimanjaro for cooking.

Table 22: Equipment Used in the Kitchen for Cooking

Ppt ID	Participant	Small Pot	Medium Pot	Large Pot	Frying pan
1	Elinaike Masawe	5	5	0	0
2	Dorcas Nkya	4	9	0	0
3	Vicky Mushi	3	10	0	3
4	Nancy Kidin	7	7	2	0
5	Ndumieshi Mushi	8	14	0	1
6	Rehema Shoo	2	8	0	1
7	Aisa Lema	4	14	0	0
8	Dorothy Swai	10	19	0	0
9	Lipina Kombe	1	15	0	1
10	Olga Shoo	4	13	0	1
11	Batuli Kimaro	0	12	1	0
12	Jenifer Mushi	11	12	0	0
	Total	**59**	**138**	**3**	**7**
	Percentage	**29%**	**67%**	**1%**	**3%**

Pots used in households were categorised into small, medium and large sizes. The small pot was of 1-4 litres, medium of 5-7 litres and large of 8-10 litres. About 67% of food is cooked in medium size pots. Light foods like tea, milk, baby foods, etc are cooked by using small pots. The large pots and medium pots are used for boiling water for bathing, milking or family size increase like when children have come back to their home places for school leaves and when the family receive guests. About 3% of users in the households used frying pans for cooking food. About 32 % of users were using lids.

10.5.3 Cooking Methods

There are different methods used for cooking foods by households in rural areas of Hai District in the Kilimanjaro Region (Table 17). The main methods used for cooking in households of rural areas in Hai District, Kilimanjaro Region include frying and boiling. Grilling, baking and roasting are used by food vendors in specific places for commercial purposes. The frequencies of using these methods were assessed for both phases with the addition of pressure cooking in the second phase.

Table 23: Methods Used for Cooking Food

Cooking Methods	Phase 1	Phase 2
Frying	208	115
Boiling	648	80
Pressure Cooking	0	764

The assessment shows that boiling is by far the most commonly used cooking method during phase 1 and 2. This was outweighed by pressure cooking in the phase 2 when the EPC was introduced in those households. Note that participants were slightly reduced for frying during phase 1 and 2 since pressure cooking could not replace these methods in the households. Boiling in this case involves both water heating and cooking some food stuff which require boiling methods. Although pressure cooker can be used for baking but this method was not practised during the study. The frequency of boiling and frying by using firewood stoves and LPG were reduced in the phase 2 compared to phase 1.

10.5.4 Characteristics of Different Cooking Devices

The types of food cooked were assessed by rating them with the type of cooking appliances used in households. The stoves found in those households during this study in phase 1 are the ones that are using charcoal, firewood and LPG.

Table 24: Type of Food Cooked by Appliances in Phase 1

Food	Charcoal Stove	Firewood Stove	LPG Stove	EPC
Bananas	1	21	4	0
Beans	2	8	1	0
Beef/Goat	2	12	3	0

Food	Charcoal Stove	Firewood Stove	LPG Stove	EPC
Fish stew (boiled)	0	3	0	0
Vegetables	3	26	1	0
Makande	2	8	0	0
Pasta	0	3	1	0
Porridge	3	13	6	0
Rice	2	15	0	0
Sweet potatoes/cassava/taro root	0	4	1	0
Ugali	4	16	2	0
Chapati	0	4	1	0
Matoke	0	2	1	0
Others	2	26	4	0
Total	**21**	**161**	**25**	**0**
Percentage	**10.1**	**77.8**	**12.1**	**0**

Almost all foods are cooked with charcoal, firewood and LPG and cookstoves related to those fuels in the selected households. Table 18 shows that many participants had access to firewood than LPG and charcoal; it can be assumed that the dominant use of firewood in Phase 1 reflects the fuel which is affordable, abundant and available in the rural Hai District. The high price of LPG compared to firewood has lowered the use of LPG stoves in households. Charcoal was rated the third to firewood and LPG since it is mostly used in the urban areas and not in the rural areas. Rural areas of Hai District are well electrified by grid electricity but none of the households in selected rural areas was using electric appliances for cooking during phase 1. This is due to past experience of high cooking costs and inefficient appliances used by end-users in rural areas for cooking with electricity.

All households were required to cook by using electricity in the EPCs in phase 2, other stoves and fuels were as well used for specific purposes such as inability to believe that Ugali and Beef Soup can be cooked in the EPC. Participants accepted the notion of the simplicity of cooking food by using EPCs, compared to charcoal, LPG and firewood stoves. It was difficult to compared charcoal stoves with firewood stoves because many participants were familiar with firewood stoves and not charcoal stoves. There was also a mentality in the study area that charcoal stove produces carbon monoxide which is dangerous to their lives.

Table 25: Type of Food Cooked by Appliances in Phase 2

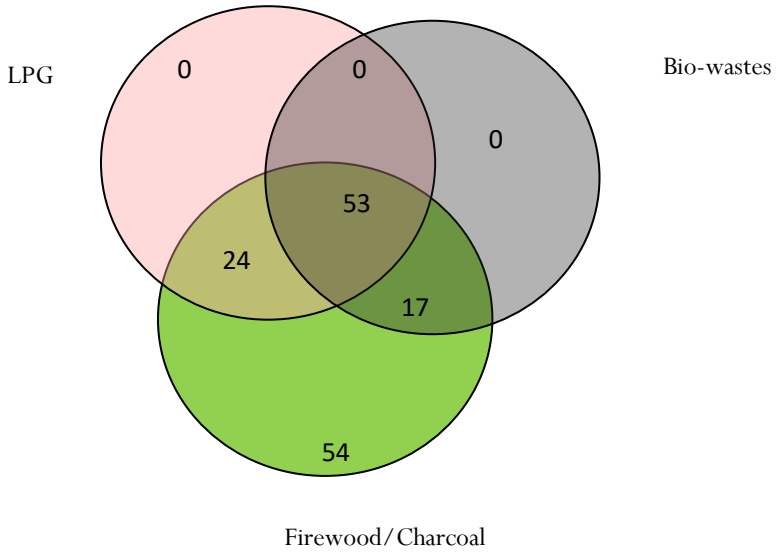
Food	Charcoal Stove	Firewood Stove	LPG Stove	EPC
Bananas	0	0	0	29
Beans	0	0	0	15
Beef/Goat	0	0	0	19
Fish stew (boiled)	0	0	0	4
Duck/chicken stew	0	0	0	1
Vegetables	0	0	0	12
Makande	0	0	0	14
Porridge	0	0	0	21
Rice	0	0	0	21
Sweet potatoes/taro root	0	2	0	1
Ugali	0	1	1	10
Soup (Beef)	0	2	0	1
Others	0	0	0	21
Total	**0**	**5**	**1**	**169**
Percentage	**0.57**	**2.84**	**0.57**	**96.02**

Despite, the inability to cook by EPCs for some households at the beginning for Ugali and Soup, almost all foods were cooked by EPCs in phase 2. EPCs use by households was rated at 96.02% compared to other stoves during phase 2. Households enjoyed the fastness, easiness, affordability and safety of these appliances during phase 2. EPCs were used to prepare many foods but not those that required frying (e.g. eggs, chapati and maandazi). Therefore, some frying pans may be required during deep frying of those foodstuffs.

10.5.5 Fuel Stacking

An important question that requires an answer is what compels the prevalence of multiple fuels used by households. During phase 1 assessment was conducted to provide explanations to the prevalence of energy stacking behaviour amongst households. Therefore, the justification for this question seeks to provide explanations for multiple fuels used by households in Hai District, Kilimanjaro Region. Understanding fuels choice behaviour and factors underlying such behaviour will enrich cooking practices on how electricity and other cleaner fuels will be adopted by the households. These can as well reflect and stimulate further assessment in the area of households' fuels choice, fuel utilization, household willingness to pay for reliable modern energy appliances and services.

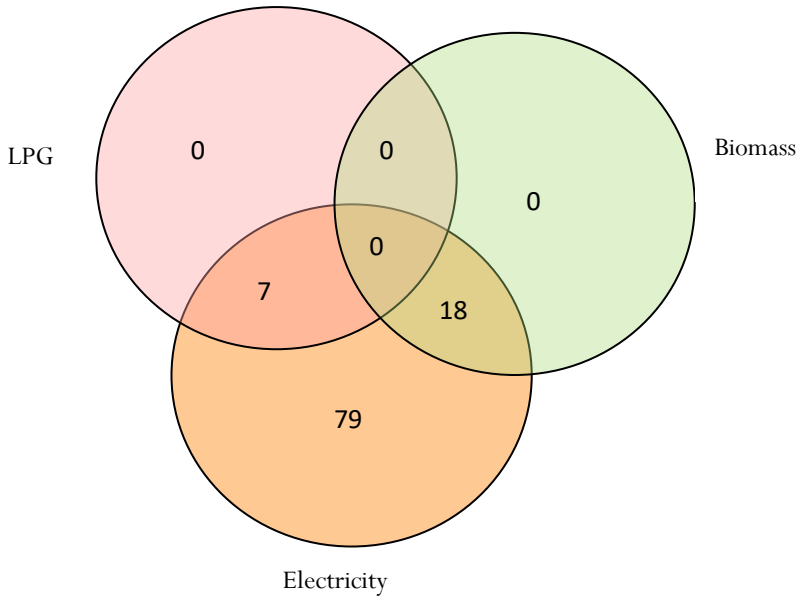
Chart 12: Frequency of Fuel Stacking During Phase 1



During phase 1 of the study, fuels that were frequently used in the selected households were firewood, charcoal and LPG. The status of fuel stacking for firewood, charcoal and LPG has reflected in chart 6 above. The frequency of stacking bio-wastes, firewood, charcoal and LPG was 28%. The frequency of using firewood, charcoal and LPG was 16% while firewood/charcoal and bio-wastes was 20%. The frequency of using single fuel was observed for firewood and charcoal which is 35.5%. None of the households used LPG and Bio-wastes as the only fuels for cooking. These fuels are stacked with firewood or charcoal. The reason for fuel stacking is to find combination fuels that are affordable by the households at the same time save time for other business and productive activities.

The behaviour of fuel stacking by households in phase 2 was tremendously reduced since the EPCs were introduced and it was easier to use them for energy which is available in the households. The only information which is missing is the behaviour of people during the power cuts. The study was performed during the time of campaigning for a national election and power utility ensured that there were no power cuts in that area. The circumstances of power blackouts forced the households to use their traditional inefficient cooking appliances. The fuel stacking in phase 2 was not intensive like in phase 1. This is as shown in chart 7 hereunder:

Chart 13: Energy Stacking During Phase 2



During phase 2 of the study, the energy carriers which were frequently used in the selected households were electricity, biomass (firewood, charcoal) and LPG. The rate of stacking fuels was reduced to 10.7%. Almost all households switched to the use of electricity for cooking. The frequency of using electricity in selected households was more than 76%. The frequency of using all energy carriers by households was 0 percent. A frequency of 17.3% was observed for biomass and electricity while frequency of LPG and electricity was 7%. There was no fuel stacking for biomass and LPG.

It is possible the affordable costs of using EPCs has waved a large number of households to the electricity and caused low use of LPG, firewood and charcoal. This implies that the increase in efficiency of appliances, reduction of cooking costs and easiness of using appliances were determinants for influencing the movement of people from inefficient technologies and biomass fuels to clean energy solutions

10.5.6 Energy Used by Electrical Appliances (Phase 2)

The electrical energy figures were collected from participants in the second phase of cooking by using EPCs. The energy used was collected from each household for different meals cooked for 7 days and determined the electricity used per day. The electricity used to cook food and water heating is as shown in table 20 below.

Table 26: Energy Used for Cooking and Water Heating in Households

Household	Owner	Device	Electricity Used to Cook Meal	Electricity Used for Water Heating	Total	Electricity Used per day
			kWh	kWh	kWh	kWh
1	Elinaike Masawe	EPC	7.8	4.2	12.0	1.7
2	Dorcas Nkya	EPC	7.6	3.4	11.0	1.6
3	Vicky Mushi	EPC	7.5	5.8	13.3	1.9
4	Nancy Kidin	EPC	9.0	4.6	13.6	1.9
5	Ndumieshi Mushi	EPC	7.8	4.8	12.6	1.8
6	Rehema Shoo	EPC	6.8	5.0	11.8	1.7
7	Aisa Lema	EPC	9.3	3.7	13.0	1.9
8	Dorothy Swai	EPC	7.8	3.8	11.6	1.7
9	Lipina Kombe	EPC	7.4	5.0	12.4	1.8
10	Olga Shoo	EPC	7.5	3.6	11.2	1.6
11	Batuli Kimaro	EPC	7.0	5.8	12.8	1.8
12	Jenifer Mushi	EPC	8.4	2.6	11.0	1.6

The average energy used for cooking per day in households is 1.74 kWh which is equivalent to 6.26 MJ. There was a significant saving of energy compared to the use of charcoal, firewood and LPG. The median is 1.7 kWh, ranging from 1.6 kWh for high saving (or low consumer) of electricity to 1.9 kWh for low saving (or high consumer) of electricity.

10.6 Time

10.6.1 Time Taken to Cook Food Types

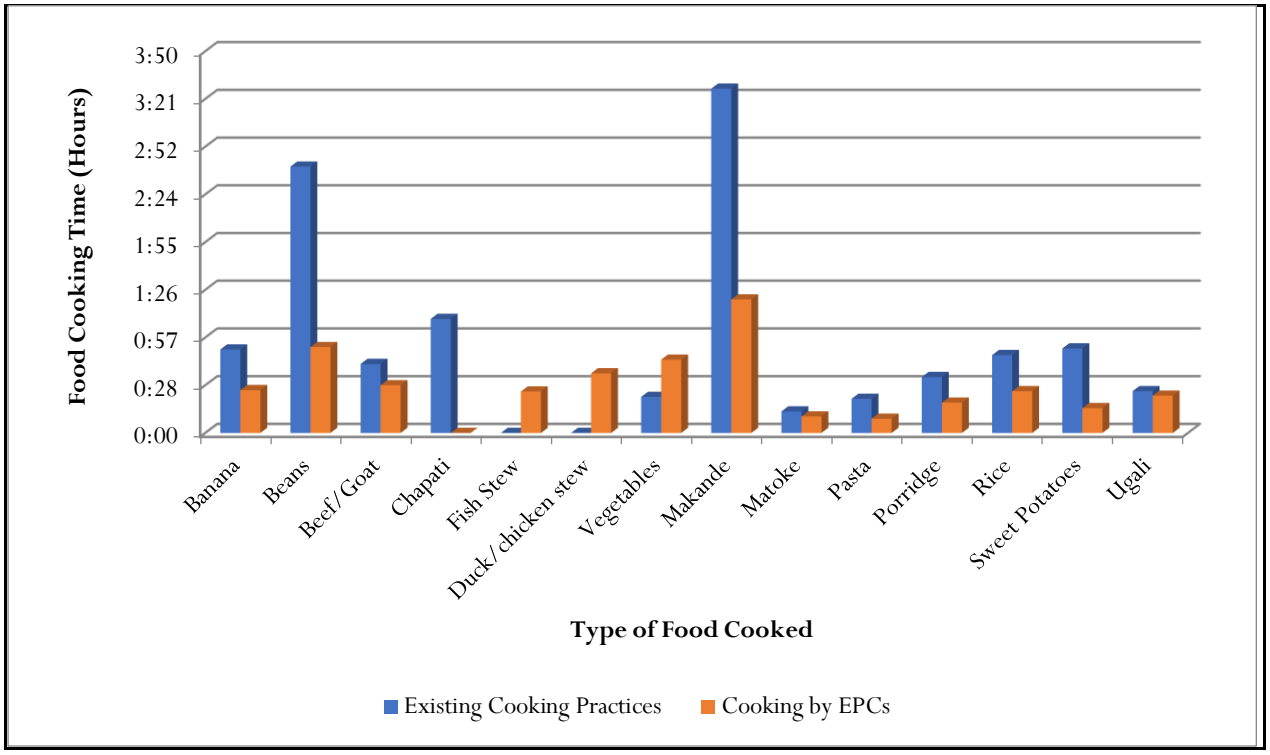
The time records were taken during cooking of different food types using Charcoal, Firewood and LPG in Phase 1 (Existing Cooking Practices) and compared to time records of electric cooking by using EPCs in phase 2 are shown in Table 21 and are illustrated in chart 8.

Table 27: Time Taken for Existing Practices and Cooking by EPCs

Food Type	Existing Cooking Practices		Cooking by EPCs	
	Mean	Median	Mean	Median
Banana	0:50	0:14	0:25	0:09
Beans	2:40	1:40	0:51	0:46
Beef/Goat	0:41	0:33	0.17	0.14
Chapati	1:08	1:20	0.00	0:00
Fish Stew	0:00	0:00	0:25	0:20
Duck/chicken stew	0:00	0:00	0:36	0:36
Vegetables	0:21	0:20	0:44	0:30
Makande	3:27	3:25	1:20	1:13
Matoke	0:12	0:12	0.09	0.85
Pasta	0:20	0:22	0.08	0.06
Porridge	0:33	0:31	0:18	0:20
Rice	0:47	0:50	0:25	0:30
Sweet Potatoes/Cassava	0:51	0:45	0:15	0:13
Ugali	0:25	0:28	0:22	0:22

The table above consists of times taken to cook individual foods when prepared as part of meals comprised of different foodstuffs. The comparison between times for cooking by using existing practices and electricity showed that there is a significant difference in cooking times during existing cooking practices and electricity by EPCs

Chart 14: Time Taken to Cook by Food Types (Existing and EPC Practices)



According to chart 14, makande and beans are heavy common foods that have been used long times during existing cooking practices, followed by Chapati. The times for other foods were less than one hour. The use of EPC has reduced cooking times for all foods (even heavy ones) to less than an hour.

10.6.2 Time Taken to Prepare Meal (Foods)

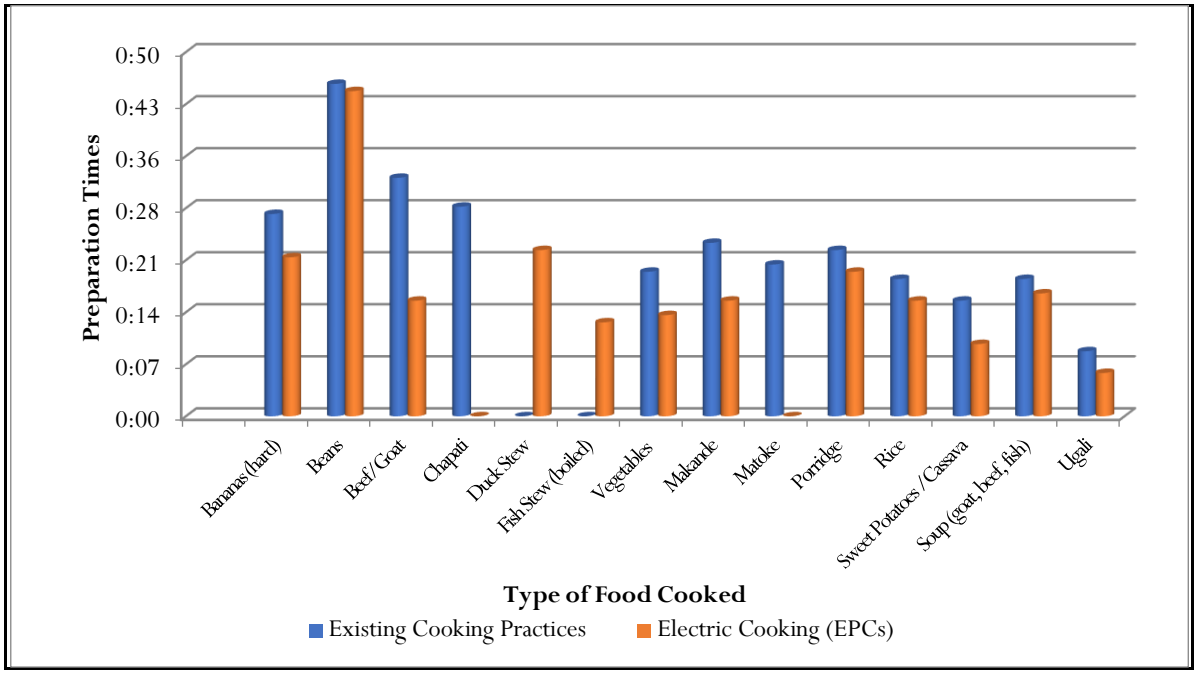
The time that was taken to prepare food was also assessed for each household by individual foods during phase1 and phase 2. There were some foods such as chapati and matoke which their times were taken during the existing cooking practices only. Other foods like Duck Stew and Fish Stew which their times were taken during electric cooking because they were only cooked by EPCs in the second phase. The findings were as shown in table 28 and chart 15.

Table 28: Times for Food Preparation

Food Type	Existing Cooking Practices			Electric Cooking (EPCs)		
	Count	Mean	Median	Count	Mean	Median
Bananas (hard)	30	0:28	0:27	30	0:22	0:24
Beans	12	0:46	0:07	14	0:45	0:11
Beef/Goat	18	0:33	0:10	11	0:16	0:15
Chapati	4	0:29	0:10	0	0:00	0
Duck Stew	0	0:00	0:00	1	0:23	0:23
Fish Stew (boiled)	0	0:00	0:00	4	0:13	0:12
Vegetables	30	0:20	0:11	12	0:14	0:11
Makande	9	0:24	0:17	14	0:16	0:12
Matoke	3	0:21	0:21	0	0:00	0:00
Porridge	10	0:23	0:22	10	0:20	0:30
Rice	17	0:19	0:15	20	0:16	0:13
Sweet Potatoes /Cassava	6	0:16	0:10	1	0:10	0:10
Soup (goat, beef, fish)	3	0:19	0:09	1	0:17	0:30
Ugali	22	0:09	0:05	12	0:06	0:03

Chart 15 on time for preparing foods provides a real picture of the time taken to prepare foods in each household.

Chart 15: Time for Preparing Foods



According to the table and chart above, with exceptional of beans, times used for the preparation of foods were less than half an hour. A long time was taken to prepare foods during phase 1. There was no much difference on times used to prepare foods during phases 1 and 2 for most of the foods. Some foods such as beans, meat, makande, sweet potatoes and cassava showed reasonable differences because the same practices used by people during the preparation of foods such as soaking beans for makande and beans themselves, boiling foods before cooking, cutting foods into small portions, etc. The reason is stoking of foods, the limit of EPC pot to six litres, processes required by EPCs such as putting lids and shyness of cooking some foods in the EPCs.

10.6.3 Time of Day

The time of day involves times of starting to prepare meals. This was assessed for both phases 1 and 2 for breakfasts, lunches and dinners. The purpose of this assessment is to check if there is a shift of time for starting to cook foods.

Table 29: Time of Day to Start Preparing Meal for Phases 1 and 2

Heating Event	N	Mean	Median	Std Dev
Phase 1:Existing Cooking Practices				
Breakfast	38	6:25	6:27	0:56
Lunch	41	13:00	12:45	1:24
Dinner	39	18:30	18:28	0:47
Phase 2: Cooking with Electricity (EPC)				
Breakfast	26	7:02	7:06	0:39
Lunch	32	13:37	13:40	1:03
Dinner	37	18:45	18:43	0:52

Despite the differences in each household, there are significant shifts of times of starting to cook for all meals (breakfasts, lunches and dinners). All of them started later in phase 2 of electric cooking

compared to phase 1 of existing cooking practices. This is attributed to assurances of putting food on the table almost in a short time due to the reduced times caused by cooking with EPCs.

10.7 Water Heating

Water heating for this study involves heating water for making tea, coffee, cocoa or other hot drinks, food for babies, water for drinking, water for adults and children bathing, washing hands, water for cow milking, etc. The frequency of heating events is as shown in table 24 hereunder:

Table 30: Purpose for Heating Water (All Records)

Purpose	Number of Heating Events				Total
	1	2	3	4	
Existing Cooking Practices					
Tea, Coffee, Cocoa and Milk	22	8	9	0	39
Food for Baby (Milk and Others)	7	4	6	3	20
Bathing	9	3	14	0	26
Washing Hands	11	5	2	0	18
Water for Milking	8	9	9	0	26
Water for Drinking	0	6	3	3	12
Cooking with Electricity (EPCs)					
Tea, Coffee, Cocoa and Milk	12	4	3	2	21
Food for Baby (Milk and Others)	7	3	5	0	15
Bathing	15	5	5	0	25
Washing Hands	2	3	1	1	7
Water for Milking	9	9	9		27
Water for Drinking	4	6	2	3	15

Unlike cooking which normally occurs at specific meal times, water heating occurs all the way throughout the day for different purposes including bathing, baby foods, drinking, milking, washing hands etc. Water heating cases that occurred during phase 1 were 56% compared to 44% cases recorded in phase 2. Water was heated for a single purpose only. The only complaint from users is to get the second pot for EPCs otherwise other users will opt to go back to the use of the LPG or firewood to heat water for breakfast. The reason is the unpleasant aroma from tea spices to other foods cooked by EPC. When tea coffee and milk is cooked in the same pot, scents of spices are smelt in other foods.

Table 31: Purpose for Heated Water (All Records)

Purpose	Frequency	Percent
Tea, Coffee, Cocoa and Milk	60	23.9
Food for Baby (Milk and Others)	35	13.9
Bathing	51	20.3
Washing Hands	25	10.0
Water for Milking	53	21.1
Water for Drinking	27	10.8

According to table 25 above, water heating in both phases is undertaken to the large extent during breakfast for tea, coffee, cocoa and milk. This is followed by water for milking which occurs in the morning, afternoon and evening. According to participants, water heating for hand washing was rarely practised. The number of water heating for washing hands has increased to 10 because of prevailing diseases (COVID 19), cold weather and other households' requirements such as hand washing before and after meals. Water for milking is normally practised because smallholder farmers are keeping dairy cows that are milked in the morning, afternoon and evening. Water for drinking is not much practised because of the availability of bottled water from the shops.

Table 32: Devices Used to Heat Water

Device	Phase 1: Existing Practices	Phase 2: Electric Cooking
Charcoal Stove	10	0
Firewood Stove	91	4
LPG Stove	13	1
EPC	0	74

The device which frequently used for water heating in several households during phase 1 was firewood stoves (Table 26). This was followed by LPG stoves and charcoal stoves which altogether amount to 20% of their uses in water heating. It means 80% of water heating is performed on firewood stoves. During phase 2, all users used EPCs to heat water. There were some cases of using firewood stoves and LPG stoves which altogether amounted to 6% of all devices used for water heating. Almost 94% of water heating was done by EPCs in the second phase. The utensils used to heat water for different purposes are presented in Table 27.

Table 33: Utensils Used to Heat Water

Utensils	Tea, Coffee, Cocoa and Milk	Food for Baby (Milk and Others)	Water for Milking	Water for Drinking	Bathing	Washing Hands
Big Pot	0	0	3	0	20	0
Medium Pot	22	4	13	3	16	1
Small Pot	27	24	1	1	2	2
EPC	21	15	27	15	25	7

Water is almost heated in small and medium pots, only water for bathing and milking is boiled by using a big pot. Water during the second phase was mainly heated by EPCs for breakfast (tea, coffee, cocoa, milk, food for babies, milking drinking, bathing and other purposes). There were some users who used small and medium pots in the second phase to avoid the aroma of tea spices to other food cooked by EPCs. Hands normally are washed by using cold water only a few households boil water for washing hands. Water for drinking is not much heated in households because of weather (cool temperature) and availability of bottled water in nearby shops.

11 User Experience of Electric Cooking

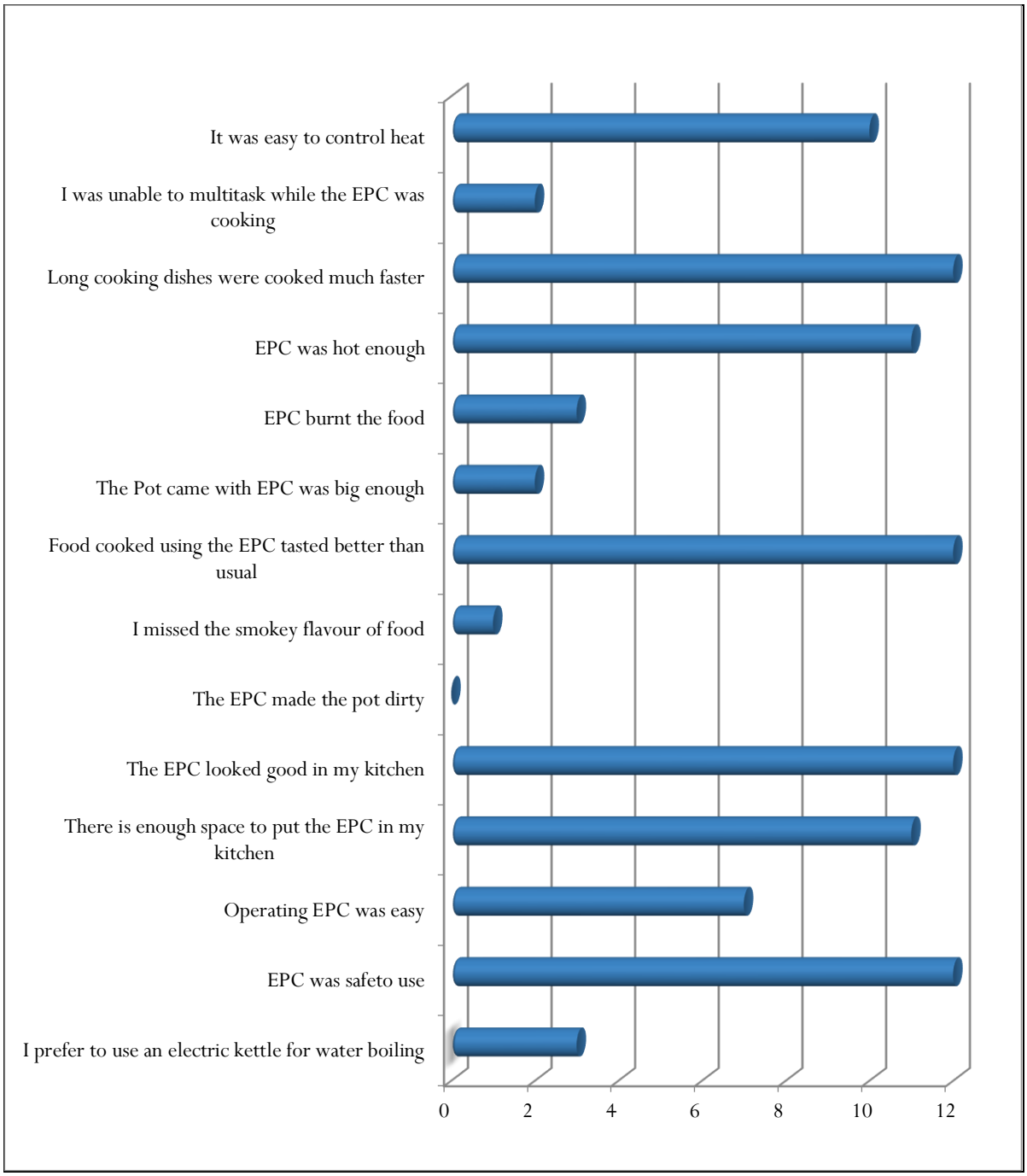
Experiences of users on their adoption of modern cooking with electricity using EPCs were collected during the exit survey, which was undertaken immediately after completing the 18 days of cooking diary. The following section begins with a presentation of the responses to each question on the exit survey and concludes with further experiences obtained during the cooking diary survey.

11.1 Responses to Exit Survey Questions

11.1.1 How did the EPC suit the way you cook in your home?

The participants were asked about the suitability of EPC for its conformity to normal practices in their households. The responses of some questions on its suitability are listed in chart 10 below:

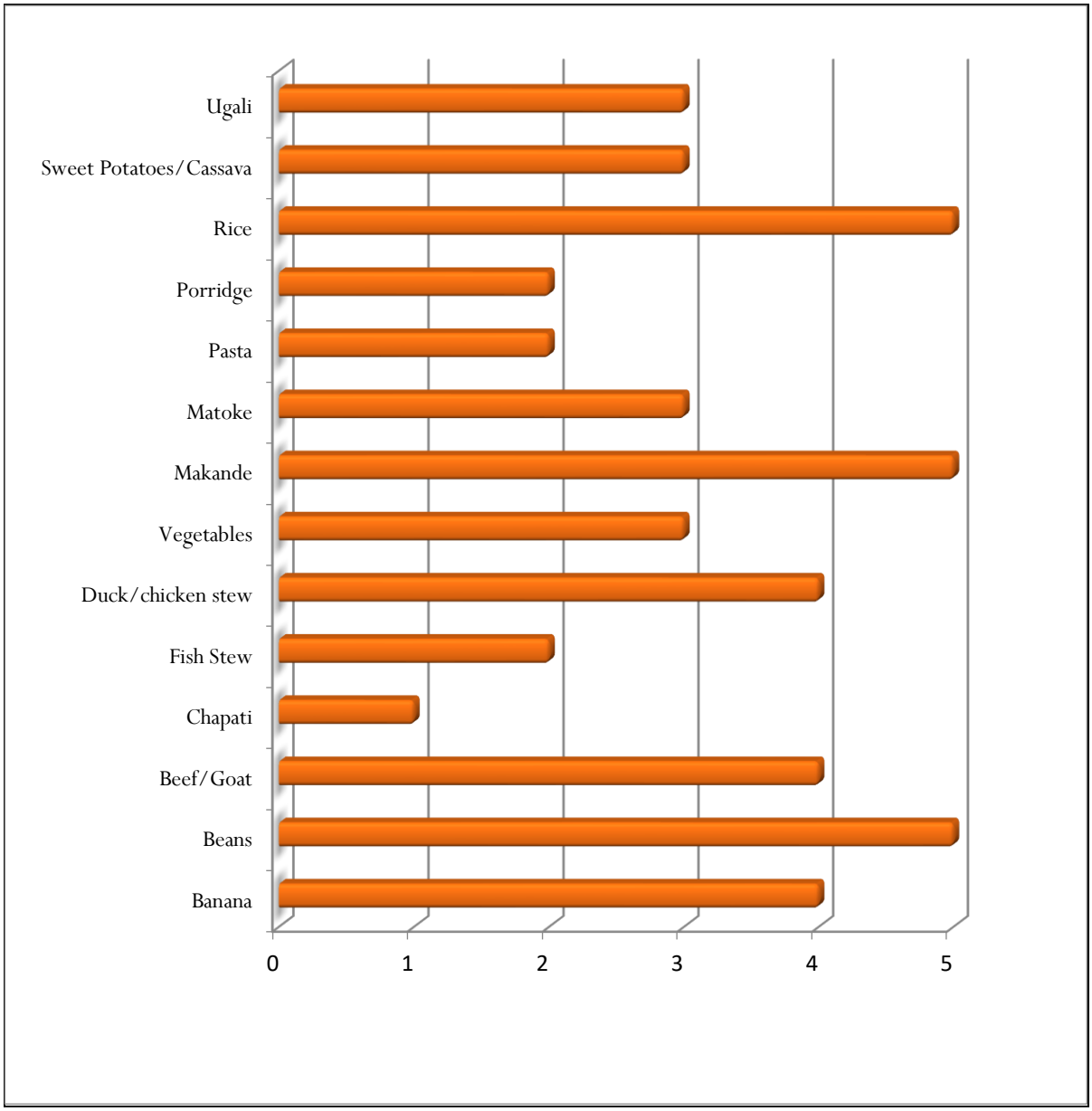
Chart 16: Suitability of EPCs for Cooking



11.1.2 How easy is it to cook each food on the EPCs?

The participants during the exit survey were asked to respond to the easiness of cooking different types of foods on the EPCs. The responses of some questions on its suitability are listed in chart 17 below:

Chart 17: Easiness of Cooking Food by EPCs



1 = very difficult, 2 = difficult, 3 = no opinion, 4 = easy, 5 = very easy

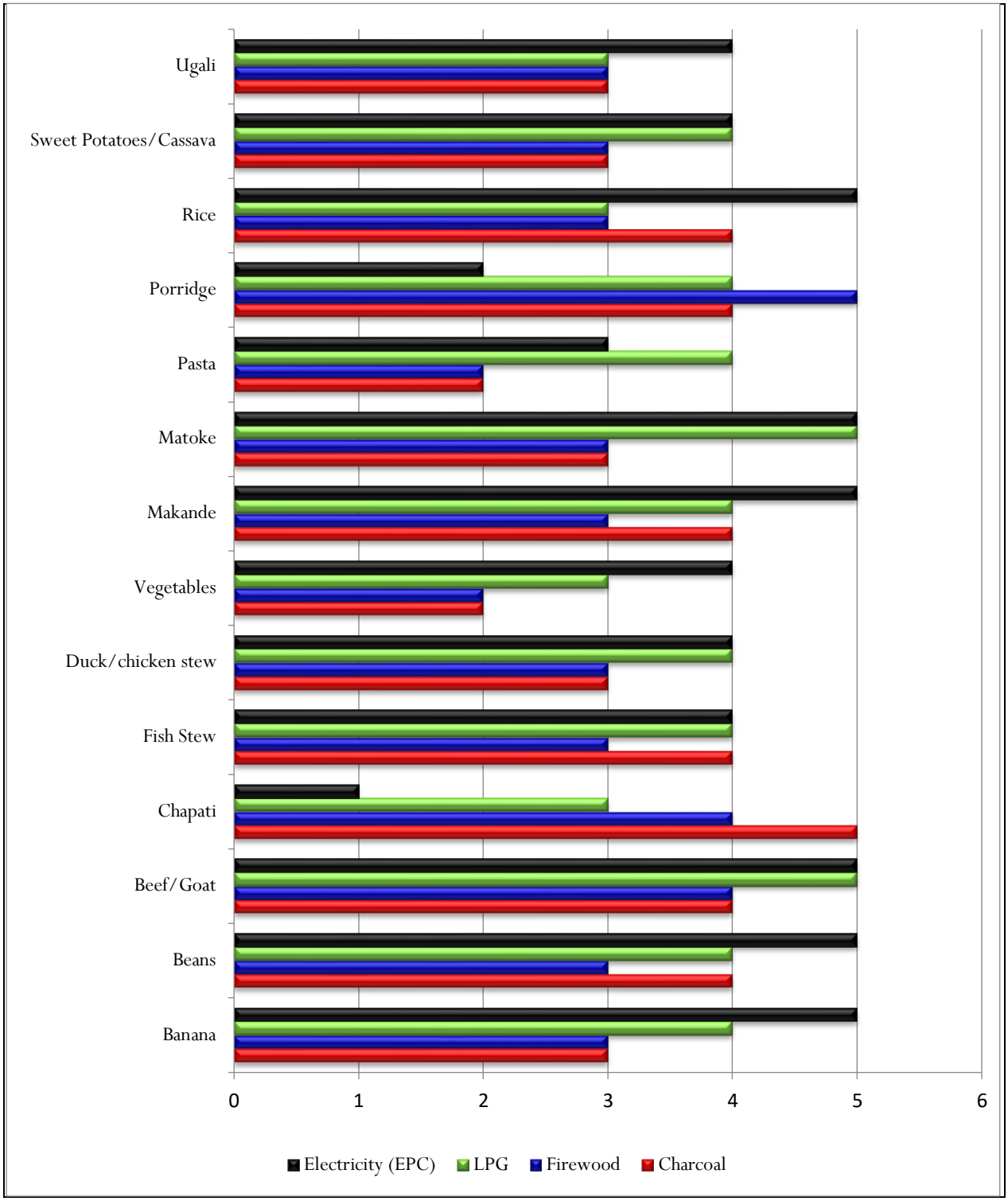
11.1.3 Do you miss the Smokey flavour of food? If so, for which dishes in particular?

Some of the foods cooked by EPCs were delicious and their taste has increased. These are some foods such as rice which used to be cooked by firewood and smoke smell was unpleasant to the consumer. There are some banana foods that require constant heat and non-smokey environment to taste good. The EPC has improved practices of cooking these foods. However, many of the participants did not miss the smokey flavour of the food.

11.1.4 Do foods taste different when cooked on different fuels? If so, please rank each fuel for each food.

The participants were asked to respond to the question on the taste of various foods cooked by different fuels. Each fuel was ranked for each food as shown in chart 18 hereunder:

Chart 18: Food Tastes Cooked on Different Fuels

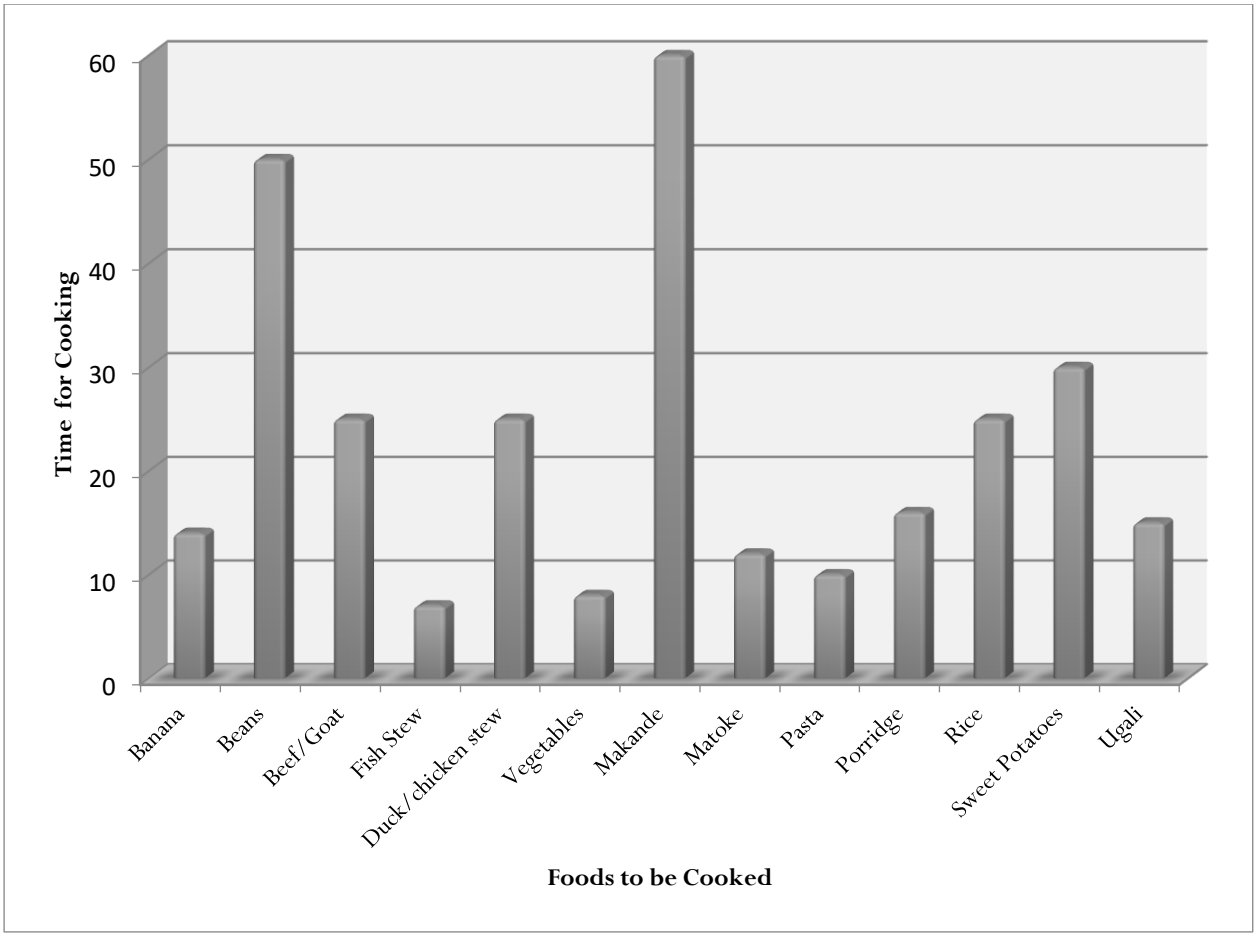


1 = bad, 2 = slightly bad, 3 = no opinion, 4 = good, 5 = very good

11.1.5 If a neighbour had just bought an EPC and asked how long they should set the timer for each food, what would you tell them?

This is an issue for supporting other people who have bought EPCs on setting the timer for each food. The responses from the participants were as shown in chart 19 below:

Chart 19: Time Setting for Each Type of Food



Beans and Makande are food types with more time compared to others. None of the food exceeded an hour, therefore times for setting on the EPC for most of the foods are less than an hour. Types of foods that are difficult to set time are porridge, fish stew and pasta. This is due to the fact that those foods depend on the type of food flour and materials used to initially prepare them and for the fish stem is the delicateness of fish during cooking.

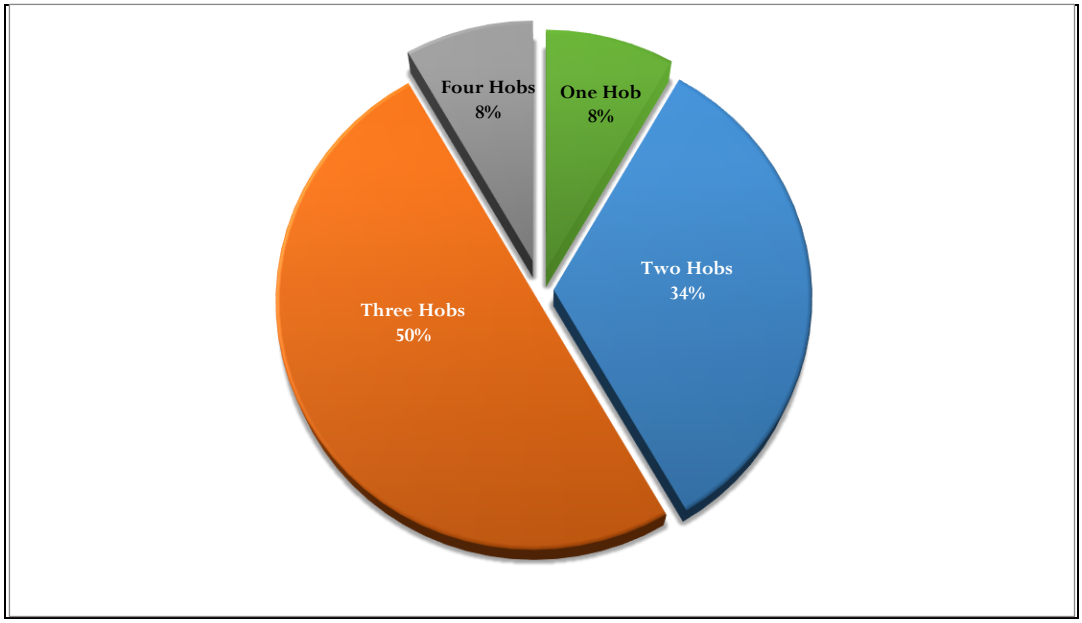
11.1.6 Which foods are not possible to cook in an EPC?

The foods which can not be cooked in an EPC in Rural areas of Hai District in the Kilimanjaro Region are those that require frying and ones which use bicarbonate soda. These foods include chapati, banana chips, dessert chips, frying eggs, pancakes, potato chips, and sausages..

11.1.7 How many hobs (rings) do you need for cooking?

The participants were required to mention hobs (rings) needed for cooking in their household kitchens. Most of the households are using one hob depending on the type of stove they use for cooking. However, for easiness and if you may observe existing cooking practices, it is obvious more hobs are required for meeting requirements of cooking in households.

Chart 20: Hobs Required for Cooking by Participants



Most of the participants are using 3 hobs per stove. However, the three hobs are preferred because they use one cookstove at a time. The main dish can be cooked on one stove and when it is ready is the pot containing food is removed from the stove and another is put on it. The response from the exit survey shows that most of them are in need of at least two hobs.

11.1.8 What were the best things about cooking with electricity?

The best things highlighted by participants about cooking with electricity in rural areas of Hai district in Kilimanjaro Region are as shown hereunder:

- It is clean cooking without smoke and other harmful gases
- It saves time for other business activities
- No need to take much care of the food while in the cooker
- It is easier to turn on and off the electric appliance,
- The kitchen stays cooler with an electric appliance
- Cooking with electricity using EPC is cheaper, efficient and enable users to work on other activities while cooking

11.1.9 What were the worst things about cooking with electricity?

The worst things highlighted in rural areas of Hai District by participants about cooking with electricity areas are listed below:

- Inability to perform deep frying
- Inability to cook traditional foods such as Kiburu, Ngararimu and Ikatwe because they use bicarbonate soda
- Difficulty of cooking porridge and milk since they spill out of the pot
- May need some practices at the beginning,
- You cannot taste food or look inside while cooking.
- If the manual is unavailable food can be overcooked or more water added which cannot be removed while cooking

11.1.10 What do you like most about cooking with charcoal/ firewood?

The things most liked by participants in rural areas of Hai District about cooking with charcoal and firewood are as highlighted hereunder:

- Easy to access these fuels in the market or around the house,
- Stoves used to burn these fuels are cheap,
- User gets heat for warming house while cooking during the cool season,
- Taste of some foods is good when cooked with charcoal and firewood,
- All types of foods including water heating can be cooked or heated with firewood and charcoal.

11.1.11 What do you like most about cooking with LPG?

The things most liked by participants in rural areas of Hai District about cooking with LPG are as highlighted hereunder:

- There is a reduced amount of smoke in the kitchen,
- The LPG stove is easy to control and use
- It is faster to cook by LPG
- It keeps the kitchen clean,
- Save fuel cost.

11.1.12 What are the best things about not cooking with charcoal/firewood?

The best things about not cooking with charcoal and firewood include:

- The kitchen will remain clean
- No smoke and walls will not be coated with soot,
- No fetching of these fuels and heavy loads from fuel vendors/ around,
- No red eyes and hitching due to smoke

11.1.13 What are the best things about not cooking with LPG?

The best things about not cooking with LPG include:

- There is no smokey flavour
- No burning of foods
- No carrying heavy loads of LPG cans
- No fear of burning the house

11.1.14 Did you change your cooking behaviour? If yes, how and why?

Cooking with the EPC has influenced the behavioural change of people in the kitchen and households. A person who has been using firewood or charcoal and LPG stoves and switched to an EPC showed the following changes in the cooking behaviours.

Table 34: Changes in Cooking Behaviours

S. No	How Cooking Behaviour Changed	Why Cooking Behaviour Changed
1	Prepare all recipes and cook later	EPC cook faster and efficiently
2	Use electricity to cook most of the time	Cheapness of cooking energy
3	Save time during washing pots	Non sticky pot
4	Cook while doing other activities	EPC does not burn food
5	Stop refrigeration of half-cooked foods	EPC has reduced time of cooking
6	Getting support of cooking from men	Cooking with EPC is simple and clean
7	Cooking indoor (not necessarily in the kitchen)	Switch for electricity are indoor and power consumption is low

11.1.15 Do you think electric cooking is affordable?

All participants accepted that with the use of EPC it is possible to cook by using electricity which means electric cooking is now affordable. This is 100% acceptance from all participants. The only challenge is the initial costs of buying the EPC. The purchase of EPC appliances is only affordable to high, medium and 40% of low-income households.

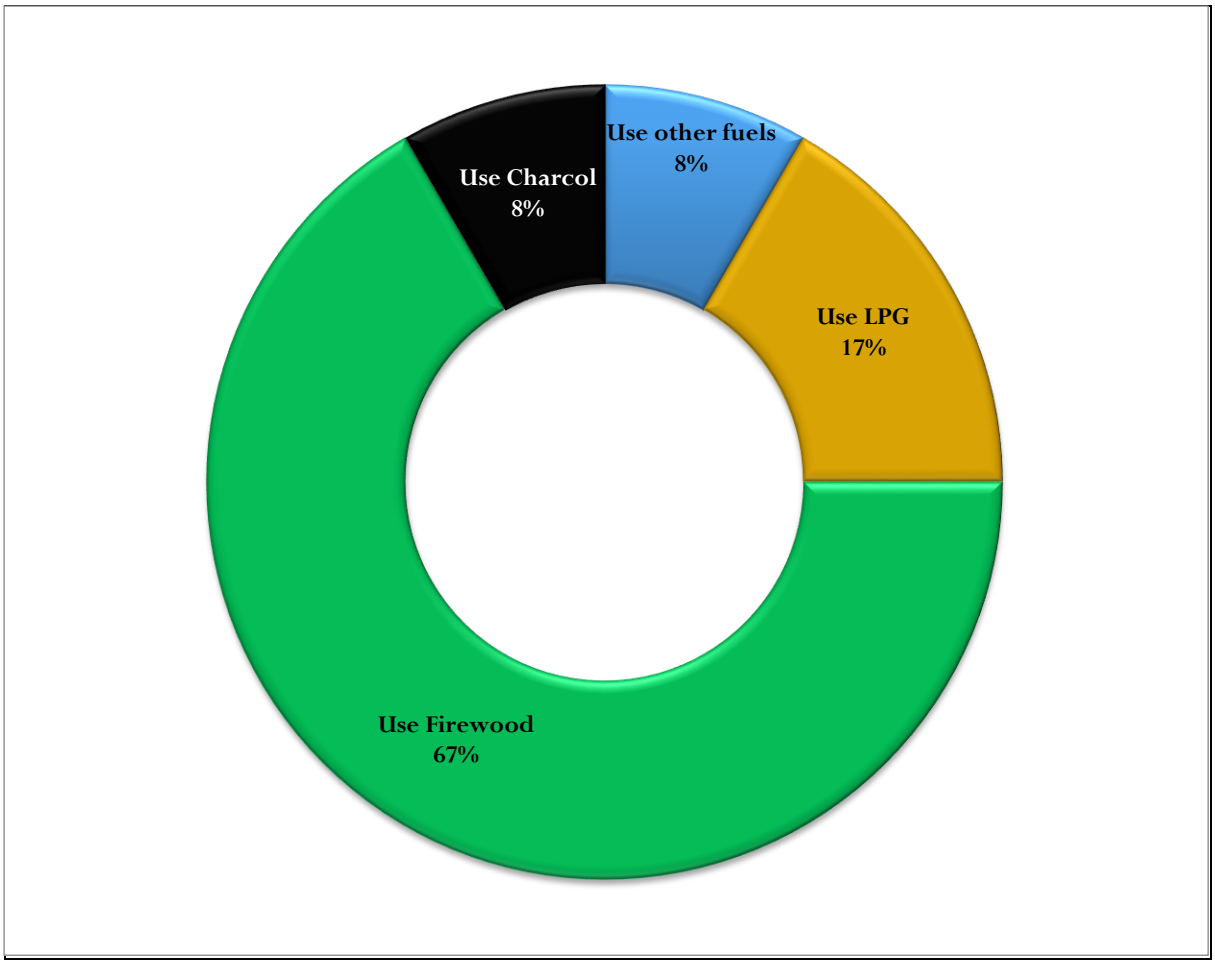
11.1.16 Do you think EPC is cheaper or more expensive than your normal fuels?

Most of the households in rural areas of Hai District used to cook with firewood and LPG, These fuels used to be cheap but now prices have shot up in recent years. The introduction of EPC has given a new way of cooking cheaply by using electricity which means the cost of cooking with electricity is now even more affordable to several households.

11.1.17 Were there times when the electricity was off and you wanted to cook? If so, what did you do?

This did not happen during the survey in Kilimanjaro since it was near the national election. The answers from participants are based on past experiences. The response from participants shows that most of them will revert back to their normal fuels. It is out of tradition to buy foods from restaurants to consume at home unless it is food that cannot be cooked at home. The responses from participants were as shown in the chart below:

Chart 21: The Fuels Which Will be Used to Cook During Blackouts



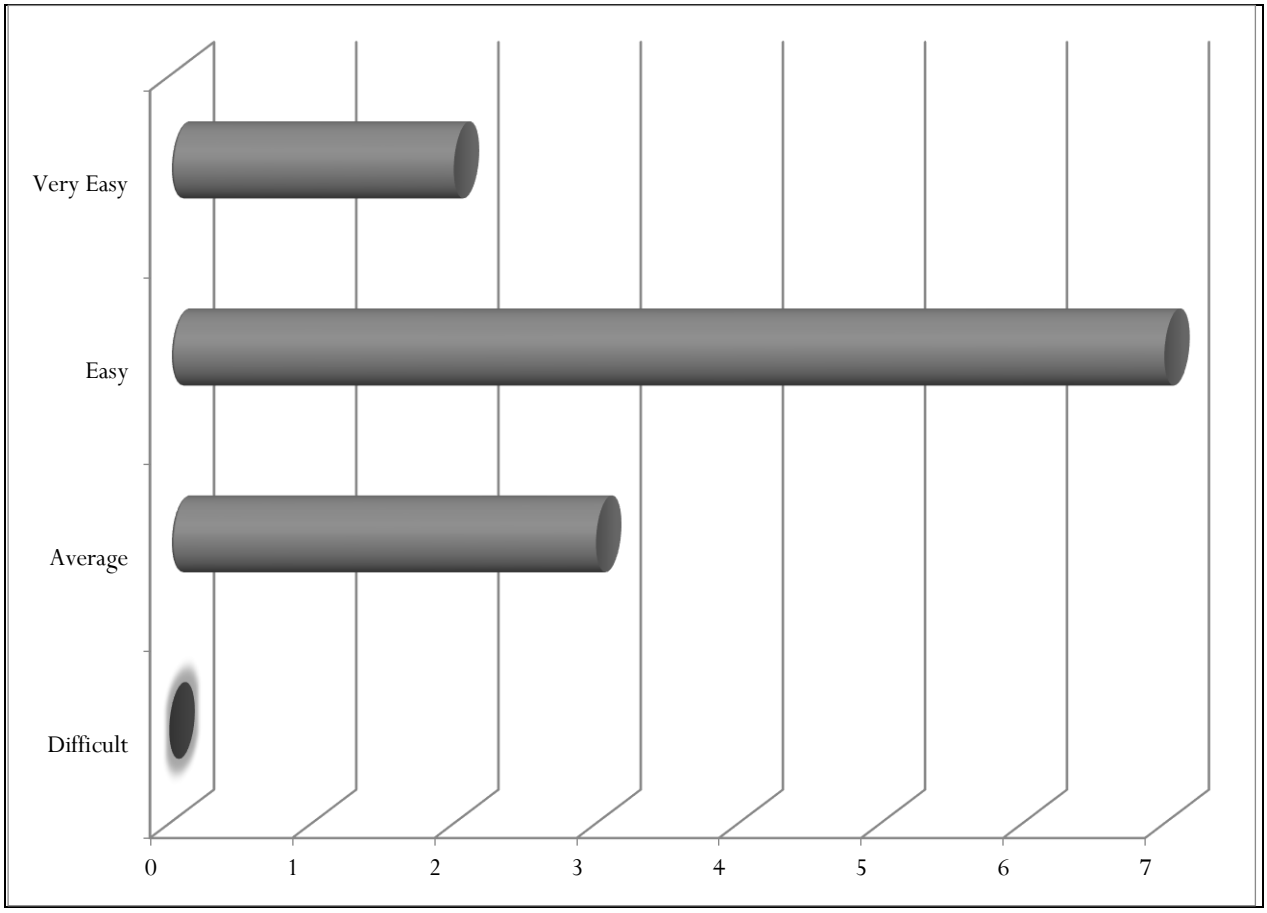
11.1.18 Do you feel that cooking with the EPC is safer or more dangerous than cooking with your normal stove, and why? (e.g. risk of fires, burns)

All participants accepted that cooking with the EPC is safer than cooking with firewood, charcoal and LPG stoves. There is no burning because the user is not exposed to open flames. It emits less heat which can be touched by hand because it is insulated. The lid of EPC unlike the one for the normal pressure cooker does not explode.

11.1.19 How easy is it to learn to cook on an EPC?

Almost 68% of responses from participants showed that it is not difficult to learn to cook by EPC. About 42% replied to easier while 26% replied to be average learning. Some of the participants claimed that learning most of the time depends on several factors being ability, determination, previous education, etc

Chart 22: Easiness of Learning to Cook on EPC



11.1.20 Would people need training on how to use an EPC, or would they be able to learn by themselves? If so, training on what?

The response from users of rotary EPC requires training on how to use it. However, if the user can read the manual and tried to cook local foods will get difficult at the beginning but later on will be able to use it properly. However, training on safety, cleaning and timing for food which are not in the manual is very important. It is important also to get knowledge on the type of food which cannot be cooked by EPCs.

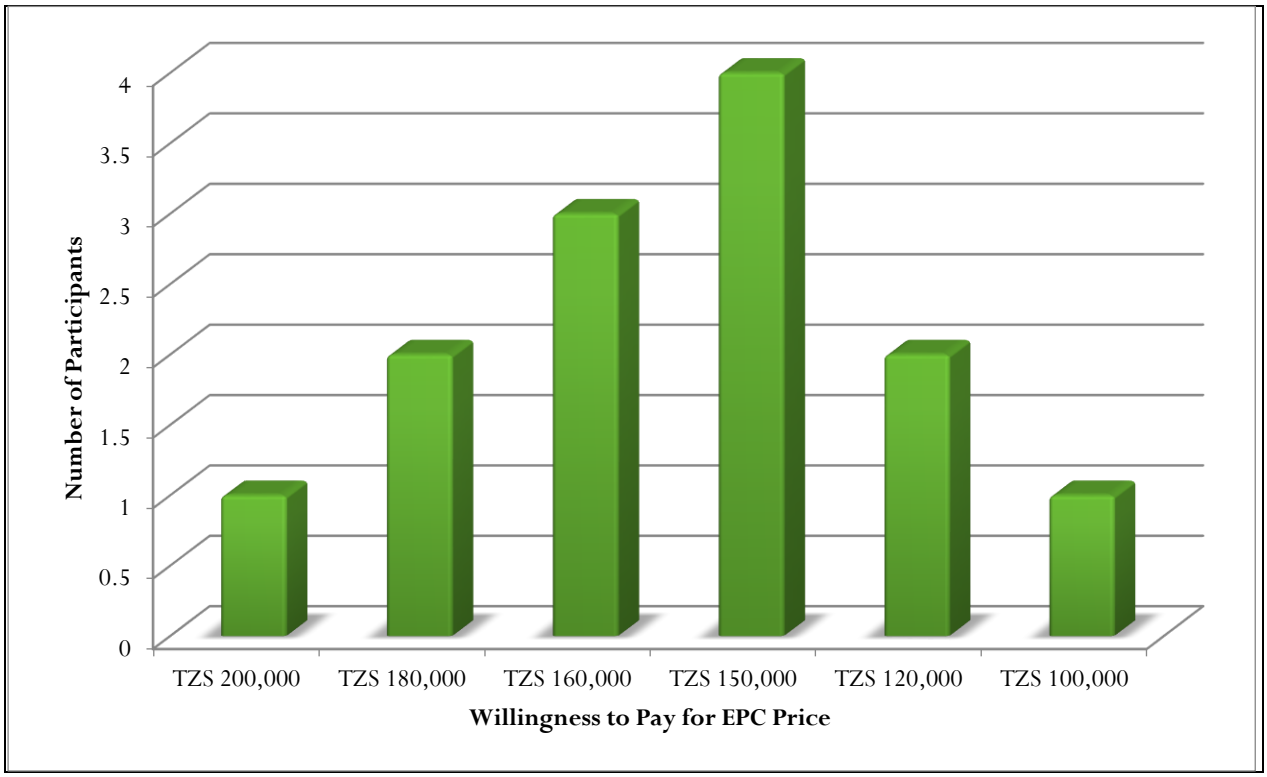
11.1.21 Would you ever cook using only electricity and no other fuels? If so, why?

Most of the participants were motivated to cook with electricity by using EPC. They claimed that there must be fuel staking if electricity bills will increase or during blackouts or power cuts.

11.1.22 Would you buy this EPC if you saw one in a shop now? If so, how much would you be prepared to pay for the EPC (TZS)?

All participants accepted that they would buy EPC if they saw one in the shop or supermarket. The reason is its ability for saving electricity and household cooking energy budgets. Every participant has been convinced with the safety of this appliance that it may not explode like the previous mode of normal pressure cookers. The participants on how much they are prepared to pay for EPC, their responses are as shown in the chart below:

Chart 23: Payments Preferred by Participants for Buying EPC



The price preferred by most of the participants was TZS 150,000. The participants argued that these are the prices which can give buyers quality EPC from the vendors.

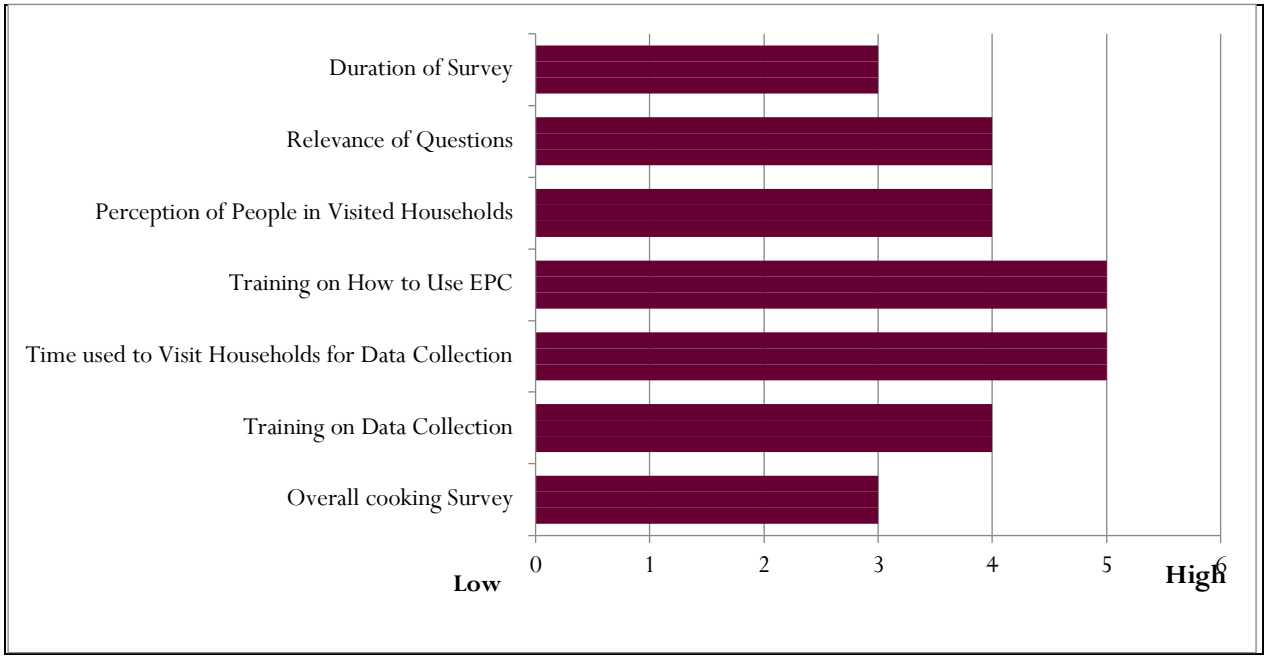
12 Evaluation of the Study

The cooking diaries study has been a way of assessing how and what people are cooking. This started with existing cooking practices and what may happen if the modern energy cooking services using EPCs will be introduced in this case, the diverse community in rural areas.

User feedbacks on the cooking diaries survey started with doubt within participants on whether they could cook by using electricity and also be able to undertake all activities of the existing cooking practices. However, after performing several visits to their households and consecutive practical trainings on how to measure fuels and how to read meters, they were very positive and accepted to continue with the study.

However, most of them were pleased to get modern practices of cooking with electricity which will help them to save time and money in their households. Chart 17 below shows feeling of the participants from asked questions, perception of other people in the households, the way training are conducted on existing cooking practices in phase 1 and phase 2 of how to use EPC, the relevance of time used to visit their households, training on data collection (theory and practices) and their perception on the overall cooking survey. The duration of the survey and overall cooking survey scored less than all other questions because, at the end of the survey, participants were anxious to get more knowledge on similar modern practices for saving energy in their houses. The response from participants on evaluation of the study was as shown in the chart below:

Chart 24: Participants Responses on Study Evaluation



However, at the end of phase 2, all participants were enthusiastic to continue with cooking by electricity using EPCs. Some of them argued that their children will not let researcher take back their EPCs.

12.1 Data Limitations

Participants were required to record information related to each heating event on separate forms, which was then entered into the database by the enumerators as a single record. A heating event could cover either a meal (breakfast, lunch, dinner) or another heating purpose, such as heating water for bathing. A single heating event record could cover multiple purposes (e.g., food could be prepared for both breakfast and lunch). The food cooked by people in rural areas of Hai District in the Kilimanjaro Region is originating from Chagga cultures living in rural areas of Hai District. Therefore, the data are for adopted cultural foods cooked and consumed in rural areas of the Hai District.

In conducting this research, several potential sources of bias or error were identified at the beginning of the study but those errors were minimized after several trainings. These biases and errors were caused by the fact that the feeling to questions asked was interrogating type of life they live: The attributes of those errors include

- Respondents were uncomfortable to reply especially when they make mistakes in data collection.
- Some questions lead to unclear data because of multiple answer options that may be interpreted differently by respondents.
- Data errors due to question non-responses existed in some households but the exercise of repeating the measurement of those data was performed by enumerators

- The reliability of data for cooking diaries survey conducted was limited to respondents feeling to provide accurate and honest answers.

Some measures were taken to mitigate data limitations during the cooking diaries survey within the constraints of the scope and budget of the research, but these were born in the mind when considering the findings. The details of these limitations will enable to improvement plan for the following study in Kilimanjaro.

12.2 Notes on Data Collection

12.2.1 Enumerator Visits for Data Collection

The survey started by bringing participants together and undertaking training of the whole group at once at the beginning during phase 1 (existing cooking practices), at the middle of the survey (transition to electricity workshop) and at the end of the survey (exist workshop). There was practical training in each household in order to ensure all participants will be able to record data and document them. Participants were advised to practice recording data immediately after or while cooking.

Many issues with the dataset were only discovered long after data collection had finished due to the mistakes observed during follow-up visits, digitisation of the data and analysis of the dataset. Enumerators were contracted to visit the households daily and asked to digitise the data collected by participants and recorded in the forms as soon as they were collected. Each enumerator was visiting five households but it was difficult due to the time data were supposed to be collected. The data used to be collected from 5.00 pm onwards to 9.00 pm because it is when the enumerator will get both breakfast, lunch and dinner records.

There were some missing data due to some constraints such as faulty meters, other cooks in the household not recording data properly or not recording because they were not at home in the afternoon, which resulted in repeating those data at the end of the days planned for data collection and which extended duration of cooking diaries survey.

12.2.2 Digitisation of Data

Kobo Toolbox was the software used to digitize data collected from participants by enumerators. The questionnaire was prepare with lead enumerator and digitised online and enable it to communicate with smart phones. This situation allowed enumerators to go to the field with a questionnaire loaded into a smart phone, enter the data into asset of fields after each question and as soon as an internet connection is available, send the data tithe Kobo server.

All responses to the questionnaire were available for download from the Kobo Server at the end of the cooking diaries survey. This also allowed the data to be verified as the study was going on by detecting mistakes in data entry, determine records to be repeated and show missing data from participants and allowed the lead enumerators in collaboration with data analyst to review the responses. This enabled to correct small errors in the data collection process as survey was continuing and omissions of those errors.

12.2.3 Sample Diversity

The cooking diaries study was undertaken as a means of collecting some preliminary data for understanding existing cooking practices and what will happen after introducing modern electric cooking to the communities in the rural areas of Hai District in the Kilimanjaro Region. Most of the participants came from low to middle-class clusters and all were from rural areas. The following

study in Tanzania should seek to assess cooking practices for other rural areas with low-income clusters and identify differences in cooking practices in other areas.

13 Conclusion

The cooking diaries study in the rural areas of Hai District in Kilimanjaro Region, Tanzania has shown that cooking with electricity is well-matched with Tanzanian cuisine and that modern energy-efficient appliances by using EPCs are highly advantageous to cooking practices in households. In particular, the EPC was observed to be the future alternative to cooking appliances in households. This is attributed to its possibility of significant reduction of electricity demand for the biggest energy consumers or 'heavy foods'.

In fact, in all rural areas of the Hai District in the Kilimanjaro Region, the grid electricity is already strong enough for direct AC cooking, meaning there is an opportunity to promote these appliances in similar rural areas with a scarcity of woodfuels. However, rural areas of Hai District in Kilimanjaro Region is situated in the area with the potential of solar PV systems adoption therefore it is also an appropriate area for practising solar PV battery-supported cooking with EPCs which may make electric cooking much more attractive, as blackouts or power cuts which frequently caused users to revert back to their baseline fuels.

LPG is already popular in rural areas of Hai District in the Kilimanjaro Region and while electric hotplates do not offer anything new for LPG users, the ability to cook faster and multi-task, whilst also saving money makes a fuel stacking scenario with EPCs is extremely attractive.

The findings from this study will be combined with those from the other activities that have been carried out under the project on promoting a Thriving Market of Modern Energy Cooking Services in Tanzania in order to build a more competitive environment of the opportunities and challenges of modern energy cooking services in Tanzania.

14 References

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15 Appendices

15.1 Appendix 1: Cooking Diaries Registration Forms

15.1.1 Cooking Diaries Information Sheet

Good (morning/afternoon). My name is _____ from the Tanzanian Traditional Energy Development Organisation (TaTEDO). We are doing a project with the Loughborough University and Gamos (UK) on cooking practices in low income countries (in both Africa and Asia). I understand you have kindly volunteered to participate in the household cooking survey. This is part of an international research programme that aims to promote a transition from hazardous and polluting biomass fuels to clean, modern cooking fuels.

How you can assist:

- You will be asked some basic information on your household as part of this registration process.
- You will be asked to keep a diary of all you cook and how you cook it over the next 7 days.
- During the first two weeks, please cook as you always do and simply record what you are doing in the data sheets.
- After a week, you will be asked to try cooking only with electricity to see how quickly you can adapt, and how practical this is. If you are already cooking solely with electricity, we may ask you to change your practices in some way.
- At the end of the exercise, a short exit survey will ask you how you got on.

How we will support you:

- I will visit tomorrow and then at least once a week (at a time that suits you) to see how you are getting on, answer any questions you may have, and collect the data sheets. In between visits, please don't hesitate to contact me with any questions on this number: _____. If you are able to send copies of the data sheets to us electronically using WhatsApp or equivalent, we can offer remote assistance.
- If you do not own an electric hob, we will provide one for the second part of the trial.
- We will pay for any additional electricity that you use for cooking during the survey.

The project meets the criteria for ethical research contained within the Code of Practice of Loughborough University's Ethical Advisory Committee. Your name will not appear in any data that shall be made publicly available and the information you provide will be strictly used for research purposes. It is up to you to decide whether to take part or not. Choosing not to take part or withdrawing at any point will not disadvantage you in any way. If there are questions that you would prefer not to answer then we respect your right not to answer them.

We will produce reports, guidance materials and academic papers detailing the findings from the research, which will be used to inform manufacturers and policy-makers in Tanzania, Africa, and globally. With your permission, we would like to use photos of your cooking appliances, pots/pans and of you cooking to illustrate these.

15.1.2 Checklist for Enumerators

i) Household Selection

Whilst any household that has an electricity supply good enough to cook on can in theory participate in the cooking diary study, the best households are:

- Households where there is one main cook, as many cooks require more training and often only some see the value in participating in the research study. This main cook should be:
  - Interested in the findings of the research study, as this will motivate them to record high quality data.
  - Well organized and literate.
- Households where the main cook volunteers to participate, rather than the head of their household volunteering them.
- Households that cook 2-3 times a day, rather than regularly buying food out or eating at a friend/family member's place.
- Low income households are our target market, but middle/high income households are likely to be easier to recruit and to be able to fill in the forms.

We are looking for a range of households in the following categories:

- Large (>9 people), medium (5-8 people) and small (1-4 people) households.
- Households that cook on electricity, gas, charcoal or a mixture.

What to take to each household

- Clipboard & 2x pens
- 2x energy meters
- 2x plug adaptors (1x 3 pin square to 2 pin round, 1x multiple to 3 pin square)
- Printed forms:
  - 1x registration form
  - 5x meal/water heating form
  - 1x daily summary form
  - 1x notepad form
- Tape measure
- Solid fuel or gas users: digital weighing scale
- Gas users: small cylinder, regulator and hose clip

ii) Registration Process

Complete consent form and registration survey

- Please leave the information sheet with the participant (remembering to fill in your contact details) and take the registration survey with you
- If the household is unsure about whether they want to sign up or not, suggest a trial for one night

iii) Talk through Cooking Diary Forms:

- Meal/water heating form:
  - Cooks should fill out one form every time they use a cooking appliance.
- A cooking appliance is defined as a device that cooks food or heats water.
  - Fill out sample form for the last meal you cooked and last time you used a cooking appliance in between meals to demonstrate
  - Ask participant to fill out sample form from last meal they cooked and last time you used a cooking appliance in between meals whilst you are there to help

- Make sure they are aware of the fuel measurements, which must be collected both BEFORE and AFTER each time they use a cooking appliance
  - Daily summary form
  - Cooks fill out one form at the end of each day.
  - Notepad form

This can be helpful in noting down the essential information if in a hurry whilst cooking or if a maid is cooking in the day who is unable to fill out the full form. This information should be transferred to a meal/water heating form as soon as you have time or by interviewing the maid as soon as you see them.

iv) Practice Taking Fuel Measurements

- Electricity:
  - The aim is to work out how much energy was used by cooking appliances during that meal
  - We need TIME and ENERGY both BEFORE and AFTER cooking
  - Readings must be taken BEFORE cooking appliances are turned on and AFTER they are turned off
- Solid fuel:
  - The aim is to calculate the weight of charcoal, wood etc. burnt during that meal
  - We need the weight of the bag of fuel BEFORE and AFTER the meal
  - We will subtract the AFTER weight from the BEFORE to calculate the charcoal burnt on the stove
  - Ask people to show you the bag they store their fuel in
    - If it is a box or a big sack, ask the household to put more charcoal out than they think they will use into a plastic bag and weigh this before and after cooking
    - Make sure they know to put any remaining charcoal that has not gone onto the fire back into the bag before weighing.
- Liquefied Petroleum Gas (LPG):
  - If a household has a big gas cylinder that is too heavy to weigh, we should purchase a small cylinder and ask them to use that instead.
  - Look for a suitable place to hang the scale from to get reliable measurements. If no place is available, have a stand made.
  - Weigh the cylinder before and after cooking, as with solid fuel.
  - Make sure the regulator is detached before taking each measurement, as the hose will pull on the cylinder and distort the reading.

Remember to measure and photograph pots/pans/buckets/kettles and photograph all cooking appliances, taking measurements of all hotplate diameters and noting the power rating of all electrical cooking appliances.

When you return the next day, review the forms the cook has filled out and describe to them the meals/water you think they cooked/heated. If your description matches what and how they actually cooked, then you have verified that they are capable of recording data independently. However, you should still continue to check up on them once a week, to collect the forms they are producing and answer any questions they may have.

15.2 Appendix 3: Cooking Diaries Registration Form

Consent

Do you consent to be part of this study? (Yes/No)_____

Do you consent to any photos taken during the course of this study being used in research publications? (Yes/No) _____

Name: _____ Signature: _____ Contact No.: _____

Date: _____

Details of Participant

1. Age:……
2. Gender:☐ Male ☐ Female ☐ Other
3. What is the highest level of school you have attended?

   ☐None☐Incomplete primary☐Completed primary☐Incomplete secondary☐Completed Secondary☐Higher than secondary

Information on your Household

4. Location:_____
5. Type of area:☐Urban☐Peri-urban☐Rural
6. How many people live in the household? _____
7. Who cooks in your household?

Name	Relationship to head of household	What proportion of the cooking do they do? (e.g. 50%, ¼, all)	When do they cook? (e.g. lunchtime only, all meals, special occasions)

8. How many rooms in the dwelling (bedrooms plus kitchen, bathroom, living room etc.)? _____
9. Type of dwelling (options to be edited to suit country context):

   ☐Compound house☐Flat/apartment☐Semi-detached house☐Separate house

10. Construction

a) Walls

   ☐ Wood /mud / thatch☐Mud bricks (traditional)☐Corrugated iron sheet☐Cement block (plastered or un-plastered)☐Bricks (burnt)☐Other…….

b) Roof

   ☐Thatch/palm leaf☐Wood☐ Corrugated iron /cement sheet☐Cement☐Tiles

☐Other _____

c) Floor

☐Dirt/Mud/Dung ☐Cement ☐Tiles☐Wood ☐Other _____

11. Where the kitchen is located?

☐Outdoor ☐Indoor, no outdoor area for solid fuel stoves ☐Indoor, with outdoor area for solid fuel stoves

12. Where do you cook?

☐Indoors ☐Outdoors ☐Sometimes indoors, sometimes outdoors

13. Please indicate how many of the following appliances are owned (even if not used).

Please take a photo of all appliances.

Type of cooking device (see above for examples)	Brand or local name/s	How many?	When is it used?	What do you usually use it for? e.g. quick things in the morning, when the gas runs out, when there is a blackout, for beans and long cooking dishes	How many hotplates/burners does it have? What is their diameter (cm)?	Power rating, W (electric only)
			☐ Regularly ☐Occasionally ☐Never		No. …….. Diameter/s (cm) ……	
			☐ Regularly ☐Occasionally ☐Never		No. …….. Diameter/s (cm) ……	
			☐ Regularly ☐Occasionally ☐Never		No. …….. Diameter/s (cm) ……	
			☐ Regularly ☐Occasionally ☐Never		No. …….. Diameter/s (cm) ……	

14. Measurement of pots/pans/pressure cookers/kettles

Please take a photo of all pots/pans/pressure cookers/kettles

Is it a pressure cooker, kettle or a big/medium/small pot or pan?	**Diameter (cm) and Height (cm) OR Volume (litres)**

15. Fuel Measurements

Charcoal/wood/kerosene/LPG users & fuel stackers only:

	Charcoal	Wood	Kerosene	LPG
How often do you usually buy charcoal/wood/kerosene/LPG?				
What quantity do you usually purchase (kg)?				
How much does this cost (TZS)?				

All households:

- How often do you usually buy electricity units? _____
- When you buy electricity units, how much do you normally spend (TZS)? _____
- Do you know how many units this gets you? _____
- Are there different rates according to how many units you purchase?

Units	Rate

15.3 Appendix 4: Cooking Diary Form

Jina ..... Tarehe:..... **TAFADHALI JAZA FOMU TOFAUTI KILA UNAPOPIKA AU KUCHEMSHA MAJI** Tanzania v180321

1 Ulitumia vyombo vya kupikia kupika nini?	Kifungua kinywa☐ Chakula cha mchana☐ Chakula cha jioni☐ vitafunwa☐ Chakula cha mtoto☐ Kuchemsha maji☐ Mengine: _____
2 Kabla kutumia vyombo vya kupikia	
2.1 Ulianza kupika saa ngapi? SAA: _____	
2.1.1 Kama unatumia umeme:	**Weka mita:Nambaza MITA 1:** _____ kWh, **MITA 2:** _____ kWh, **MITA 3:** _____ kWh
2.1.2 Kama unatumia gesi/mafuta ya taa:	**Uzito wa gesi/mafuta ya taa kabla kupika**: Gesi: _____kg Mafuta ya taa: _____kg
2.1.3 Kama unatumia mkaa/kuni:	**Uzito wa mkaa/kuni kabla kupika:** Mkaa: _____kg Kuni: _____kg Mengine _____ : _____kg ilikuchukua muda gani kuwasha moto? Dakika _____, moto ulishawashwa kabla☐

3 Wakati unapika (ama muda mfupi baada ya kupika)

3.1 Ulipikia watu wangapi? Watu wakubwa: _____ Watoto: _____

3.2 Ulitenga vyakula vyovyote ambavyo hukuvipika? Hapana ☐ Ndio, vingine havikuhitaji kupikwa(kama mkate, matunda) Ni vitu gani haswa? _____.
Ndio,nilipika vyakula vingine mapema na sikupasha moto?_____. Ndio, nilinuanua/nilipewa vyakula ambavyo vilikuwa vimepikwa? _____.

3.3 Ulitayarisha vyakula vya kutumia baadaye? Hapana☐ Ndio☐ Baadhi☐

3.4 Je, ulipika vyakula vyovyote? Tafadhali tumia mstari mmoja kwa kila chakula kisha ujaze sehemu zote kuhusu hicho chakula	Ujazo kwa mfano (1/2 kuku, vikombe 2, kilo 1)	Vyombo vya kupikia? Tafadhali chagua vyote vinavyofaa	Je, ulitumia vyombo tofauti (sufuria,sahani,chungu)? Tafadhali chagua vyote vinavyofaa:		Freshi au vyakula vya kupasha moto?	Njia ya kupika? Tafadhali chagua njia zote ulizotumia	Muda wa kupika
CHAKULA 1		Jiko la mkaa☐ Jiko la gesi☐ Oveni☐ Jiko la umeme☐ Induction hotplate☐ Birika la umeme☐ Rice cooker☐ Electric pressure cooker☐ Microwave☐ Heater☐ Vingine _____	Sufuria: kubwa☐/ kati☐/ dogo☐, Bakuli/sahani☐ Kikaangio☐ Birika☐ Vingine_____	*Je, ulifunika?* Hapana☐ Ndio☐ Ulifunika kwa muda☐	Freshi☐ Kupasha☐	Kaanga☐ Kuoka☐ Chemsha☐ Choma☐ Microwave☐ Mvuke☐ Pressure cooking☐ Nyngine_____	Masaa ____ Dakika ____
CHAKULA 2		Jiko la mkaa☐ Jiko la gesi☐ Oveni☐ Jiko la umeme☐ Induction hotplate☐ Birika la umeme☐ Rice cooker☐ Electric pressure cooker☐ Microwave☐ Heater☐ Vingine _____	Sufuria: kubwa☐/ kati☐/ dogo☐, Bakuli/sahani☐ Kikaangio☐ Birika☐ Vingine_____	*Je, ulifunika?* Hapana☐ Ndio☐ Ulifunika kwa muda☐	Freshi☐ Kupasha☐	Kaanga☐ Kuoka☐ Chemsha☐ Choma☐ Microwave☐ Mvuke☐ Pressure cooking☐ Nyngine_____	Masaa ____ Dakika ____
CHAKULA 3		Jiko la mkaa☐ Jiko la gesi☐ Oveni☐ Jiko la umeme☐ Induction hotplate☐ Birika la umeme☐ Rice cooker☐ Electric pressure cooker☐ Microwave☐ Heater☐ Vingine _____	Sufuria: kubwa☐/ kati☐/ dogo☐, Bakuli/sahani☐ Kikaangio☐ Birika☐ Vingine_____	*Je, ulifunika?* Hapana☐ Ndio☐ Ulifunika kwa muda☐	Freshi☐ Kupasha☐	Kaanga☐ Kuoka☐ Chemsha☐ Choma☐ Microwave☐ Mvuke☐ Pressure cooking☐ Nyngine_____	Masaa ____ Dakika ____

Jina ..... Tarehe:..... **TAFADHALI JAZA FOMU TOFAUTI KILA UNAPOPIKA AU KUCHEMSHA MAJI** Tanzania v180321

3.5 Je,ulichemsha maji? Tafadhali jaza sababu na ujaze sehemu zote	Njia unazotumia?	Ulitumia sufuria la ujazo gani?		Je,ilijaa kwa ujazo gani?	Kiasi cha joto cha maji?	Je,uliweza kuyatunza kwenye thermos kwa ajili ya matumizi ya baadaye?	Muda wa kuchemsha	**Kama unatumia mkaa, je ulitumia mpaka ukazima?**
Kuoga☐	Jiko la mkaa☐ Jika la gesi☐ Heater☐ Microwave☐ Birika la umeme☐ Jiko la umeme☐ Induction hotplate☐ Vingine_____	Sufuria: kubwa☐ / kati☐ / dogo☐ Birika☐ Vingine_____	*Je,ulifunika?* Hapana☐ Ndio☐ Wakati mwingine☐	¼☐ ½☐ ¾☐ Kamili☐ 2x☐ 4x☐ Vinginevyo_____	Joto☐ Moto☐ Yaliyochemka☐	Hapana☐ Kiasi☐ Yote☐	Masaa ____ Dakika ____	Ndio☐ Hapana☐
Maji ya kunywa☐	Jiko la mkaa☐ Jika la gesi☐ Heater☐ Microwave☐ Birika la umeme☐ Jiko la umeme☐ Induction hotplate☐ Vingine_____	Sufuria: kubwa☐ / kati☐ / dogo☐ Birika☐ Vingine_____	*Je,ulifunika?* Hapana☐ Ndio☐ Wakati mwingine☐	¼☐ ½☐ ¾☐ Kamili☐ 2x☐ 4x☐ Vinginevyo_____	Joto☐ Moto☐ Yaliyochemka☐	Hapana☐ Kiasi☐ Yote☐	Masaa ____ Dakika ____	Ndio☐ Hapana☐
Chai/kahawa/ kakao/Milo☐	Jiko la mkaa☐ Jika la gesi☐ Heater☐ Microwave☐ Birika la umeme☐ Jiko la umeme☐ Induction hotplate☐ Vingine_____	Sufuria: kubwa☐ / kati☐ / dogo☐ Birika☐ Vingine_____	*Je,ulifunika?* Hapana☐ Ndio☐ Wakati mwingine☐	¼☐ ½☐ ¾☐ Kamili☐ 2x☐ 4x☐ Vinginevyo_____	Joto☐ Moto☐ Yaliyochemka☐	Hapana☐ Kiasi☐ Yote☐	Masaa ____ Dakika ____	Ndio☐ Hapana☐
Kwa matumizi mengine_____	Jiko la mkaa☐ Jika la gesi☐ Heater☐ Microwave☐ Birika la umeme☐ Jiko la umeme☐ Induction hotplate☐ Vingine_____	Sufuria: kubwa☐ / kati☐ / dogo☐ Birika☐ Vingine_____	*Je,ulifunika?* Hapana☐ Ndio☐ Wakati mwingine☐	¼☐ ½☐ ¾☐ Kamili☐ 2x☐ 4x☐ Vinginevyo_____	Joto☐ Moto☐ Yaliyochemka☐	Hapana☐ Kiasi☐ Yote☐	Masaa ____ Dakika ____	Ndio☐ Hapana☐

4 Baada ya kutumia vifaa vya kupikia	
4.1 Ulimaliza kupika saa ngapi? SAA:_____	
4.2 Kama unatumia umeme:	**Weka mita: Namba za MITA 1:** _____ kWh, **MITA 2:** _____ kWh, **MITA 3:** _____ kWh
4.3 Kama unatumia gesi/mafuta ya taa:	**Uzito wa gesi/mafuta ya taa baada ya kupika**: Gesi: _____kg Mafuta ya taa: _____kg
4.4 Kama unatumia mkaa au kuni:	**Uzito wa mkaa/kuni baada ya kupika**: Mkaa: _____kg Kuni: _____kg Mengine: _____kg Je,uliacha moto uwake mpaka uwe jivu ? ndio☐ hapana☐, nilihifadhi kwa matumizi ya baadaye☐
4.5 Mambo yaliyojitokeza? (je,uliunguza chakula? je,moto ulichukua muda kuwaka kuliko kawaida?Je, marafiki walikutembelea? Je umeme ulikatika siku mzima?) kama ndiyo toa maelezo	_____ _____ _____

For more information, suggestions or any questions, please contact Mr. Jensen Shuma (0713-420387), Mary Swai (0789-345463) au Nelson Vilema(0762-507600). The research has been supported by DFID/UK through the MECS Programme implemented by GAMOS and University of Loughborough of United Kingdom.

15.4 Appendix 5: Cooking Diaries Exit Survey

Please remember to take with you:

- This form
- A pen
- A clipboard
- An energy meter (in case theirs is broken)
- A measuring jug (for rice & water measurements)

- Unga
- Rice

Please remember to collect:

- All energy meters
- Hanging scales
- Hanging stand
- LPG cylinder & regulator
- Any completed forms

Name: _____HH ID: _____Date: _____
Location:_____

Which fuel/s did you cook with before the survey?
……

Your Experience of Cooking with Electricity

1. How did the EPC suit the way you cook in your home?

(Score: 1 = strongly disagree; 2 = disagree; 3 = no opinion; 4 = agree; 5 = strongly agree)

	Electric pressure cooker					
QUESTION	1	2	3	4	5	Comment
It was easy to control heat						
I was able to multitask while the EPC was cooking						
Long cooking dishes were cooked much faster						
EPC was hot enough						
EPC burnt the food						
The Pot it came with was big enough						
Food cooked using the EPC tasted better than usual						
I missed the smokey flavour of food						
The EPC made the pots dirty						
The EPC looked good in my kitchen						
There is enough space to put the EPC in my kitchen						
Operating the EPC was easy						
EPC was safe to use						
I prefer to use an electric kettle for water boiling						

2. How easy is it to cook each food on the EPC?
3. Did you miss the smokey flavour of food? If so which dishes in particular?
4. Do foods taste differently when cooked on different fuels? If so please rank each fuel for each food.
5. If neighbour has just bought an EPC and asked how long he should set the time for each food, what would you tell them?
6. Which food are not possible to cook on EPCs
7. How many hobs (rings) or separate appliances do you need for cooking?

[ ] 1 [ ] 2 [ ] 3 [ ] 4

8. What were the best things about cooking with electricity?

……
……
……
……

9. And what were the worst things about cooking with electricity?

……
……
……
……

10. What do you like most about cooking with charcoal/ firewood?

……
……
……
……

11. What do you like most about cooking with LPG/kerosene?

……
……
……
……

12. What are the best things about not cooking with charcoal/ firewood?

……
……
……
……

13. What are the best things about not cooking with LPG/kerosene?

……
……
……
……

14. Did you change your cooking behaviour? If yes, how and why?

……
……
……
……

15. Do you think electric cooking is affordable?

……
……

……
……

16. Do you think EPC is cheaper or expensive than your normal fuels?

……
……
……
……

17. Were there times when the electricity was off and you wanted to cook? If so, what did you do?

……
……
……
……

18. Do you feel that cooking with the EPC is safer or more dangerous than cooking with your normal stove, and why? (e.g. risk of fires, burns)

……
……
……
……

19. How easy is it to learn to cook on an EPC?

……
……
……
…….

20. Would people need training on how to use an EPC, or would they be able to learn by themselves? If so, training on what?

……
……
……
……

21. Would you ever cook using only electricity and no other fuels? If so, why?

……
……
……
……

22. Would you buy this EPC if you saw one in a shop now? If so, how much would you be prepared to pay for the EPC (TZS)?

……
……

……
……

15.5 Appendix 6: Form for Evaluating the Cooking Diary Study on How you Feel about the Survey

1. In the table below, please give us your opinions of the study. Tick where appropriate, where 1 is the worst and 5 the best

QUESTION	1(worst)	2	3	4	5(best)
Duration of survey					
Relevance of questions					
Perception of People in the Visited Houses					
Training on How to Use EPC					
Time Used to Visit Households for Data Collection					
Training on Data Collection					
Overall cooking survey					

2. When you were approached to be part of the electric cooking survey were you hesitant? Has it been different to what you expected?
   ……
   ……
   ……
   ……

3. At the beginning of the electric cooking, what was your expectation and was it met?
   ……
   ……
   ……
   ……

4. What do you think we could have done better in the survey?
   ……
   ……
   ……
   ……

5. Were the enumerator's visits helpful or did you feel it was too much or too little?

……
……
……
……

6. If we were to do another similar survey in the future would you be willing to be part of it?

……
……

END OF SURVEY

Thank the household for participating in the survey.