Cooking Diaries Study Performed in the City of Dodoma, Tanzania

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TaTEDO

Acknowledgements

The cooking diary report is a result of a cooking practices component of the MECS project on Promoting a Thriving Market of Modern Energy Cooking Services in Tanzania implemented by TaTEDO.

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Executive Summary

Access to affordable and reliable Cooking Energy is part of SDG 7 and SE4ALL Initiatives and it intends to increase the segment of the population with primary reliance on clean cooking solutions with low emission targets.

The objective of the cooking diary 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 energy cooking services.

The area selected for the cooking diary study was the City of Dodoma, Tanzania. A total of 12 households for Dodoma Municipality were selected to participate in the study, which was designed to explore the cooking practices of individual households. 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 was split into two phases. The first phase focused on existing traditional cooking practices whereas the second phase focused on cooking practices with electricity by using Electric Pressure Cookers (EPCs). Therefore, the second part of the study, the households were asked to use solely electricity for cooking.

The diaries data were recorded by participants on paper records and those data were copied to digital form using Kobo Collect Software. Data from each cooking and heating event were entered into separate data forms by enumerators using smart phones.

The findings of this cooking diary survey in Dodoma can be categorised into energy consumption, meals cooked, cooking appliances, time and water heating. This was followed by experiences of users on electric cooking assessed during exit survey.

The fuels used in the study areas during the baseline phase (which also are fuels that households use for most cooking) were firewood (22%), charcoal (40%) and LPG (38%). In phase 2, almost 75% of households started to use electricity as their main cooking energy carrier. The rates of using charcoal, LPG and firewood were reduced to 8%, 7% and 10%, respectively. The frequency of using electricity was high in those households but consumption of energy was very low compared to charcoal, firewood and LPG.

The type of foods cooked were categorised into breakfast, lunch or dinner, water heating and food for babies. Foods for breakfast in Dodoma are tortilla (chapatti), dough, pasta, porridge, sweet potatoes, cassava and taro. Food preferred for lunch and dinner are banana, beans, fish, makande, meat, ugali and vegetables. Porridge (5.11%) and water heating in terms of tea, coffee and cocoa (71.32%) had high frequency in the breakfast but these two types of food are consumed with other side dishes (chapatti, rice fritters (rice cakes (vitumbua)) and dough). Food stuff with high frequency during lunch and dinner is rice (20.04%) which was followed by ugali (16.77%). These are accompanied by animal protein food (fish, beef, goat and lamb), beans and vegetables.

Whether food was cooked from fresh or reheated was part of the data collected from households. Reheating food is expected to take less energy than cooking a fresh meal and indeed this can be seen to be the case except food prepared and reheated by firewood in phase 1. Most of households in phase 2 stopped reheating food by using charcoal, firewood as well as LPG and, instead those households used electricity.

The cooking appliances used to cook foods by households are charcoal stove, LPG stove and firewood stove in the baseline phase. The study also assessed other equipment such as cooking pots by their sizes, frying pans and lids for covering pots. Pots used in households were categorised into

small, medium and large sizes. About 70% of food is prepared in medium size pots. Light foods like tea, milk, baby foods, etc are cooked by using small pots. The large pots are used during festivals, boiling water for bathing, when family size increases like when children have come back to their home places for school leaves and when the family receive guests.

The methods used for cooking in Dodoma include frying, boiling, grilling, baking and microwaving. During the baseline, almost all foods were cooked by charcoal, firewood and LPG and cookstoves related to those fuels in the selected households. The high price of charcoal compared to LPG has lowered use of charcoal in the city. Although all households were asked to cook with electricity as much as possible in the EPCs in phase 2, other stoves and fuels were as well used during power cuts. Households enjoyed saving time, 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).

An important question that requires an answer is what compels the prevalence of multiple fuels use by households (stacking). In the baslien phase, the frequency of using firewood, charcoal and LPG was 9% (27 times). The frequency of using LPG and Charcoal was 35% (106 times) while the rate of using firewood and LPG was 24% (72 times) while firewood and charcoal was 14% (43 times). The frequency of using single fuel was observed for LPG (5%)(15 times) and charcoal (13%)(41 times). None of the households used firewood as the only fuel for cooking, this fuel was always stacked with LPG and charcoal.

There were practices of fuel stacking by households in phase 2 especially during power cuts and during initial days of practising on how to cook with EPCs. However, the frequency of fuel stacking was tremendously reduced in the phase 2. The frequency of using all energy carriers by households was only 2%. The frequency of 1% was observed for LPG and electricity while about 1.4% for both biomass and electricity. The frequency of using LPG and biomass fuels (as single fuel) was 2.3%. The frequency of using electricity as a single energy carrier is 76% (166 times). The frequency of cooking with biomass fuels was 12%. This implies that the increase in efficiency of appliances, reduction of cooking costs and easiness of using appliances were determinants for influencing movement of people from inefficient technologies and biomass fuels to clean and efficient energy solutions.

The average energy consumption per day for households which is using both charcoal and LPG for cooking in phase 1 was 13.1 MJ. The average energy used per day during the use of EPCs in households was 1.63 kWh which is equivalent to 5.868 MJ. There was a significant saving of energy in phase 2 compared to phase 1.

The times taken to cook different food types using Charcoal, Firewood and LPG in Phase 1 (Existing Cooking Practices) were compared to using EPCs in Phase 2. The comparison showed that there is a significant difference in cooking times between existing cooking practices and cooking by EPCs.

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, purification and washing hands. Water heating frequencies were compared in the first and second phases, more water heating cases (65%) occurred during phase 1 and they were lowered to 35% cases recorded in phase 2.

Experiences of the users on the transition to modern cooking with electricity using EPCs were collected during the exit survey, which was undertaken immediately after completing cooking diary.

The cooking diaries study in the city of Dodoma, Tanzania has shown that cooking with electricity is well-matched with Tanzanian cuisine and that modern energy-efficient appliances (EPCs) are highly

advantageous to cooking practices in households. In fact, in all areas of the city of Dodoma, grid electricity is already strong enough for direct AC cooking, meaning there is an opportunity to promote these appliances in the city. 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 complete picture of the opportunities and challenges of modern energy cooking services in Tanzania.

Abbreviations

A2EI	Access to Energy Institute
AC	Alternating Current
GW	Giga Watts
ICS	Improved Cook Stove
IRENA	International Renewable Energy Agency
kWh	Kilo Watt Hour
LBNL	Lawrence Berkeley National Laboratory
LPG	Liquefied Petroleum Gas
MECS	Modern Energy Cooking Services
MFI	Micro Financial Institution
MJ	Mega Joule
MT	Metric Tons
NEP	National Energy Policy
PG	Power Gen
REA	Rural Energy Agency
SDG	Sustainable Development Goals
SE4ALL	Sustainable Energy for All
SME	Small and Medium Enterprise
SPPA	Small Power Purchase Agreement
TANESCO	Tanzania Electric Supply Company
TaTEDO	Tanzania Traditional Energy Development Organization
UK	United Kingdom

1.0 Introduction

1.1 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).

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." (IRENA 2017)

1.2 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.

1.3 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).

1.4 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.

2.0 Objective

The objective of the cooking dairy study is to assess the existing cooking practices and find out means of rapidly accelerate 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 asking them to undertake transition to new practices of cooking with electricity for the remaining duration of the study.

3.0 Area of the Study

The area selected for the cooking diary study was the City of Dodoma. Dodoma is located in the middle of the Country. It is boarded by Chamwino district in the East and Bahi district in the West. It lies between Latitudes 6.000 and 6.300 South, and Longitude 35.300and 36.020 East.

Dodoma covers a land area of 2,669 square kilometres of which 625 square kilometres is the urban area. Dodoma is characterized with both urban and rural settings. It stands on broad upland plateau with an altitude ranging between 900-1000 meters above sea level, with beautiful stony hills such as Image, Isanga, Mkalama and Mlimwa. It experiences a long draught and short rainfall seasons. Due to unreliable rainfall, the area has scanty vegetation such as shrubs, grasses as well as conspicuous baobab and acacias trees.

Dodoma has semi-arid climate with warm to hot temperatures throughout the year. The weather is characterized by a marked seasonal rainfall distribution with a long dry and short wet seasons, an average annual rainfall of about 550 – 600mm per year, which falls between December and April each year.

According to the population and housing census of 2012, Dodoma city had 410,956 people of which male are 196,487 and females 211,469. The number of households is 93,339. The city recently changed into capital city of Tanzania and people have shifted from different areas of the country to the city. The population in year 2021 is estimated to escalate to 456,035 people.

Dodoma has received fringe economic position from the government by deliberately crowning it to become the new Capital City. Already tremendous developments have taken place to support the capital transfer plan by the central government. As a result, regional economic growth has increased over the recent past two years to match the national average, with acceleration on per capita income and poverty reduction. Various sources of energy are used in the region for domestic and commercial purposes. These include energy from hydro, solar, firewood and charcoal. Electricity is available in many districts that have peri-urban characteristics. The proportions of customers using electricity in the region are: 63 percent of all commercial institutions and 46 percent of all households.

The majority of households in Dodoma are taking three meals per day. Several food recipes are cooked and consumed in the city but staple foods are maize, meat and sorghum. Dodoma is also famous for production of fruits such as grapes, mango, papaya, guava, baobab, tamarind and dates. Crops such as cassava and potatoes are produced in small quantities but from available literature it shows that, they have a higher productivity. Several vegetables are grown in Dodoma, which include spinach, amaranths, tomatoes, Chinese cabbage, onions, okra, lettuce, egg plant, bell pepper and carrots. The livestock products are coming from nearby districts which keep various livestock such as beef cattle dairy cattle, indigenous cattle, goats, sheep, broilers, layers, indigenous poultry and pigs. With the rapid increase in population of Dodoma, caused by the new government move, investment in large-scale production for cash crops is imperative.

4.0 Methodology

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

4.1 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, equipment and approach of the study are as discussed in the heading hereunder:

4.1.1 Participants and Facilitators

The study was supported by the Local Government in Dodoma through the Community Development Officers and partners in Dodoma 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 of 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.

4.1.2 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 kilograms 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.

4.1.3 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.

4.2 Cooking Diaries in Dodoma Region, Tanzania

Cooking is very much embedded in culture and due to cultural resistance to clean cooking solutions; it has been difficult to adopt the 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 Dodoma, Tanzania 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 Dodoma which will deliberately try to find out how to transform traditional cooking practices to new practices of using modern clean cooking solutions. In so doing, MECS will change lifestyles of several people in households and across several government agencies, business sector, development partners and private sector and may change the shape of the 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 the modern energy cooking services. The household payments for cooking energy will be redirected from biomass fuels to modern energy services.

5.0 Results

5.1 Typical Food for People in the Area Selected for Dodoma Urban

Dodoma Urban being the government administrative centre is populated by different ethnic groups with different culture from different parts of the country. The distinguished ethnicity of people also indicates the different types of food cooked and consumed in Dodoma Urban areas. 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. These categories were not only adopted from the study areas but also from previous experiences of cooking diaries. According to Cooking Diaries study, the following are food stuff consumed in Dodoma Urban:

Food Type	Description
Heavy Foods	
Legumes(Palse) (Maharage, Kunde, NjuguMawe, etc)	Grain legumesare re used in Dodoma are beans and cow peas. Pigeon peas and peanuts are mostly obtained in Dodoma. These grains are boiled and beans stew is made for eating with other starchy foods i.e. Ugali, rice, etc.
Makande	The dish is cooked by combining maize with beans which are sometimes soaked overnight and then cooked until they become soft and then cooked by coconut milk or oil, tomatoes and onion. There two types of Makande. One is mixed with vegetables and another flavoured with ginger, cumin and cardamom.
Moderate Light Foods	
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.
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!
Wali	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.
Ndizi-Machalari	Ndizi-Machalari is a dish using bananas and meat as the main ingredients.

Ndizi-Matoke	Mattock is spicy soft green banana consumed as mashed or sometimes not mashed mixed with meat and vegetables. Matoke bananas are boiled and accompanied with other meals such as stews, curry, beans, etc .
Boiled Foods	
Tea/Coffee	These are boiled food consumed with snacks as breakfast and occasionally can be consumed in the afternoon and evening.
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.
Porridge (Uji)	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
Mchemusho	Mchemsho is a tasty dish in the form of soup consisting of numerous ingredients such as potatoes, green beans, carrots, bananas, tomatoes, cabbage, eggplant, sweet peppers, and a variety of spices.
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.
Simple Fry Food	
Vegetables (Mchicha, Cabbages, Stew, etc)	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 (Nyama, Kiti Moto, Fish, Chicken,etc)	meat/fish/veg stew –many people will pre-cook (boil) meat in bulk and wet fry portions throughout the week. Chicken/fish/veg generally cooked for a lot less time than meat, but difficult to separate out without going through the quantity field one by one.
Mayai (Eggs)	Could be boiled, fried or omelette. If omelette, can often be combined with potatoes (chips mayai), which may need deep frying first.
Deep Fry Food	
Chapati	Chapati is food which can be eaten for breakfast, for lunch or supper. Chapati is made of whole wheat flour salt and water mixed into dough and then flattened.
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.
Vitumbua	Vitumbua is a Tanzanian dish, made by mixing rice flour, sugar, yeast and cardamom overnight and frayed in the next morning. These are foods used as snacks for breakfast
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.

Table 1: Food Consumed in Dodoma Municipality

5.2 Overview of Data

5.2.1 Overview of Participating Households

The cooking diary study was explored deeper into the unique cooking practices of individual households. A total of 12 households which were selected to participate in the study in Dodoma, were used to prepare meals during cooking diary workshops, trained on how to weigh and measure fuels, record data 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 owning smart phones.

5.2.2 Overview of Diaries Data

The 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 a 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.

Heating Events	Frequency	Percent (%)
Breakfast	50	28
Food for Baby	10	6
Lunch	19	10
Dinner	23	13
Water Heating(Bath)	21	11
Snack	7	4
Missing Cases	50	28
Total	**180**	**100**

Table 2: Number of Heating Events[1]

Water heating is most of the time is not considered as stuff which is using much energy although most of participants cannot complete a day without heating water for different purposes such as drinking, tea, bathing (babies and family members), washing, etc.

Most of heating events are occurring during breakfast due to 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. Water heating during lunch is at medium level since most of family members are not at their households.

i) Zero Energy Meals

Zero Energy meals simply means no heat, which implies the stove or cooker was kept off or food which 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.

Food Type	Frequencies	Percent
Fruits (Lunch and Dinner)	34	22
Bites (Breakfast)	83	53
Food from Vendors	12	8
Raw Food (Lunch and Dinner)	17	11
Did Not Eat at Home	9	6
Total	**155**	**100**

Table 3: Zero Energy Meals

The most of missing cases are instances in which no food was eaten in the households (especially food brought from vendors and families which did not eat at home), 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,

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

chapati, rice cakes (vitumbua), etc) which are bought from vendors. Those cases did not affected cases of collected data, because these foodstuffs were part of meals.

5.3 Energy Consumption

The fuels used in the study areas are firewood, charcoal and LPG. There were no any case of using electricity for cooking during the survey but possibly it is used in high income households for light foods. 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.

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

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

These values will be 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.

5.3.1 Mix of Fuels (Fuel Stacking)

The mix of fuels used in Dodoma for phase 1 is presented Table 5. This shows that charcoal and LPG accounts for the majority of energy consumed in households in Dodoma. The firewood is used by few households and most of these households are located to the outskirts if the city and other households have ability of getting firewood from the rural areas. Electricity is occasionally used by few households for warming foods and cooking light foods.

Participants	Electricity	LPG	Charcoal	Firewood
NuruChambuso		x		
Mariamu Lyimo		x	x	
Monica Mganda		x		X
Pendo Masawe		x	x	
Veronica Kudeli		x	x	
Jamila/Anzerani Omary			x	
Sekela Mwaibale		x	x	
Faith Kiboko		x	x	
Martha Mogwa			x	X
Zena Hassani		x	x	X
Mary Abel			x	
Asha Jama		x		X

Table 5: Cooking Events by Fuels Used by Participants (Phase 1)

Chart 1 shows cooking energy used by households in Phase 1. Although most of households are using LPG and charcoal, rate of using LPG (38%) is almost the same as charcoal (40%) and firewood (22%). This is not only attributed to easiness of lighting LPG stoves, affordability, type of food (hard or soft) but also cleanness of LPG compared to charcoal and firewood.

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

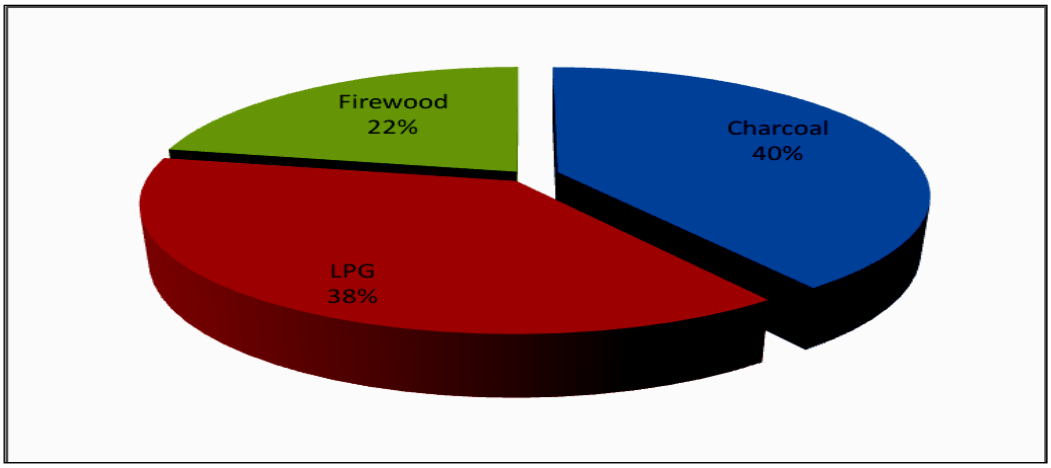

Chart 1: Frequencies of Using Energy by Households in Dodoma (Phase 1)

The experiences from some participants indicate that, a large number of households were using charcoal and firewood as fuel for cooking. The pattern has changed recently to most of them and they are switching gradually to the use of LPG. This is the reality was observed in most of households which implies that frequency of cooking with LPG was 38% while the charcoal was 40%.

The introduction of EPCs in households shifted a large number of households to the use of electricity (75%). There were some households used charcoal, LPG and firewood during power cuts and for foods which could not be cooked in EPCs. The rates of using charcoal, LPG and firewood were reduced to 8%, 7% and 10%, respectively. The frequencies of using various energy carriers by households are as shown in the Chart 2:

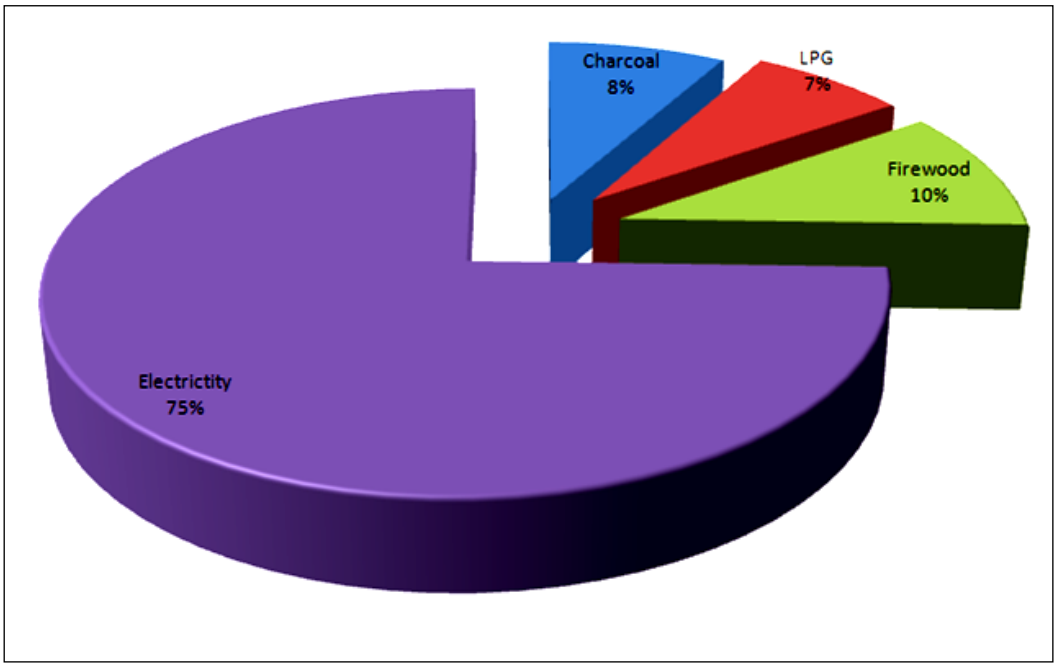

Chart 2: Frequencies of Energy Consumption After Introducing EPCs in Households

5.3.2 Energy Consumption by Households

The comparative analysis was done for both phase 1 and phase 2 of the cooking diary survey to assess energy consumptions by households. Energy carriers (fuels) used in Dodoma by households are charcoal, firewood and LPG. Charcoal and LPG are used for cooking by households in the city

centre while firewood is used by low income households and those located at the peri-urban areas. Sometimes, firewood is also used for frying and cooking in business enterprises. The frequencies of using charcoal and LPG by households are 40% and 38% while firewood is used by 22% of surveyed households in Dodoma.

S. No.	Names	Charcoal			Firewood			LPG		
		Median	Mean	N	Median	Mean	N	Median	Mean	N
1	Jamila Omary	43.355	66.079	26	0	0	0	0	0	0
2	Veronica Kudeli	6.578	11.96	17	0	0	0	1.344	2.688	9
3	Martha Mogwa	13.156	15.847	18	13.356	13.515	25	0	0	0
4	Monica Mganda	0	0	0	32.436	34.821	14	1.792	1.792	14
5	Pendo Masawe	85.813	82.823	9	0	0	0	8.512	7.168	11
6	Asha Jama	0	0	0	18.285	12.879	13	3.584	4.48	31
7	Zena Hassani	8.073	12.259	9	29.892	7.473	15	2.688	7.168	3
8	Mary Abel	12.259	12.558	15	0	0	0	0	0	0
9	Mariam Lyimo	15.847	20.93	9	0	0	0	4.032	21.952	9
10	Nuru Chambuso	0	0	0	0	0	0	3.584	4.48	15
11	Sekela Mwaibale	10.465	10.166	8	0	0	0	3.136	13.888	19
12	Faith Kiboko	8.97	9.867	10	0	0	0	7.168	7.168	5
Mean for all households			20.21			5.72			5.9	

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

The average charcoal consumption by households per day is 0.68 Kg (equivalent to 20.21 MJ per household) (range of 0 to 2.77 Kg) while average LPG consumption per day by households is 0.13Kg (equivalent to 5.9 MJ per household) (range of 0 to 0.49) per day. The households using firewood are consuming average of 0.36 Kg per day (equivalent to 5.7 MJ per household). The frequency of using charcoal per day by households is still high in Dodoma. Almost a reasonable number of households has shifted to the use of LPG but has not outweighed use of charcoal for cooking. Most of households in the city centre have limited themselves from using firewood due to unavailability and hard work of fetching or buying this fuel.

There was not any case of cooking by using kerosene and electricity in phase 1. Some participants declared that they have previously tried to use those energy carriers but they were expensive and were not affordable.

The frequencies of using woodfuels and LPG in the phase 2 were 8% for charcoal, 10% for firewood and 9 % for LPG. All households in phase 2 used EPC for cooking. If compared to other fuels used in the second phase, the frequencies of households in using electricity after introducing Electric Pressure Cooker (EPCs) to the participants is 73%.

S. No.	Names	Charcoal (MJ /day)			Firewood (MJ /day)			LPG (MJ / day)			Electricity (MJ)		
		Median	Mean	N	Median	Mean	N	Median	Mean	N	Median	Mean	N
1	Jamila Omary	11.96	13.13	5	0	0	0	0	0	0	4.68	5.08	11
2	Vero Kudeli	23.32	5.38	1	0	0	0	0.90	1.34	0	4.68	5.00	17
3	Martha Mogwa	0	0	0	0.80	10.81	7	0	0	0	4.32	6.12	14
4	Monica Mganda	0	0	0	23.85	20.19	13	5.38	1.79	3	5.04	5.54	21
5	Pendo Masawe	49.34	49.34	1	0	0	0	1.34	2.24	3	4.68	4.64	10
6	Asha Jama	0.00	0	0	0	0	0	0	0	0	5.58	5.72	12
7	Zena Hassan	3.89	15.85	2	15.74	9.38	1	2.24	4.93	2	5.04	5.18	15
8	Mary Abel	3.59	4.19	5	0	0	0	0	0	0	6.12	5.94	12
9	Mariam Lyimo	8.97	15.85	1	0	0	0	0	0	0	4.32	4.36	8
10	NuruChambuso	0	0	0	0	0	0	0	0	0	5.94	5.72	14
11	Sekela Mwaibale	0	0	0	0	0	0	3.58	6.27	3	2.52	5.94	13
12	Faith Kiboko	10.47	7.48	2	0	0	0	4.93	5.38	4	5.04	5.15	8
Mean for all households			9.27			3.37			1.83			5.37	

Table 7: Energy Consumption by Households (Phase 2)

The energy consumption rates by households tumbled down for charcoal, firewood and LPG in phase 2 and almost all households shifted to the use of electricity with frequency of cooking with EPCs of 75% . The findings show that average charcoal consumption was reduced to 0.31 Kg (equivalent to 9.27MJ) compared to 0.68 Kg (equivalent to 20.3 MJ) in phase 1. The average consumptions per day by households in phase 1 was 0.05Kg (equivalent to 1.83 MJ) for LPG and 0.212 Kg per day(equivalent to 3.37 MJ) for firewood. The firewood consumption for households was reduced to 0.22Kg (equivalent to 3.37 MJ) and 0.05 Kg (equivalent to 1.83 MJ/Kg) for the household which used LPG for cooking. The average electricity consumption by household was 1.49 Kwh (equivalent to 5.37MJ). The frequency of using electricity was high in those 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 65% compared to first phase of survey of traditional cooking practices. The electricity consumption was 83% lower than other energy carriers. This was caused by type of cooking appliances used (which means is EPCs) for cooking in those households in the phase 2.

5.3.3 Per Capita Energy Consumptions

It has already been pointed out that energy consumption depends on the number of people that eat the cooked meals. Therefore, the per capita energy consumptions have 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 major heating events practised during cooking for households in Dodoma. These are breakfast, lunch and dinner. Other heating events are water heating and cooking baby foods which occurs whenever members of household is in need of them. Water heating is divided into water for bathing, tea, coffee, milk, etc. The energy consumption by type of heating event is as shown in the Tables and Charts below:

Heating event	Frequency	Mean	Median	Std.dev.
Breakfast	23	5.83	2.68	10.12
Lunch	32	4.43	2.92	4.53
Dinner	25	4.60	2.44	7.47
Water Heating	41	2.95	2.49	2.73
Food for Babies	2	2.10	2.10	0.96

Table 8: Per Capital Energy Consumption by Heating Events (MJ/person/event) (Single Events Only) – Phase 1 Charcoal Only

According to Table 8, charcoal is used in all heating events in Dodoma. The fuel is mostly used for cooking lunch and heating water followed by cooking breakfast and the last one is food for babies.

Heating event	Frequency	Mean	Median	Std. Dev.
Breakfast	14	4.43	2.39	1.69
Lunch	17	5.86	3.98	4.99
Dinner	14	4.60	2.39	1.69
Water Heating	21	2.90	2.20	2.40
Food for Babies	4	2.10	4.63	2.32

Table 9: Per Capita Energy Consumption by Heating Event (MJ/person/event) (Single Events Only) – Phase 1 Firewood Only

The frequency of using firewood was also higher for water heating and lunch. This is followed by cooking dinner and breakfast. Food for babies was the least in terms of frequencies of cooking by using firewood.

Heating event	Frequency	Mean	Median	Std.Dev.
Breakfast	44	1.05	0.56	1.14
Lunch	51	1.09	0.82	1.09
Dinner	43	1.18	0.77	1.17
Water Heating	48	0.80	0.55	0.90
Food for Babies	9	0.63	0.30	2.32

Table 10: Per Capita Energy Consumption by Heating Events (MJ/person/event) (Single Events Only) – Phase 1 LPG Only

The rate of LPG consumption per person is higher for all heating events compared to other fuels. The fuel was used more in lunch cooking followed by water heating, breakfast and dinner. The households with babies prefer to use LPG for cooking food for babies compared to use of charcoal and firewood because of simplicity of rekindling LPG compared to other fuels.

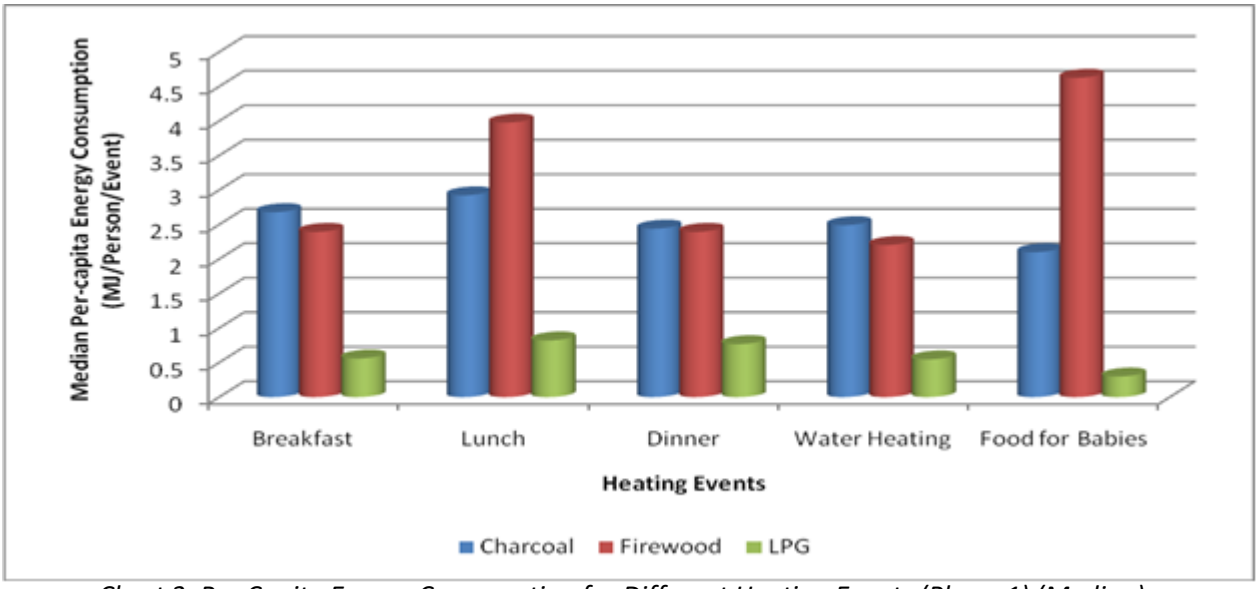

Chart 3: Per Capita Energy Consumption for Different Heating Events (Phase 1) (Median) (Single Events Only)

According to Chart 3, the meadina per capita shows that charcoa and fiirewood contribute much heat or energy in all heating events. The frequency of using LPG is high but this fuiel is used in small quantity by households for soft food throughout all heating events.

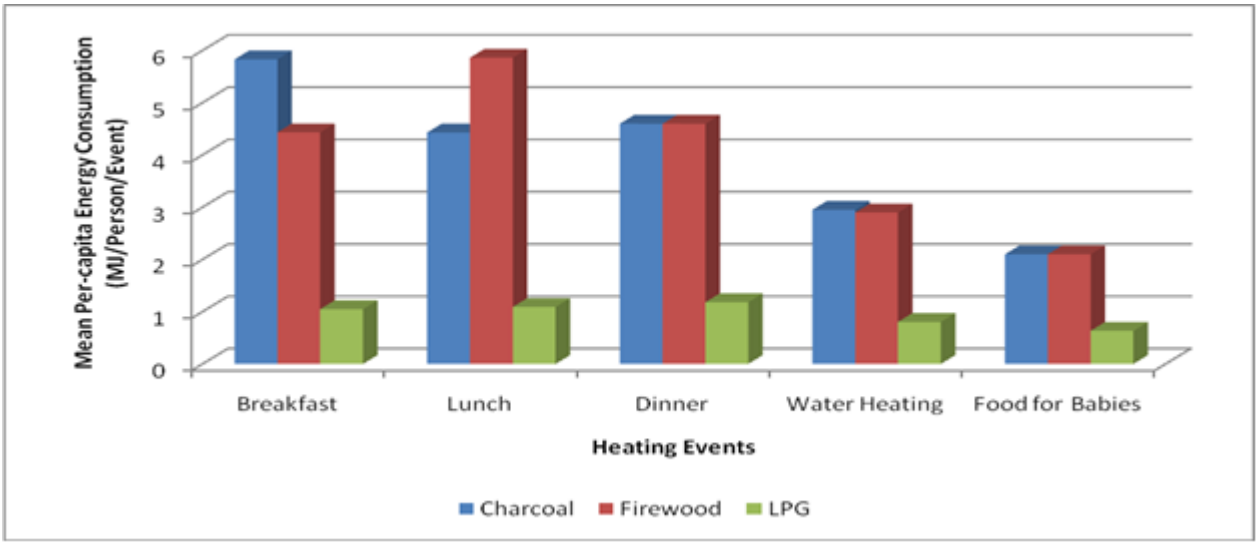

Chart 4: Per Capita Mean Energy Consumptions for Different Heating Events (Phase 1) (Mean) (Single Events Only)

The mean for per capita energy consumption in Phase 1 shows that there were higher consumption during breakfast for charcoal followed by use of firewood for cooking lunch. There were no significant changes in per-capita energy consumption across the five major heating events. The energy consumption was low for food for babies, 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. However, there was slight reduction of the energy consumption for dinner because some households are cooking meal for consuming in the evening during the afternoon. Foods for babies are cooked occasionally for households with babies. Use of firewood implies that more amount of energy from this fuel is used compared to energy consumed from charcoal and LPG. LPG in Dodoma is mostly used for heating

soft and liquid foods such as tea, coffee, milk, etc that is the reason of being much used for water heating during breakfast and dinner.

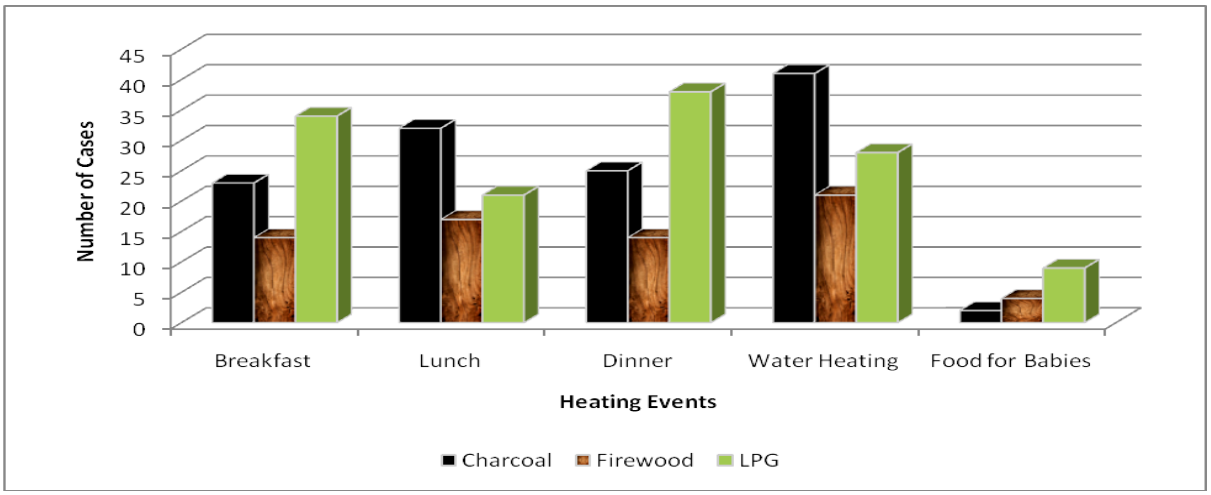

Chart 5: Choice of Fuels for Heating Events (Phase 1)

The Table above is for meals with multiple fuels where fuel stacking is practised. The LPG was ranked as the main fuel used for cooking across all heating events. This is followed by charcoal and the last one is firewood. Charcoal is mostly used for cooking lunch and water heating. During Phase 1, it was observed that charcoal and LPG were used by households which are in the city centre but firewood is used by households located at periphery of the city. Different participants use different fuels, so per capita energy consumption values will depend on the fuel which is being used. A single fuel was used in most heating events, so per capita consumptions for heating events using the main fuels have been calculated.

During the second phase, electricity was priority cooking energy carrier in the second phase, there were some instances of power cuts which forced households to use other fuels such as firewood and charcoal. Each household opted to use alternative fuels available to them during electricity blackouts being charcoal, firewood or LPG.

S. No.	Names	Charcoal			Firewood			LPG			Electricity		
		Median	Mean	N	Median	Mean	N	Median	Mean	N	Median	Mean	N
1	Jamila Omary	3.3	3.6	5	0	0	0	0	0	0	0.29	0.40	11
2	Vero Kudeli	7.2	7.2	1	0	0	0	0.4	0.4	4	0.32	0.43	17
3	Martha Mogwa	0.0	0.0	0	9.1	7.3	7	0	0	0	0.22	0.68	14
4	Monica Mganda	0.0	0.0	0	16.1	21.0	13	0.4	0.9	3	0.58	0.79	21
5	Pendo Masawe	93.3	93.3	1	0	0	0	0.4	0.9	3	0.43	0.43	10
6	Asha Jama	0.0	0.0	0	0	0	0	0	0	0	0.68	0.76	12
7	Zena Hassan	29.6	29.6	2	8.6	8.6	1	1.3	1.8	2	0.79	0.86	15
8	Mary Abel	13.5	12.6	5	0	0	0	0	0	0	0.94	0.86	12
9	Mariam Lyimo	43.4	43.4	1	0	0	0	0	0	0	0.25	0.25	8
10	Nuru Chambuso	0.0	0.0	0	0	0	0	0	0	0	0.97	0.86	14
11	Sekela Mwaibale	0.0	0.0	0	0	0	0	1.3	2.2	3	0.86	0.83	13
12	Faith Kiboko	30.5	30.5	2	0	0	0	1.3	1.3	4	0.79	0.83	8

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

Totals show that cooking with charcoal during this phase used 6 times energy for cooking compared to energy from firewood and 28 times of energy cooking compared to electricity. EPC in this phase used small amount of energy of about 8 MJ/kWh. This was more attractive to involved households because using electricity for cooking was previously impossible due to high loads and unaffordable electric units (kWh) used for cooking but use of EPCs has change this impossibility into possibility and real cooking practice.

Heating event	Frequency	Mean	Median	Std.dev.
Breakfast	2	2.54	2.54	1.47
Lunch	11	2.82	2.84	3.44
Dinner	3	3.62	3.60	1.65
Water Heating	1	0.45	0.44	0.23
Food for Babies	0	0.00	0.00	0.00

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

According to Table 12, the rate of using charcoal in the phase 2 was reduced in terms of cases and per capita energy consumption. There was no any case for cooking food for babies by using charcoal. High per capita energy consumption is observed dinner while high frequency of using fuel was observed for lunch. During the lunch and dinner, is time charcoal is needed for cooking and reheating foods especially when power cuts occurs and people in the households are in need of meal.

Heating event	Frequency	Mean	Median	Std.dev.
Breakfast	2	1.63	1.56	1.13
Lunch	8	1.82	1.75	0.94
Dinner	4	0.72	0.64	0.57
Water Heating	7	1.03	0.95	0.23
Food for Babies	0	0.00	0.00	0.00

Table 13: Per Capita Energy Consumption by Heating Event (MJ/person/event) (Single Events Only) – Phase 2 Firewood Only

According to Table 13, the per capita energy consumption from firewood indicates that this fuel was used for cooking breakfast, lunch, dinner and water heating. It was not used for cooking food for babies. The Lunch had more per capita energy consumption followed by breakfast. The frequencies of using these fuels are higher for lunch followed by water heating. Firewood was not much used for preparing dinner foodstuffs.

Heating event	Frequency	Mean	Median	Std.dev.
Breakfast	6	2.20	1.60	1.22
Lunch	3	1.30	1.23	1.41
Dinner	5	1.80	1.30	0.95
Water Heating	2	0.90	0.40	0.46
Food for Babies	3	0.40	0.42	0.52

Table 14: Per Capita Energy Consumption by Heating Event (MJ/person/event) (Single Events Only) – Phase 2 LPG Only

Table 14 above shows that per capita consumption of LPG in Dodoma tumbled down in terms of cases and per-capita energy consumption. The per capita energy consumptions ranged from 0.4 MJ per person for food for babies to 2.2 MJ per person for breakfast. The frequency of cooking by LPG was high for breakfast. This was followed by dinner, lunch/food for babies and the last one was water heating. This shows that LPG is not much used for water heating (bathing and drinking).

Heating event	Frequency	Mean	Median	Std.dev.
Breakfast	31	0.70	0.54	0.48
Lunch	52	1.53	1.08	1.23
Dinner	60	1.22	0.90	0.94
Water Heating	37	0.67	0.54	0.41
Food for Babies	6	0.78	0.54	0.57

Table 15: Per Capita Energy Consumption by Heating Event (MJ/person/event) (Single Events Only) – Phase 2 Electricity Only

During phase 2, there was high frequency of cooking by electricity using EPCs. 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 phase 1.

There was slight increase of energy per person from electricity during food cooking for lunch, which was followed energy from electricity used per person to cook food for dinner. The per capita energy consumption was much lower for water heating, breakfast, and food for babies when soft foods are cooked in households.

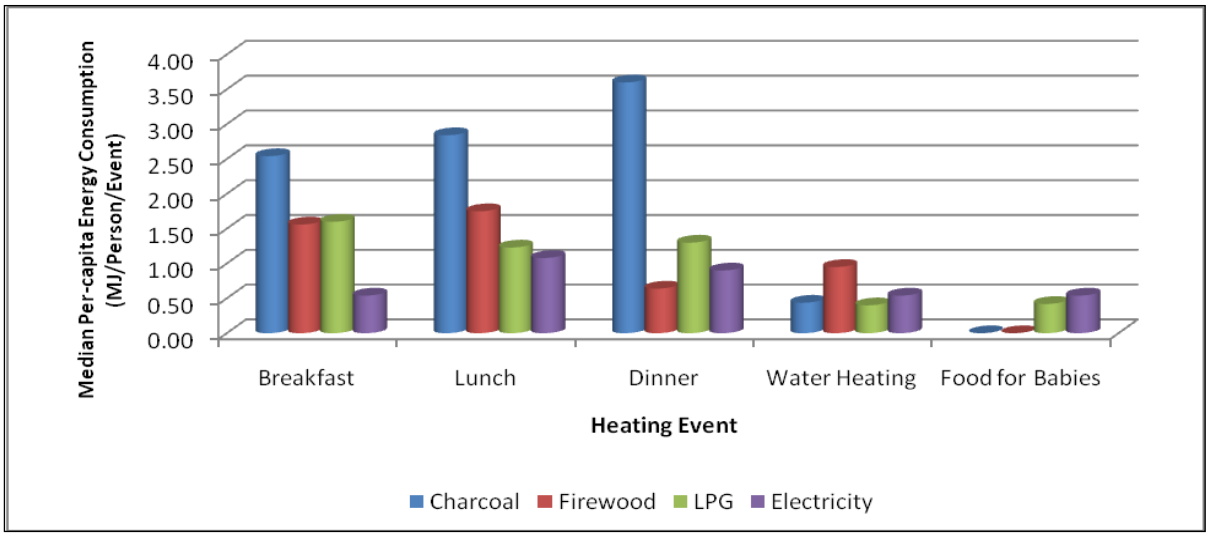

Chart 6: Per Capita Energy Consumption for Different Heating Events (Phase 2) (Median – Single Events Only)

According to Chart 6, the median per-capita in Table 6 shows that per capita energy consumption is higher for charcoal when foods were cooked for breakfast, lunch and dinner. Per capita energy from charcoal was higher for dinner compared to other energy carriers.

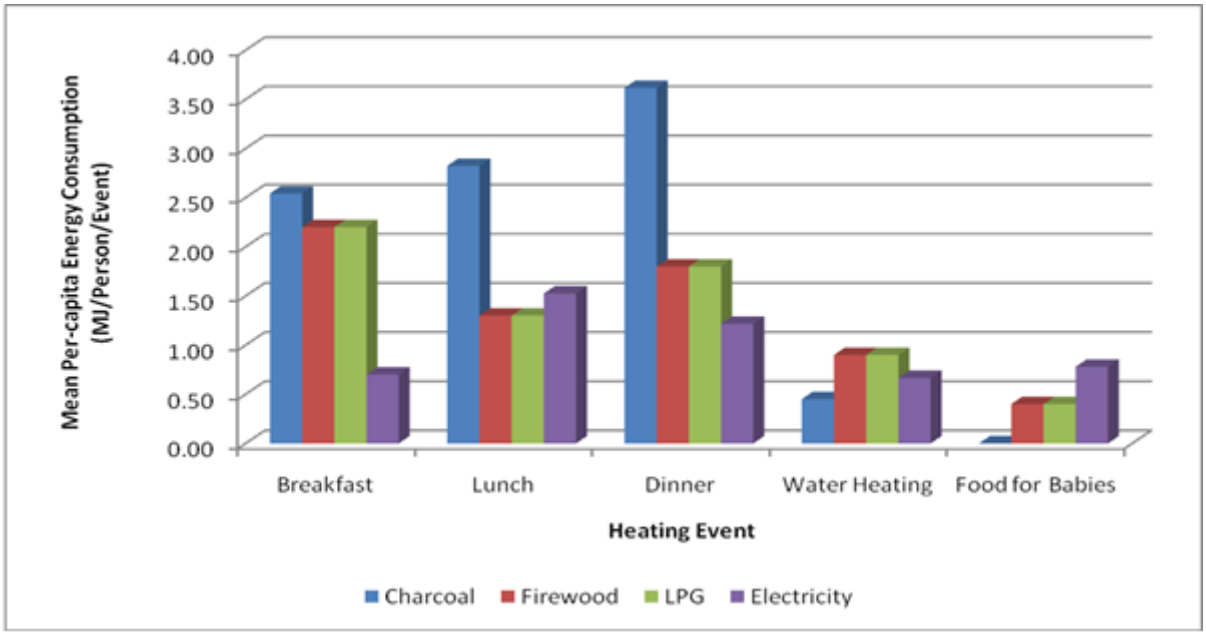

Chart 7: Per Capita Mean Energy Consumptions for Different Heating Events (Phase 2) (Mean – Single Events Only)

The per-capita energy consumption was also higher for charcoal in three heating events of breakfast, lunch and dinner. This was followed by energy consumption per person for firewood and LPG. The per capita energy consumption for firewood and LPG was higher during food cooking for breakfast and dinner and slightly lower during food cooking for lunch and much lower for water heating and food for babies. Energy consumption per person from electricity by using EPCs were almost less than 1.5 MJ in all heating events. According to Chart 7, they were slightly high during lunch and dinner which implies that it is time EPCs are used to the large extent for cooking foods.

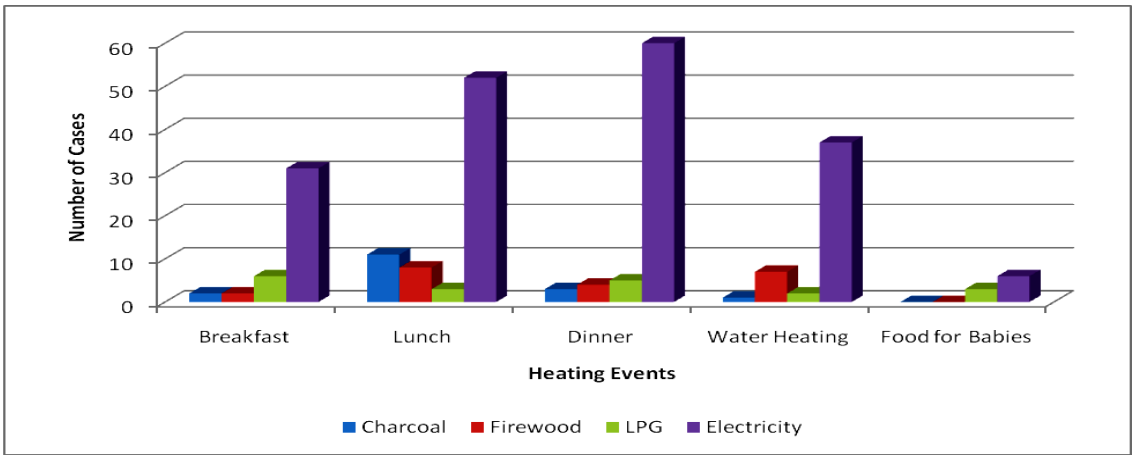

Chart 8: Choice of Fuels for Heating Events (Phase 2)

The per-capita energy consumption in Phase 2, shows was reduced from 2.97 MJ per person for households which were using charcoal to almost 1.27MJ per person for households switched to the cooking by electricity using Electric Pressure Cooker (EPC). The frequency of using electricity was higher compared to other cooking fuels. The frequency of using EPCs was higher during cooking foods for dinner, followed by lunch and breakfast. Water heating also used slightly large amount of energy and the least user was food for babies.

5.3.4 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.

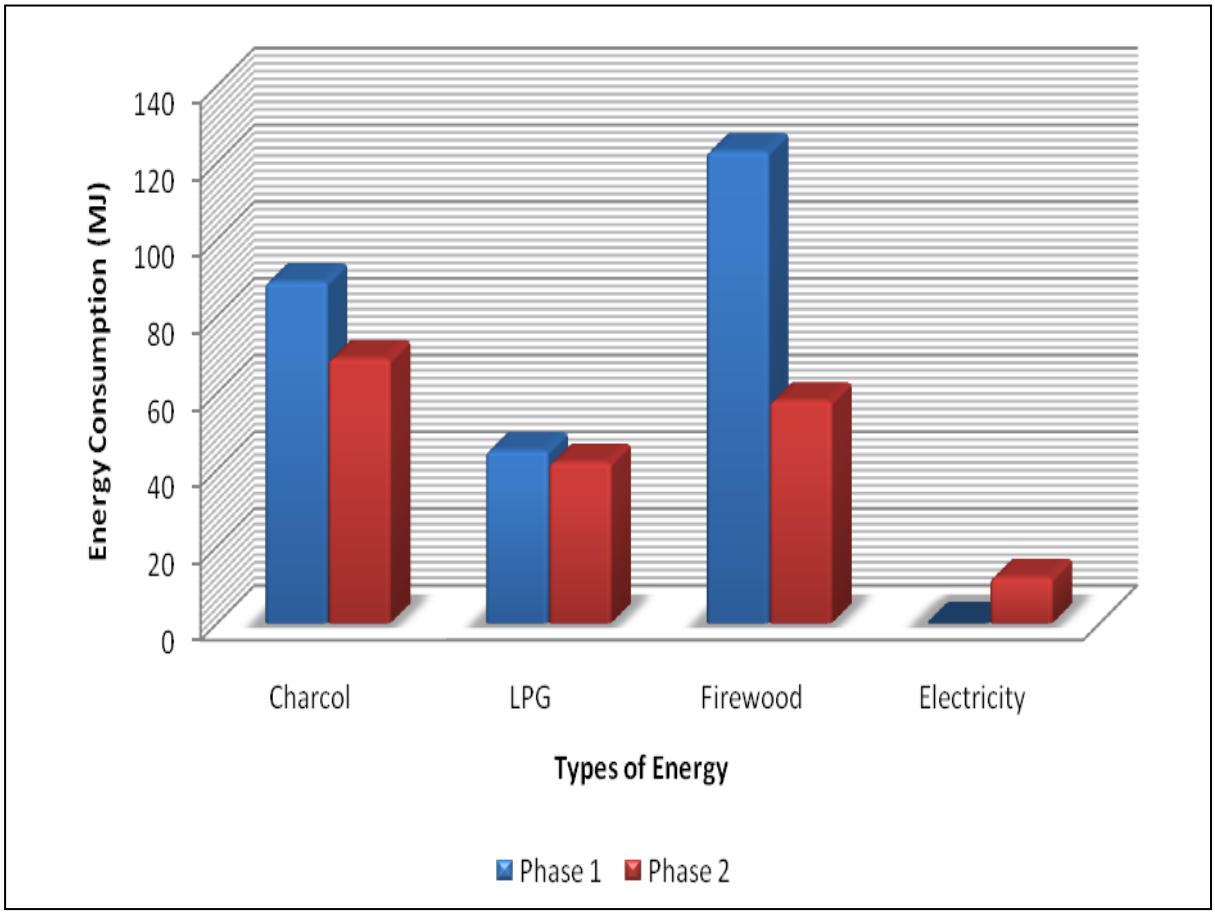

Chart 9: Total of Energy Consumed for all Heating Events per Day

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 household used electricity in phase 1. The phase 2 also showed use of fuels which have more energy such as charcoal, LPG and firewood during power blackouts and heating of water for bathing. However, households which used electricity solely for lighting started to use it for cooking . Use of efficient cooking appliances made them to believe that electricity is affordable and can be used for cooking, if used in the efficient devices. The total electricity used per day by households was 12 MJ/kWh.

5.4 Meals Cooked

5.4.1 Food Types Cooked

Type of food cooked were categorised into breakfast, lunch or dinner events as shown in Table 10. Food for breakfast in Dodoma are tortilla (chapatti), dough, pasta, porridge, sweet potatoes, cassava and taro. As shown in the Table 11: milk, tea, coffee and cocoa are also used for breakfast. Food preferred for lunch and dinner are banana, beans, fish, makande, meat, ugali and vegetables. Some

of the breakfast foods types such as tortilla and dough are not cooked by households but bought as bites from nearby vendors.

Food	Event	Dish 1	Dish 2	Dish 3	Dish 4	Total	Percent
Chapati	Breakfast	6	2	1	0	19	3.89
Dough (Maandazi)	Breakfast	20	0	0	0	20	4.09
Pasta	Breakfast	9	2	2	0	13	2.66
Porridge	Breakfast	21	3	1	0	25	5.11
Sweet potatoes /Cassava/Taro	Breakfast	9	2	3	0	14	2.86
Banana	Lunch/Dinner	12	2	0	0	14	2.86
Beans	Lunch/Dinner	24	9	3	2	38	7.77
Fish	Lunch/Dinner	15	14	3	0	32	6.54
Makande	Lunch/Dinner	9	1	2	0	12	2.45
Meat (Beef/Goat/Lamb)	Lunch/Dinner	35	15	4	7	61	12.47
Rice	Lunch/Dinner	56	30	9	3	98	20.04
Ugali	Lunch/Dinner	39	26	11	6	82	16.77
Vegetables	Lunch/Dinner	21	24	11	5	61	12.47

Table 16: Frequency of Type of Food Cooked by Households (Phase 1)

Water	Event	Dish 1	Dish 2	Dish 3	Dish 4	Total	Percent
Water for Drinking	Lunch/Dinner	0	0	0	3	3	2.21
Tea/Coffee/Cocoa	Breakfast/Babies	70	18	9		97	71.32
Milk	Breakfast	10	2	2	22	36	26.47

Table 17: Frequency of Type of Hot Drinks (Water Heating) (Phase 1)

Porridge (5.11%) and water in terms of tea, coffee and cocoa (71.32%) had high frequency in the breakfast but all these two types of food are consumed with bites (chapatti, rice fritters (rice cakes (vitumbua)) and maandazi (dough)). Food stuff with high frequency during lunch and dinner is rice (20.04%) which was followed by ugali (16.77%). The frequencies of animal protein food (fish, beef, goat and lamb) and vegetables are also appearing in the table to have high frequencies because they are consumed with rice and ugali. Other food stuffs are makande and beans which are occasionally consumed in the afternoon.

Most of the participants were much interested to use EPCs after introducing it to them. All these food stuff were cooked in all phases but participants felt palatability and increased taste for rice and ugali cooked in EPCs during phase 2. All hard and simple food stuffs were easily cooked in phase 2 due to appliance which simplified work and lessened time for cooking.

5.4.2 Reheating Food

Fresh cooking and reheat of food were part of data collected from households involved in the cooking diary survey in Dodoma. 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.

Energy Carrier	Phase 1			Phase 2		
	Fresh	Reheated	N	Fresh	Reheated	N
Charcoal	42.69	26.19	71	21.18	0	17
Firewood	40.52	34.15	38	11.33	12.28	21
LPG	9.26	6.10	131	7.32	2.22	19
Electricity	0	0	0	1.08	0.54	155

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

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

Item	Dish 1	Dish 2	Dish 3	Dish 4	Total	Percent
Reheated	8	7	18	2	35	12.6
Fresh	76	77	66	23	242	87.4

Table 19: Frequency of Reheating/Cooking Fresh Food

The dinners had a higher degree of reheating dishes than lunches and breakfast and this was true of both Phase 1 and Phase 2. There was reheating of food during breakfast for foods 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 87.4 percent compared to reheating food was only 12.6 percent.

5.4.3 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 number of times each dish was cooked using each fuel are as shown hereunder.

Energy	Food	F, Dish1	F, Dish 2	F, Dish3	F, Dish 4	Total	Percent
Charcoal	Rice	6	6	1	2	15	19
	Ugali	5	8	5	2	20	25
	Makande	2				2	3
	Beans	5		2	1	8	10
	Porridge	1	1			2	3
	Beef/Goat	5		2	1	8	10
	Chapati	3		1		4	5
	Fish	3				3	4
	Vegetable	5	3	1	1	10	13
	Dough (Maandazi)	2				2	3
	Sweet potatoes/cassava/taro	3		2		5	6

Energy	Food	F, Dish1	F, Dish 2	F, Dish3	F, Dish 4	Total	Percent
	Pasta		1			1	1
						80	100
LPG	Bananas (hard)	6	1			7	4
	Beans	4	4			8	5
	Beef/Goat	12	7	3	2	24	15
	Chapati	3	2			5	3
	Fish	5	7	2		14	9
	Vegetables	6	13	7	1	27	17
	Pasta	1				1	1
	Porridge	8	1	1		10	6
	Rice	14	9	3		26	17
	Sweet potatoes/cassava /taro	2	1		1	4	3
	Ugali	14	13	2	2	31	20
						157	100
Firewood	Banana	2				2	7
	Rice	1				1	4
	Fish		5	5		10	36
	Ugali		1	2		3	10
	Vegetable		4	4		8	29
	Beef/Goat		1	1	1	3	10
	Beans				1	1	4
						28	100

Table 20: Number and Percent of Times Each Dish was Cooked Using Different Fuels

According to the table above, fuels used in phase 1 which were charcoal, LPG and firewood cooked all types of foods. Charcoal and LPG are the dominant fuels used by all households. Almost all foods were cooked by these fuels. Rice (23%) and Ugali (17%) as main dishes are cooked by charcoal. Rice and Ugali in other households were cooked at the rates of17% and 20% by LPG, respectively. These dishes are not consumed themselves, but are mixed with vegetables or meat. These dishes have moderate rates because Ugali and Rice can also eaten with other foodstuff such as beans, fish, milk, etc.

Firewood is used in places where it could be fetched easily such as at the outskirts of the city (the case of Nala Ward in Dodoma). According to this study, foodstuff such as fish (36%), vegetables (29%) and meat (10%) have ranked high because these are types of food which are obtained at the periphery of the city. Most of households are consuming vegetables and meat with Ugali and occasionally with rice.

Banana in the city centre is only cooked by LPG. The reason is requirements of constant heat during cooking of this dish (It does not require heat fluctuation during cooking which can be well maintained by LPG stoves). 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.

Cooking with electricity using EPCs was practiced in all households in phase 2 which were before used charcoal ,firewood and LPG. The percentages of cases of electricity consumption by households for different types of food are as shown in the Chart 10 below.

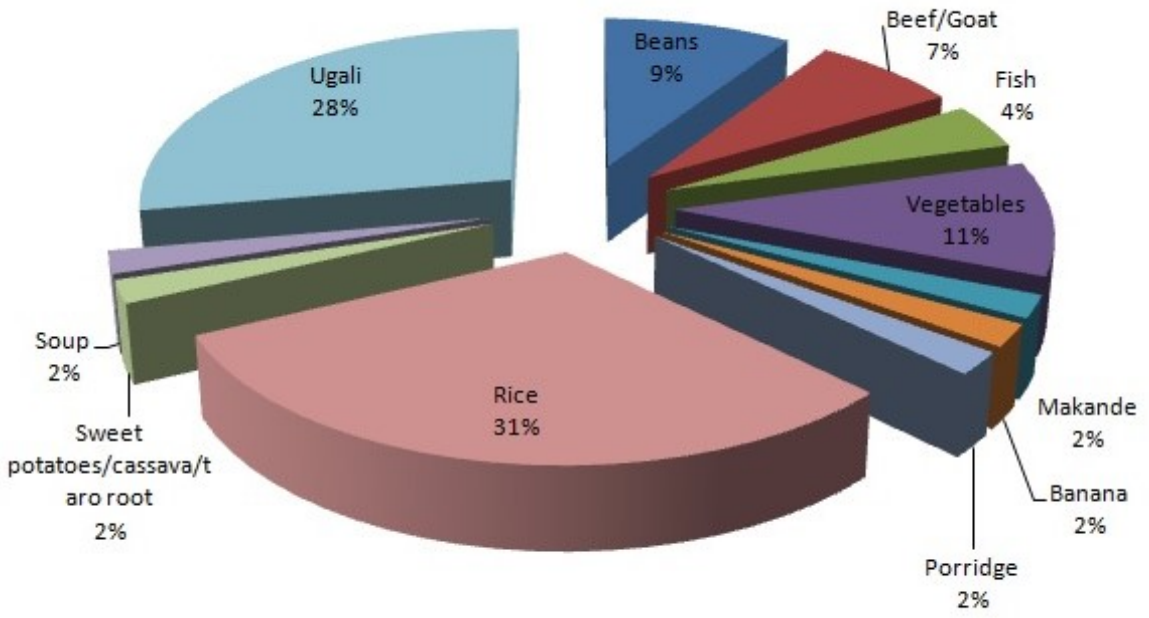

Chart 10: Percentages of Cases of Electricity Used for Different Types of Foods (Phase 2)

The main dishes remained to be Rice and Ugali which their rates were 31% and 28%, respectively. The complimentary food stuffs were rated at 11% for vegetables, 9% for beans, 7% for meat and 4% for fish. All other remaining food stuffs (soup, banana, porridge, makande and tubers (roots)) had rates of 2%. The rate of cooking beans by electricity increased because of short time, easiness and affordability of cooking this type of food in the EPCs. The frequency of cooking rice increased in households because of taste and easiness of cooking this dish compared to Ugali.

5.4.4 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 the phase 1 are tea, coffee, cocoa and milk (Chart 11). Although, these foodstuff were not further analysed but experiences shows that tea and milk are liquid foods mostly consumed in those households compared to cocoa and coffee. In the phase 1, it was realized that LPG is the fuel which is used by several households for cooking liquid foods. This is followed by charcoal and firewood which are used for water heating whenever hot water is required in the large quantity in those households.

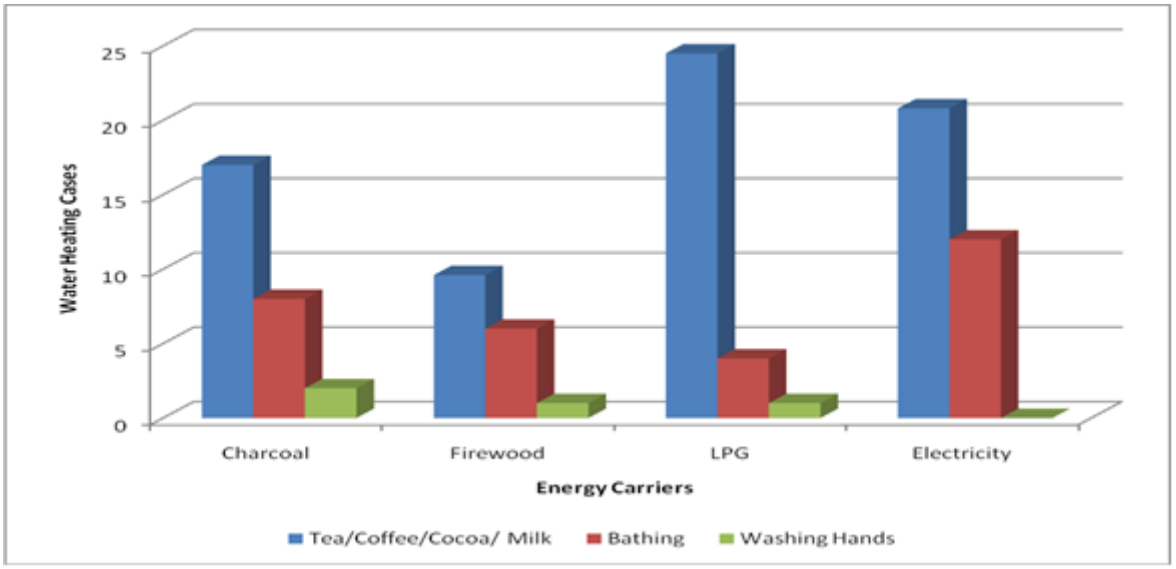

Chart 11: Frequency of Water Heating by Different Energy Carriers

Water is also heated for the purpose of bathing and washing hands. The main fuels used to heat water for bathing and washing hands are charcoal in the urban areas and firewood in the peri-urban areas.

Preparation of hot drinks and heating of water for bathing in the phase 2 were heated by electricity. According to Chart above, water for washing hands was heated by other fuels. This is attributed to amount of water heated for washing hands. Hands in most of those households are washed by the cold water.

5.5 Cooking Appliances

5.5.1 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 in Table 15. Note that any single record can contain information on up to four foods, so the table includes each separate food–appliance combination. This shows that 49% of foods were cooked with LPG. The LPG stoves were used in both phase 1 and 2. The LPG in phase 2 was used during power cuts and for heating water for bathing. During phase 2, about 31%of households used EPCs. Charcoal stoves (11%) and firewood stove (9%) were also used by those households during phase 1.

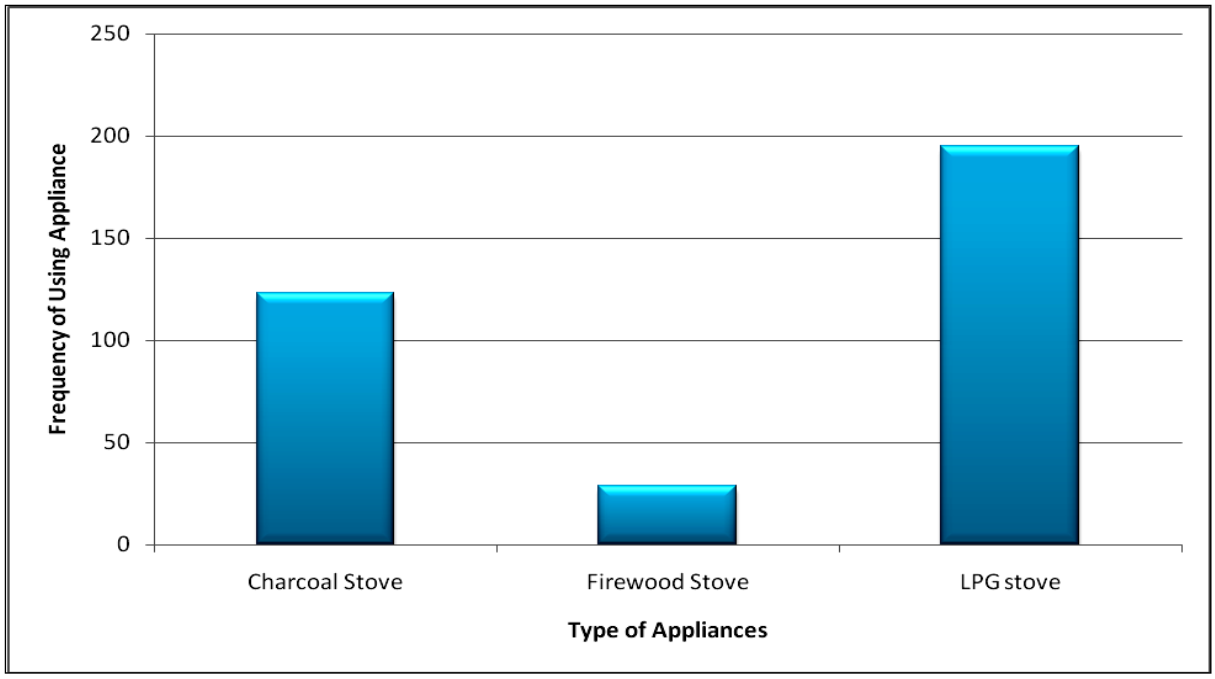

Chart 12: Frequency of Using Cooking Appliances in Phase 1

The frequency of using cooking appliances was higher for LPG stoves during the phase 1 in Dodoma. This was followed by charcoal stoves and the least in the frequency of using appliances was firewood stoves. The LPG stove was used 195 times while charcoal stoves were used 123 times and firewood stoves were used 29 times. None of the households used electric appliance in the first phase.

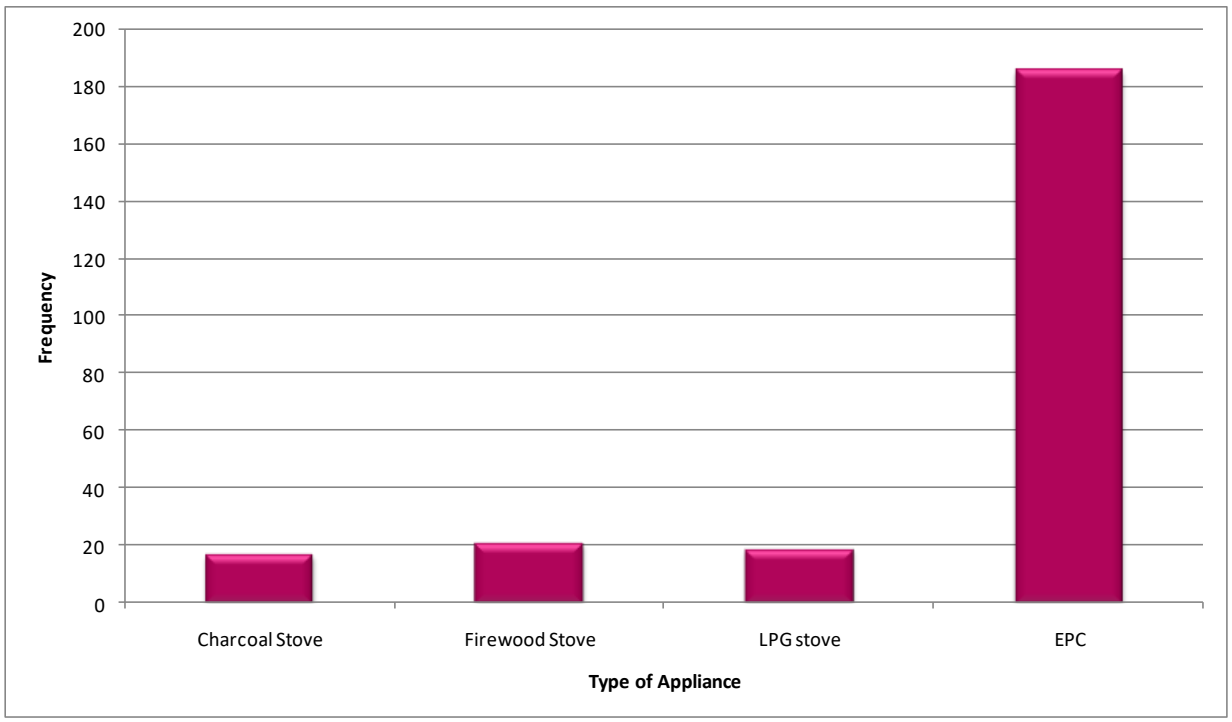

Chart 13: Frequency of Using Appliances in Phase 2

According to Chart 13, the frequency of using charcoal, firewood and LPG was reduced to below 20 times in the phase 2 of switching to the use of electricity. The frequency of using Electric Pressure

Cooker (EPC) was 10 times as much as other three cooking fuels. Almost all households used EPC for cooking and heating food and boiling water. The EPC was accepted by a large number of households because of its characteristics of saving, energy, time and money. The taste of food and safety were also other attractive factors for using this appliance.

5.5.2 Equipment Used During Cooking

The study also assessed other equipment used in the kitchen for cooking. The assessed equipment are cooking pots by their sizes, frying pans and lids for covering pots. Uses of these equipment have effects to the energy consumption in households whenever user is cooking. The following Table 16 shows equipment used in Dodoma for food preparation.

Ppt ID	Participant	Small Pot	Medium Pot	Large Pot	Frying pan	Lid	No Lid
1	Jamila Omary	6	15	0	0	8	13
2	Vero Kudeli	5	16	1	0	9	13
3	Martha Mogwa	6	27	1	1	30	5
4	Monica Mganda	6	46	4	2	54	4
5	Pendo Masawe	6	2	1	1	6	4
6	Asha Jama	9	17	1	3	18	12
7	Zena Hassan	8	16	0	3	6	21
8	Mary Abel	4	12	0	6	3	19
9	Mariam Lyimo	10	42	5	1	19	39
10	NuruChambuso	6	13	3	3	10	15
11	Sekela Mwaibale	15	16	2	1	15	19
12	Faith Kiboko	1	16	1	3	4	17
	Total	**82**	**238**	**19**	**24**	**182**	**181**
	Percentage	**23%**	**66%**	**5%**	**7%**	**50.1%**	**49.9%**

Table 21: Equipment Used in the Kitchen for Cooking

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 70% of food is prepared in medium size pots. Light foods like tea, milk, baby foods, etc are cooked by using small pots. The large pots are used during festivals, boiling water for bathing, when family size increase like when children have come back to their home places for school leaves and when the family receive guests. About 7% of dishes in the households used frying pans for cooking food. About 10 % of dishes used lids.

5.5.3 Cooking Methods

There are different methods used for cooking foods by households in Dodoma (Table 22). The methods used for cooking in Dodoma include frying, boiling, grilling, baking and microwaving. The frequencies of using these methods were assessed for both phases in each household.

Cooking Methods	Phase 1	Phase 2
Frying	34	35
Boiling	130	90
Grilling	12	11
Steaming	0	0
Baking	4	4
Microwaving	1	0
Pressure Cooking	0	97

Table 22: Frequencies of Methods Used for Cooking Food

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 electric pressure cooker was introduced in those households. Note that participants were almost the same for frying and grilling during phase 1 and 2 since pressure cooking could not replace these methods in the households. Although pressure cooker can be used for baking but this method was almost the same for both phases because users did not get training on how to bake by using pressure cookers.

5.5.4 Characteristics of Different Cooking Devices

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

Food	Charcoal Stove	Firewood Stove	LPG Stove	Microwave	Rice Cooker
Bananas	4	2	4	0	0
Beans	7	1	14	0	0
Beef/Goat	18	5	24	0	0
Dagaa (dried)	2	2	8	0	0
Fish stew (boiled)	2	0	4	1	0
Fried fish	0	2	2	0	0
Vegetables	15	3	28	0	0
Makande	2	1	0	0	0
Pasta	1	3	2	0	0
Porridge	2	0	10	0	0
Rice	18	3	27	0	1
Sweet potatoes/cassava/taro root	5	1	4	0	0
Ugali	20	11	32	0	0
Total	96	34	159	1	1
Percentage	33.0	11.7	54.6	0.3	0.3

Table 23: Type of Food Cooked by Appliance in Phase 1 (Frequencies)

Almost all foods are cooked by charcoal, firewood and LPG and cookstoves related to those fuels in the selected households. The Table 18 shows that most participants had access to both LPG and charcoal; it can be assumed that the dominant use of LPG in Phase 1 reflects an overwhelming preference for LPG. The high price of charcoal compared to LPG has lowered uses of charcoal in households. Firewood was rated the third to charcoal and LPG since it is mostly used at the peri-urban areas and not at the city centre. Only two households used electricity during the phase 1 in microwaves and rice cookers

Although all households were required to cook by using electricity in the EPCs in phase 2, other stoves and fuels were as well used during power cuts and during transition because they didn't know how to cook some foods on EPCs such as baking, deep frying, etc. The trend shows simplicity of using stoves. It is simple to cook food by using EPCs, compared to LPG stoves. It is also easier to cook with LPG stoves compared to charcoal stoves. It was difficult to compared charcoal stoves with firewood stoves because of different environments of urban and peri-urban areas.

Food	Charcoal Stove	Firewood Stove	LPG Stove	Microwave	Rice Cooker	EPC
Bananas	0	1	1	0	0	3
Beans	0	1	0	0	0	18
Beef/Goat	2	1	4	0	0	16
Dagaa (dried)	1	0	2	0	0	4
Fish stew (boiled)	0	0	1	0	0	3
Fried fish	0	0	1	0	0	2
Vegetables	0	0	4	0	0	14
Makande	1	0	0	0	0	24
Pasta	0	0	0	0	0	7
Porridge	1	0	2	0	0	13
Rice	2	1	3	0	0	44
Sweet potatoes/cassava/taro root	1	0	1	0	0	5
Ugali	2	0	3	0	0	28
Total	10	4	22	0	0	181
Percent	4.6	1.8	10.1	0.0	0.0	83.4

Table 24: Type of Food Cooked by Appliances in Phase 2 (Frequencies)

Almost all foods were cooked by EPCs in the phase 2. Despite, the inability to cook by EPCs during power blackouts, EPCs cooked 83.4% of the dishes compared to other stoves during the phase 2. Households enjoyed fastness, easiness, affordability and safety of these appliances during phase 2. Microwaves and Rice cookers were not used during the phase 2 due to alternative of using EPCs. EPCs were used to prepare many foods but not those that required frying (e.g. eggs, chapati and maandazi).

5.5.5 Fuel Stacking

An important question that requires an answer is what compels the prevalence of multiple fuels use 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 Dodoma. 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 utilizations, household willingness to pay for reliable modern energy appliances and services.

Chart 14: Frequencies of Fuel Stacking (Energy Combination) During Phase 1

During phase 1 of the study, fuels which were frequently used in the selected households were firewood, charcoal and LPG. Electricity was used once by two households. The status of fuel stacking for firewood, charcoal and LPG is reflected in the Chart 14 above. The frequency of using firewood, charcoal and LPG was 9% (27 times). The frequency of using LPG and Charcoal was 35% (106 times) while the rate of using firewood and LPG was 24% (72 times) while firewood and charcoal was 14%(43 times). The frequency of using single fuel was observed for LPG (5%)(15 times) and charcoal (13%)(41 times). None of the household used firewood as the only fuel for cooking, this fuel was stacked with LPG and charcoal.

There was behaviour of fuel stacking by households in the phase 2 especially during power cuts and during initial days of practising on how to cook with EPCs. The circumstances of power blackouts forced the households to use their previous cooking appliances. The fuel stacking in the phase 2 was not intensive like in the phase 1. This is as shown in the Chart 15 hereunder:

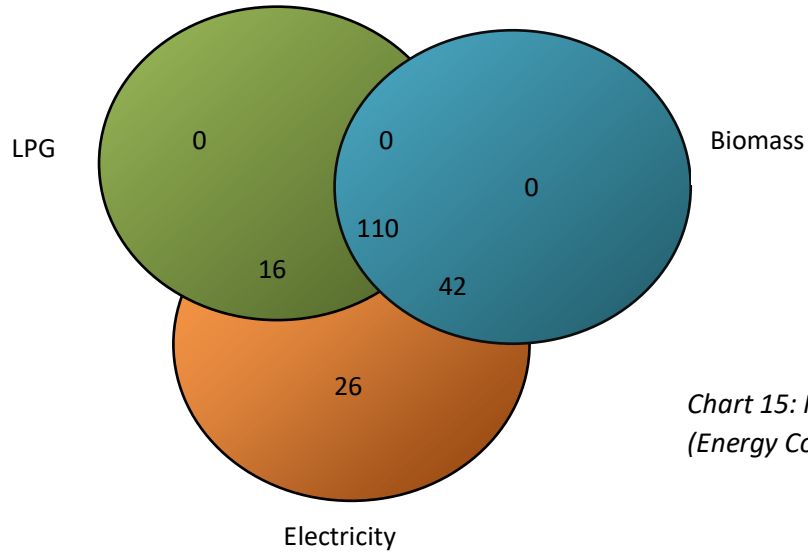

Chart 15: Frequencies of Energy Stacking (Energy Combination) During Phase 2

During phase 2 of the study, the energy carriers which were frequently used in the selected households were electricity, biomass (firewood, charcoal) and LPG. There were practices of fuel stacking by households in phase 2 especially during power cuts and during initial days of practising on how to cook with EPCs. The frequency of fuel stacking was moderately reduced in the phase 2. The energy carriers which were frequently used in the selected households were electricity, biomass (firewood, charcoal) and LPG. All 12 households had ability of using electricity as fuel for cooking. The frequency of using all energy carriers by households was only 56 percent (110 times). The frequency of 8% (16 times) was observed for LPG and electricity while about 22% (42 times) for both biomass and electricity. The frequency of using LPG and biomass fuels was 0%. The frequency of using electricity as a single energy carrier is 13% (26 times). The frequency of cooking with biomass fuels was 12 percent(26 times) The rate of using electricity for cooking by households increased to about 80% (single + stacking with other fuels). It is possible the affordable costs during use of 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 appliance were determinants for influencing movement of people from inefficient technologies and biomass fuels to clean and efficient energy solutions.

5.5.6 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 households for different meals cooked for 7

days and determined the electricity used per day. The electricity used to cook food and water heating are as shown in the Table 25 below.

Household	Owner	Electricity Used to Cook Meal	Electricity Used for Water Heating	Total	Electricity Used per day
		kWh	kWh	kWh	kWh
1	Jamila Omary	8.8	2.5	11.3	1.61
2	Vero Kudeli	5.6	6.0	11.6	1.66
3	Martha Mogwa	3.5	7.2	10.7	1.53
4	Monica Mganda	8.4	3.5	11.9	1.70
5	Pendo Masawe	7.7	4.0	11.7	1.67
6	Asha Jama	8.4	4.2	12.6	1.80
7	Zena Hassan	5.6	6.0	11.6	1.66
8	Mary Abel	5.6	3.6	9.2	1.31
9	Mariam Lyimo	7.0	4.2	11.2	1.60
10	NuruChambuso	7.0	5.8	12.8	1.83
11	Sekela Mwaibale	6.5	6.0	12.5	1.79
12	Faith Kiboko	8.4	1.4	9.8	1.40

Table 25: Energy Used for Cooking and Water Heating (Overall for All Heating Events) by EPC in Households

The average energy used for cooking per day in households is 1.63 kWh which is equivalent to 5.868 MJ/kWh. There was significant saving of energy compared to use of charcoal, firewood and LPG. The median is 1.66 kWh, ranging from 1.31 kWh for high saving (or low consumer) of electricity to 1.83 kWh for low saving (or high consumer) of electricity.

5.6 Time

5.6.1 Time Taken to Cook Food Types

The times taken to cook different food types using Charcoal, Firewood and LPG in Phase 1 (Existing Cooking Practices) in comparison to electric cooking by using EPCs are shown in Table 26 and are illustrated in the Chart 16.

Food Type	Existing Cooking Practices		Cooking by EPCs	
	Mean	Median	Mean	Median
Banana	0:31	0:30	0:20	0:18
Beans	3:04	2:48	0:59	0:52
Beef/Goat	0:39	0:31	0:16	0:15
Chapati	0:59	0:57	0:00	0:00
Dagaa	0:22	0:23	0:11	0:07
Fish Stew	0:23	0:23	0:10	0:05
Fried Fish	0:32	0:30	0:11	0:08
Leaf Vegetables	0:15	0:12	0:08	0:04
Maandazi	0:43	0:43	0:00	0:00
Makande	3:03	3:00	1:02	0:56
Matoke	0:40	0:32	0:12	0:09
Pasta	0:13	0:11	0:09	0:07
Porridge	0:14	0:12	0:07	0:06
Rice	0:41	0:43	0:23	0:19
Sweet Potatoes/Cassava	1:49	1:50	0:22	0:20
Ugali	0:29	0:21	0:15	0:10

Table 26: Time Taken for Existing Practices and Cooking by EPCs (h:mm)

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 using EPCs showed that, there is significant difference in cooking times during existing cooking practices and electricity by EPCs.

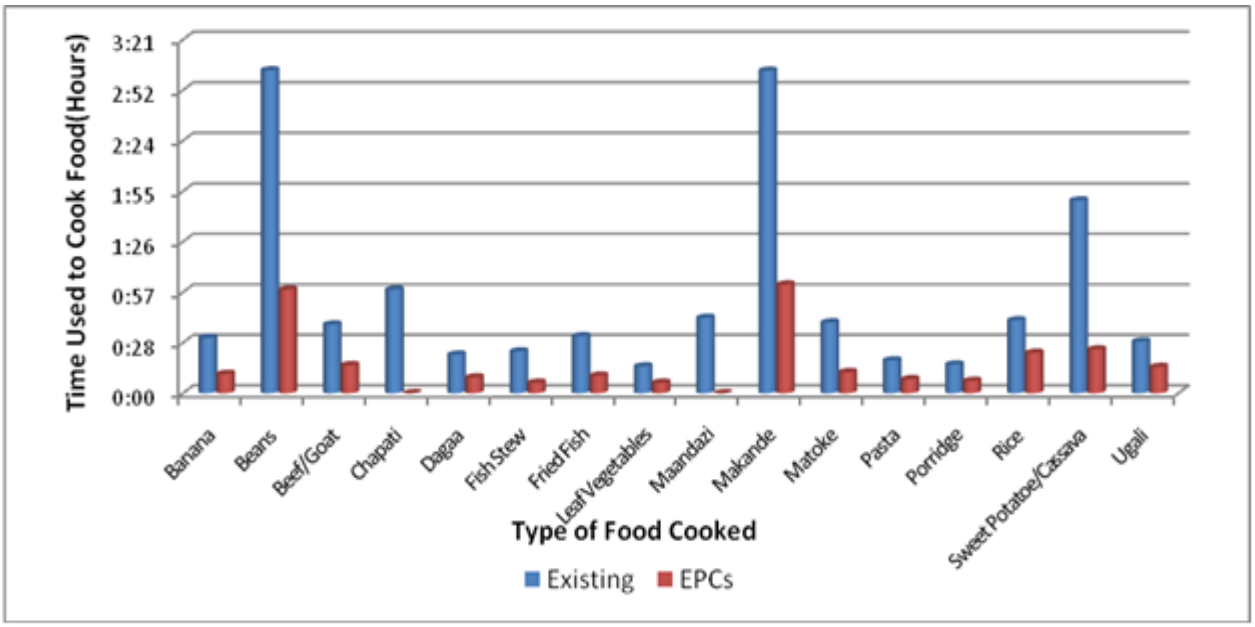

Chart 16: Time Taken to Cook by Food Types (Existing and EPC Practices)

According to Chart 16 makande and beans are heavy common foods which used long times during existing cooking practices, followed by Sweet Potatoes and Cassava. 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.

5.6.2 Time Taken to Prepare Meal (Foods)

Time 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 maandazi which their times were taken during the existing cooking practices only. These were deep frying foods which could not be cooking by EPCs. The findings were as shown in the Table 27 and Chart 17.

Food Type	Existing Cooking Practices			Electric Cooking (EPCs)		
	Count	Mean	Median	Count	Mean	Median
Bananas (hard)	5	0:16	0:15	3	0:15	0:15
Beans	9	0:22	0:10	13	0:14	0:14
Beef/Goat	24	0:18	0:07	11	0:13	0:08
Chapati	4	0:30	0:29	0	0	0
Dagaa (dried)	4	0:09	0:10	2	0:07	0:07
Fish Stew (boiled)	2	0:07	0:07	2	0:08	0:08
Fried Fish	1	0:12	0:12	2	0:07	0:08
Leafy Vegetables	12	0:11	0:04	7	0:12	0:11
Maandazi	2	0:31	0:31	0	0	0
Makande	2	0:21	0:21	6	0:15	0:21
Matoke	3	0:21	0:30	1	0:16	0:16
Pasta	4	0:07	0:08	5	0:08	0:05
Porridge	9	0:02	0:01	12	0:08	0:10
Rice	29	0:14	0:14	27	0:13	0:07
Sweet Potatoes /Cassava /Taro	6	0:14	0:17	3	0:09	0:09
Ugali	27	0:06	0:05	11	0:04	0:04

Table 27: Times for Food Preparation (h:mm)

The Chart 17 on time for preparing foods provides a real picture of time taken to prepare foods in each household.

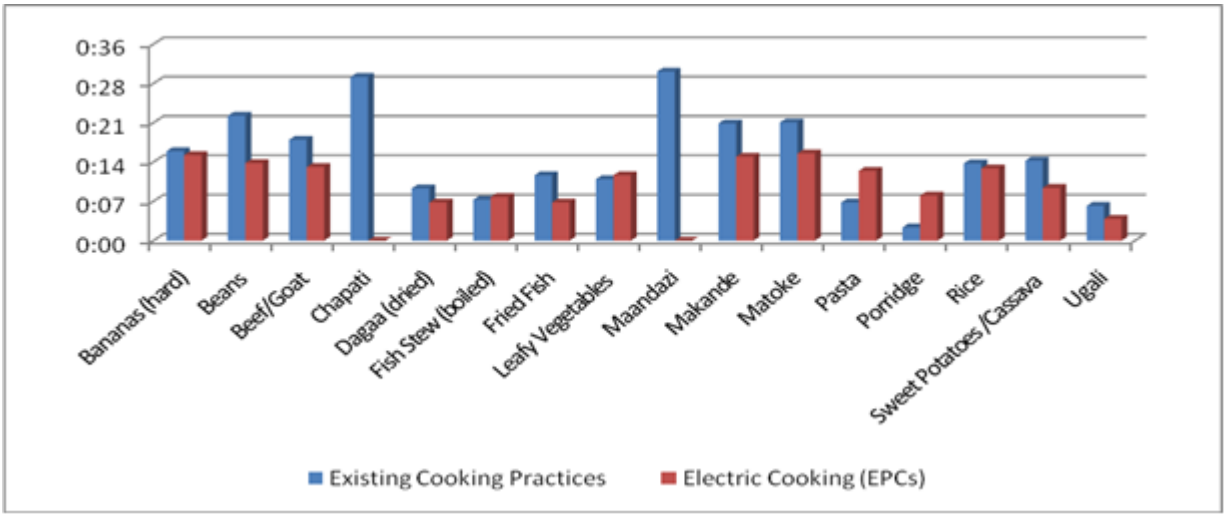

Chart 17: Time for Preparing Foods

According to the Table and Chart above, times used for cooking foods were less than half an hour. The long time was taken to fry foods during phase 1. There was no much difference for times used to cooked foods during phase 1 and 2 for most of foods. Some foods such as beans, meat, fried fish, makande, sweet potatoes and cassava showed reasonable differences because of some practices used by people during preparation of foods such as soaking beans for makande and beans themselves, boiling foods before cooking, cutting foods into small portions, etc. However there were some foods which showed increase in preparation times such as pasta, fish stew, porridge and vegetables. The preparation of these food before cooking required flour filtering, cutting other foodstuff for combining with these food and cutting to the size which will fit in the pot and some unfamiliarity to new cooking by EPCs.

5.6.3 Time of Day

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

Heating Event	N	Mean	Median	Std Dev
Phase 1:Existing Cooking Practices				
Breakfast	41	8:25	8:37	0:52
Lunch	42	12:48	13:00	1:36
Dinner	39	18:00	19:27	2:05
Phase 2: Cooking with Electricity (EPC)				
Breakfast	22	9:03	9:26	0:42
Lunch	34	12:57	12:40	1:53
Dinner	47	19:05	19:04	2:11

Table 28: Time of Day to Start Preparing Meal for Phases 1 and 2 (h:mm)

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.

5.7 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 adult and children bathing, washing hands, etc. The frequency of water heating events including whether or not the water heating event occurred during the heating event or on its own is as shown in the Table 29 hereunder:

Purpose	Number of Water Heating Events			Total
	1	2	3	
Existing Cooking Practices				
Tea, Coffee, Cocoa and Milk	58	14	19	91
Food for Baby (Milk and Others)	8	3	9	20
Chew Snacks plus Tea, Coffee, Cocoa and Milk	2	5	4	11
Water for Drinking /Purifying	4	2	6	12
Bathing	11	17	25	53
Washing Hands	11	13	16	40
Cooking with Electricity (EPCs)				
Tea, Coffee, Cocoa and Milk	33	15	5	53
Food for Baby (Milk and Others)	4	5	5	14
Chew Snacks plus Tea, Coffee, Cocoa and Milk	3	2	2	7
Water for Drinking /Purifying	11	4	14	29
Bathing	15	7	17	39
Washing Hands	11	9	13	33

Table 29: Purpose for Heating Water (All Records) (Frequencies)

Unlike cooking which normally occurs at a specific meal times and water heating occurs all the way throughout the day for different purposes including bathing, baby foods, drinking, purification, washing hand etc. Water heating cases occurred during phase 1 were 65% compared to 35% cases recorded in phase 2. Water was heated for a single purpose only. The only complain 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 unpleasant aroma from other foods cooked by EPC. When tea coffee and milk is cooked in the same pot, scents of other foods are smelt in the water for the breakfast foods.

Purpose	Frequency	Percent
Tea, Coffee, Cocoa and Milk	144	35.8
Food for Baby (Milk and Others)	34	8.5
Chew Snacks plus Tea, Coffee, Cocoa and Milk	18	4.5
Water for Drinking /Purifying	41	10.2
Bathing	92	22.9
Washing Hands	73	18.2

Table 30: Purpose for Heated Water (All Records)

According to the Table 30 above, water heating in both phases is undertaken to the large extent during the breakfast for tea, coffee, cocoa and milk. This is followed by water for bathing which may occur any time. According to participants, water heating for hand washing was not normal practices. The number of water heating for washing hands has increased to 18.2% because of prevailing diseases (COVID 19) and for other households' requirements such as hand washing before and after meals.

Device	Phase 1: Existing Practices	Phase 2: Electric Cooking
Charcoal Stove	38	3
Firewood Stove	12	6
LPG Stove	53	12
Electric Pressure Cooker	0	69
Rice Cooker	1	0

Table 31: Devices Used to Heat Water

The devices which frequently used for water heating during phase 1 were charcoal, firewood and LPG stoves (Table 31). There was single case of using rice cooker. LPG stove was used to the large extent for water heating followed by charcoal during phase 1. During phase 2, all users used EPCs to heat water. There were some cases of electric blackouts and fear of using EPCs at the beginning which made some participants to revert back to the uses of LPG, firewood and charcoal stoves. The utensils used to heat water for different purposes are presented in Table 32.

Utensils	Tea, Coffee, Cocoa and Milk	Food for Baby (Milk and Others)	Chew Snacks	Water for Drinking /Purifying	Bathing	Washing Hands
Big Pot	1	0	0	3	67	6
Medium Pot	53	14	4	17	12	23
Small Pot	34	11	8	12	8	36
Electric Pressure Cooker	56	9	6	8	5	8
Electric Kettle	0	0	0	1	0	0

Table 32: Utensils Used to Heat Water

Water is almost heated in small and medium pots, only water for bathing is boiled by using big pot. Water during the second phase was mainly heated by EPCs for breakfast (tea, coffee, cocoa, milk and other hot drinks. There was some users who used small and medium pots in the second phase because of electricity blackouts. It is interesting to note that electric kettles are mostly used for boiling water for drinking and are rarely used for making hot drinks, which are mostly prepared using pots.

6.0 User Experience of Electric Cooking

Experiences of users on transition to 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 cooking diary survey.

6.1 Responses to Exit Survey Questions

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

The participants were asked on suitability of EPC for its conformity to normal practices in their households. The responses of some questions on its suitability are listed in the Chart 18 below:

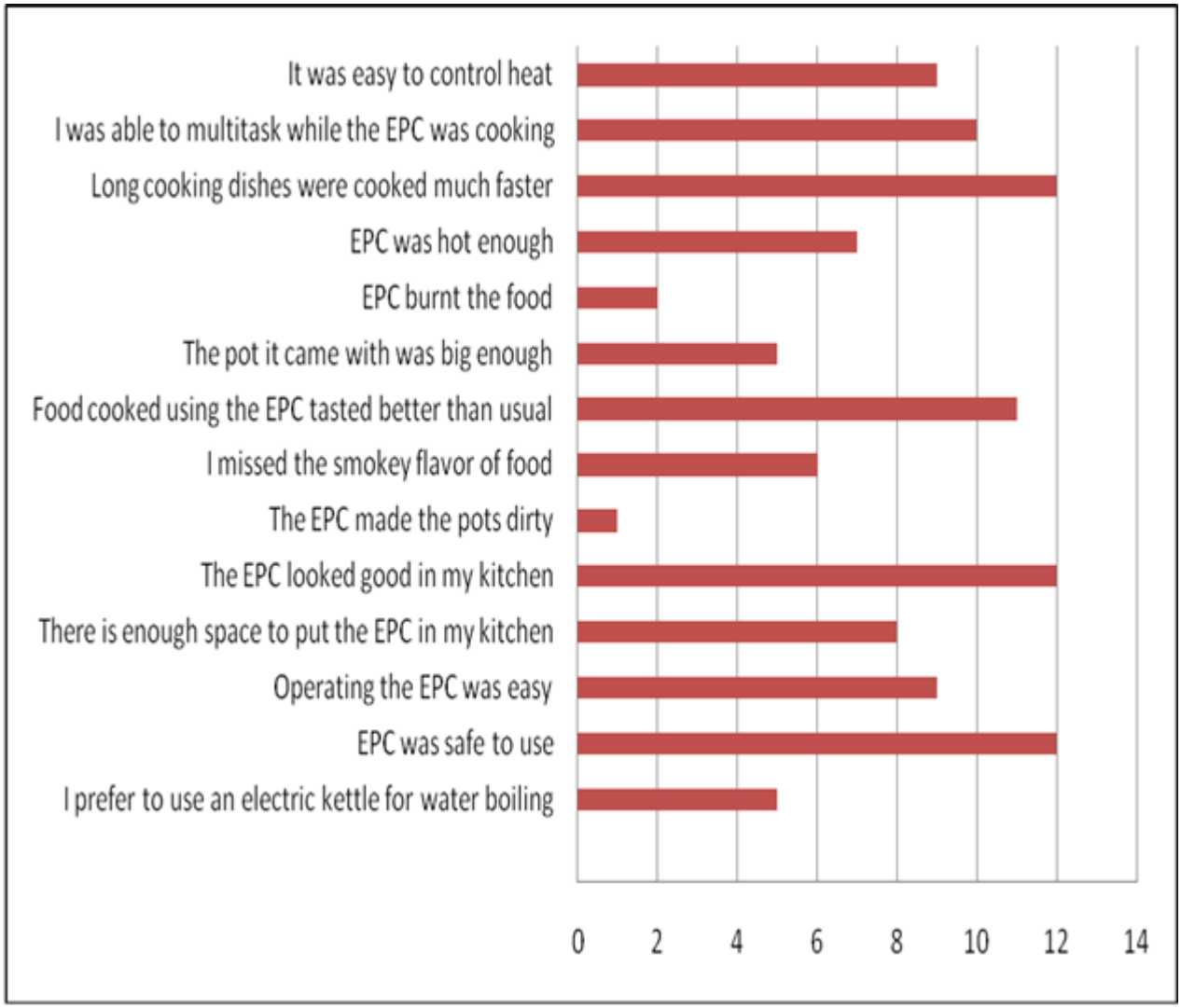

Chart 18: Suitability of EPCs for Cooking

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

The participants during 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 the Chart 11 below:

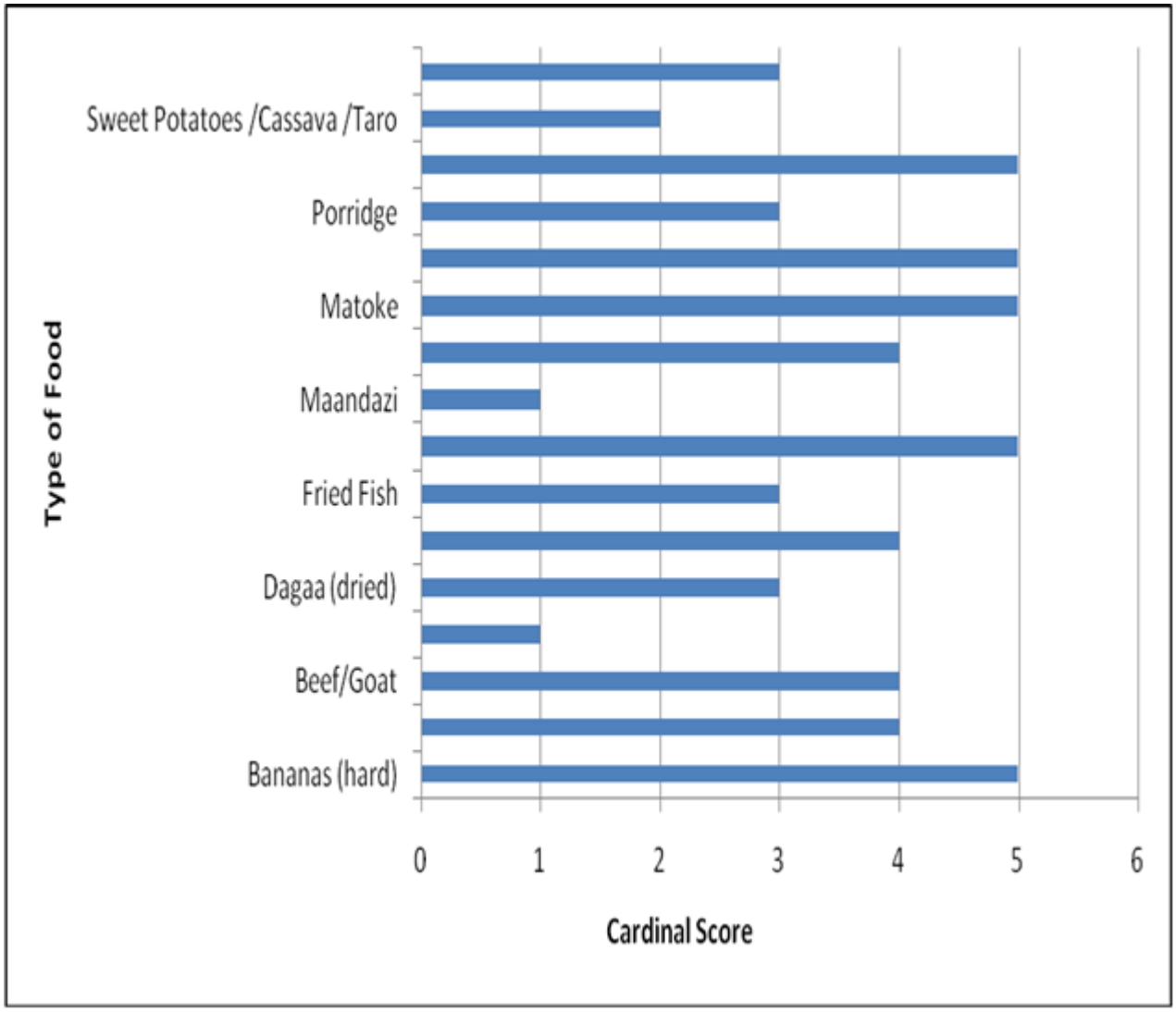

Chart 19: Easiness of Cooking Food by EPCs

iii) 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 which used to be cooked by woodfuels and at the end stages charcoal is put on top of it. These foods are rice and pilau. Some of the participants are also missing crust for rice and ugali. However, many of the participants did not miss the smokey flavour of food.

iv) 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 taste of various foods cooked by different fuels. Each fuel was ranked for each food as shown in the Chart 20 hereunder:

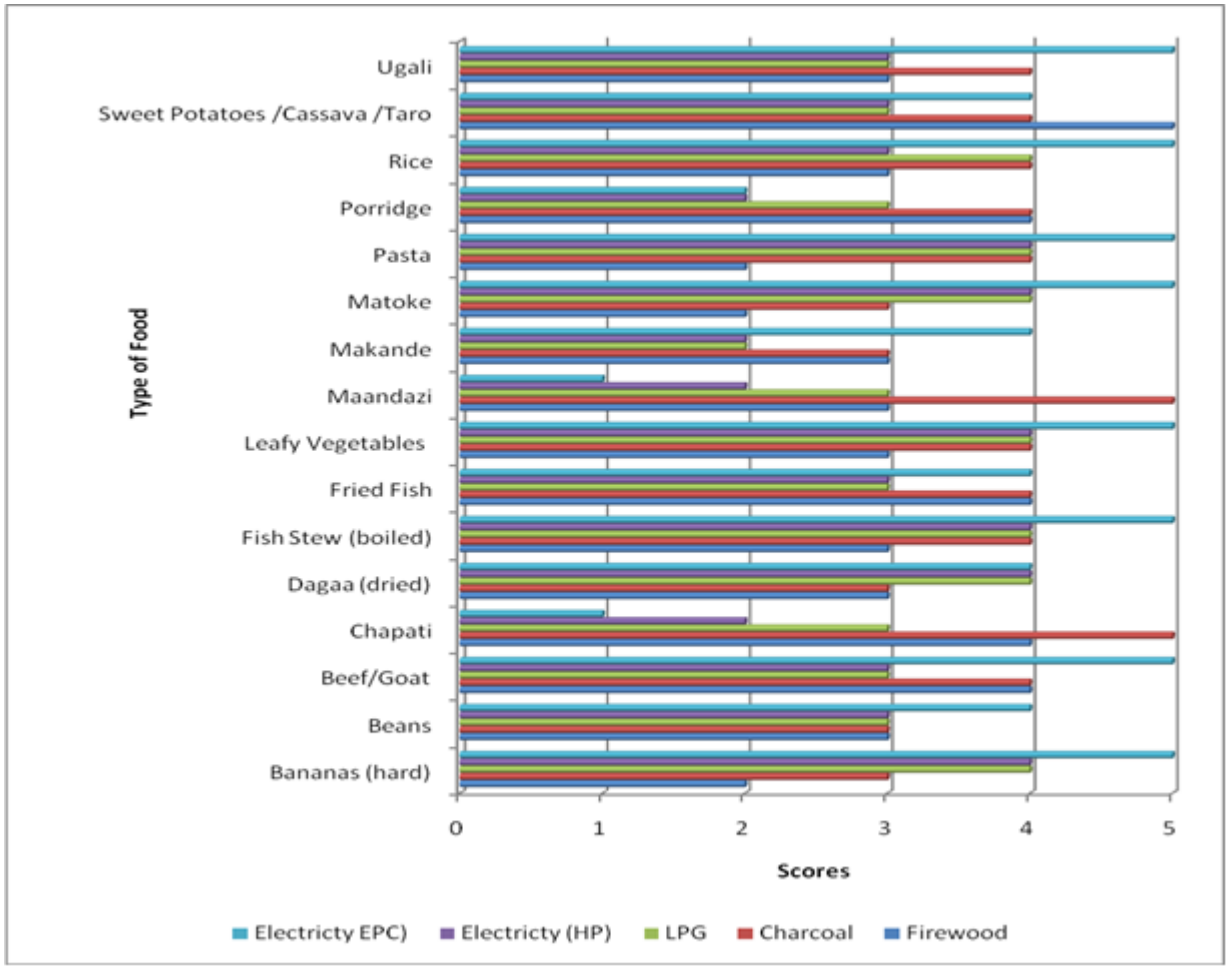

Chart 20: Food Tastes Cooked on Different Fuels

v) 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 the Chart 21 below:

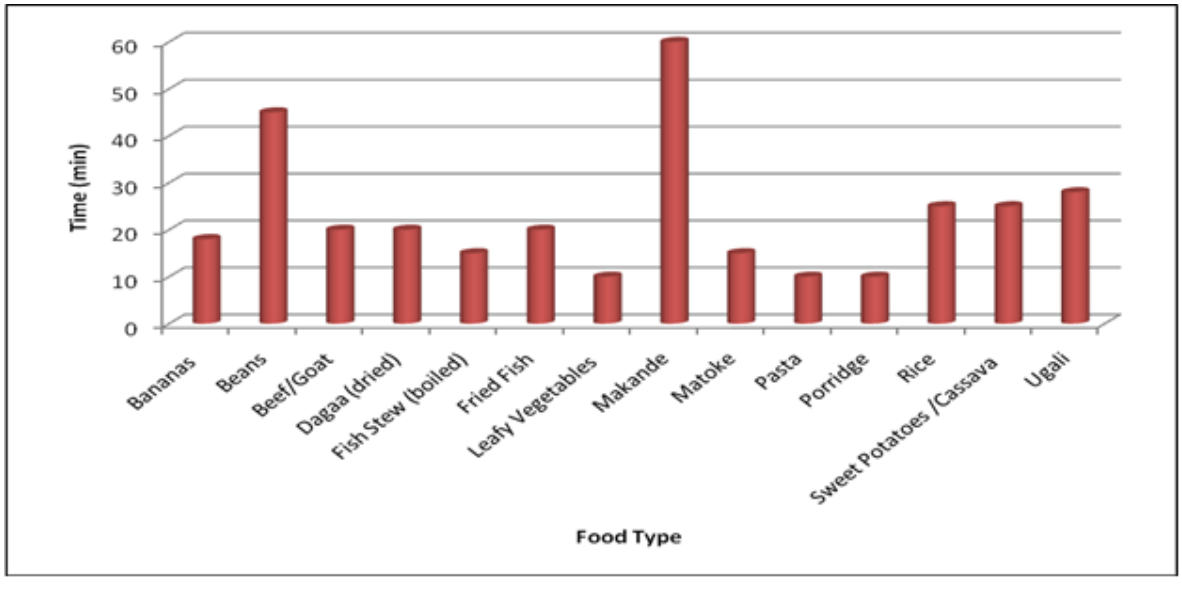

Chart 21: Time Setting or Each Type of Food

Beans and Makande are food types with more time compared to others. None of food exceeded an hour, therefore time for setting on the EPC for most of the foods are less than an hour.

vi) Which foods are not possible to cook in an EPC?

The foods which are no possible to cook in an EPC in Dodoma are those require frying. These foods include chapatti, coughs, frying eggs, pancakes, potato chips, and sausages.

vii) 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 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.

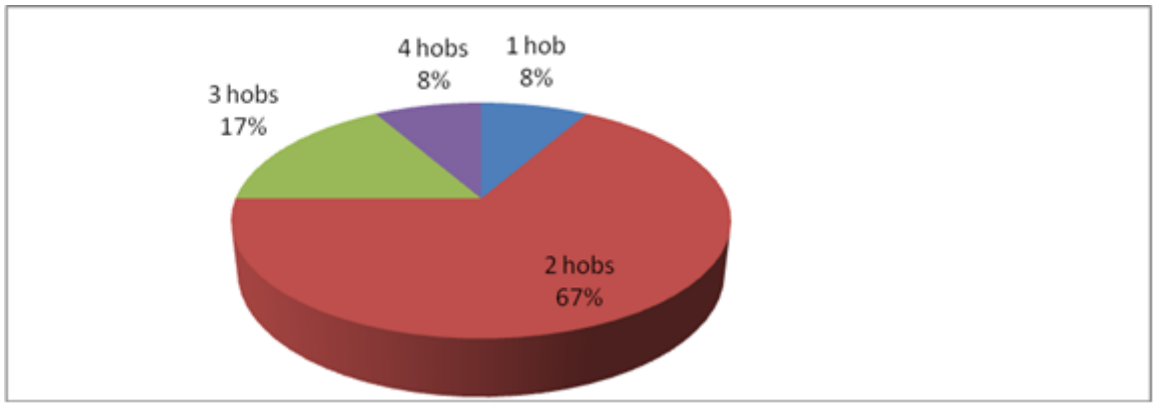

Chart 22: Hobs Required for Cooking by Participants

Most of the participants are using one hob per stove. However, they simultaneously use two to three stoves at the same time. The main dish can be cooked in one stove and soup in another stove. The response from exit survey shows that most of them are in need of at least two hobs.

viii) What were the best things about cooking with electricity?

The best things highlighted by participants about cooking with electricity in Dodoma Municipality are as shown hereunder:

- It is fast and save time for other economic activities
- It is clean cooking without smoke and other harmful gases
- It is easier to turn on and off 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

ix) What were the worst things about cooking with electricity?

The worst things highlighted in Dodoma Municipality by participants about cooking with electricity are as listed below:

- Blackouts or electric cuts,
- Inability to perform deep frying

- Obtaining EPC is expensive,
- Setting heat for food which is not shown in the EPC manual.

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

The things mostly liked by participants in Dodoma 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 cool season,
- Taste of some foods is good when cooked with woodfuels

xi) What do you like most about cooking with LPG/kerosene?

The things mostly liked by participants in Dodoma about cooking with LPG/Kerosene are as highlighted hereunder:

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

xii) 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

xiii) 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.

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

Cooking with the Electric Pressure Cooker (EPC) has influence behavioural change of people in the kitchen and households. A person who have been using firewood or charcoal and LPG stoves and switched to electric pressure cooker showed the following changes in the 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	Cook while doing other activities	EPC does not burn food
3	Stop refrigeration of half-cooked foods	EPC has reduced time of cooking
4	Getting support of cooking from men	Cooking with EPC is simple and clean
5	Cooking indoor (not necessarily in the kitchen)	Switch for electricity are indoor and power consumption is low

Table 33: Changes in Cooking Behaviours

xv) Do you think electric cooking is affordable?

All participants accepted that with 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 purchase of EPC appliance is only affordable to high, medium and 40% of low income households.

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

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

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

The response from participants shows that most of the will revert back to their normal fuels. Only 8% of people will opt to buy cooked food from the restaurant or take away food vendors. The responses from participants were as show in the Chart below:

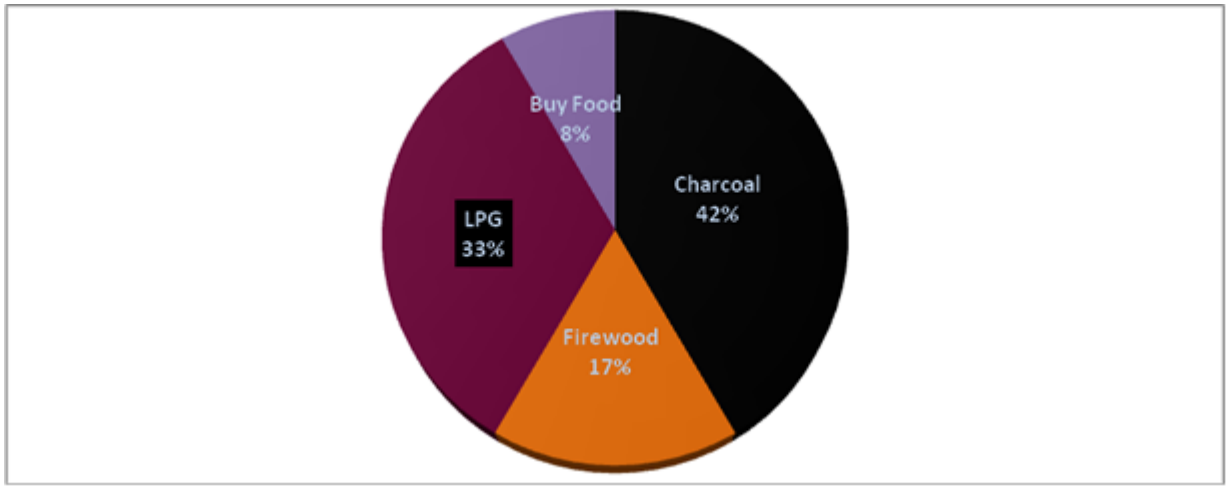

Chart 23: Fuel Used to Cook During Blackouts

xviii) 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 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.

xix) How easy is it to learn to cook on an EPC?

Almost 77% of responses from participants showed that it is not difficult to learn cooking by electric pressure cooker. About 46% replied to easier while 31% 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

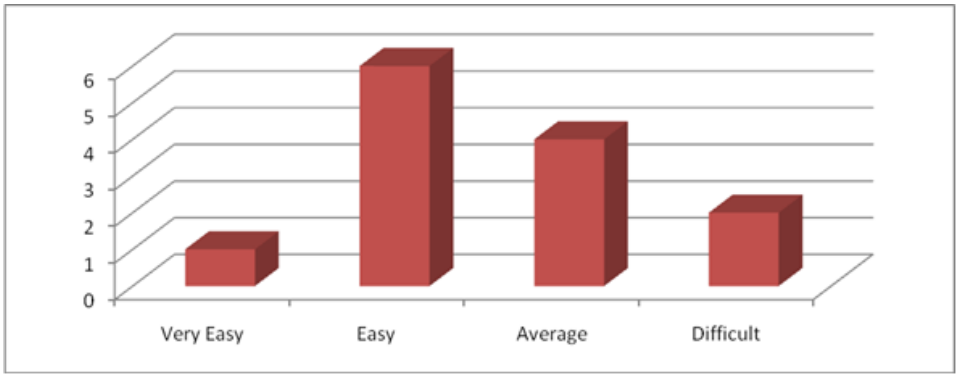

Chart 24: Easiness of Learning to Cook on an EPC

xx) 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 type of food which cannot be cooked by EPCs.

xxi) 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 because of the blackouts or power cuts.

xxii) 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)?

The large number of participants (83%) 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 safety of this appliance that it will not explode like 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:

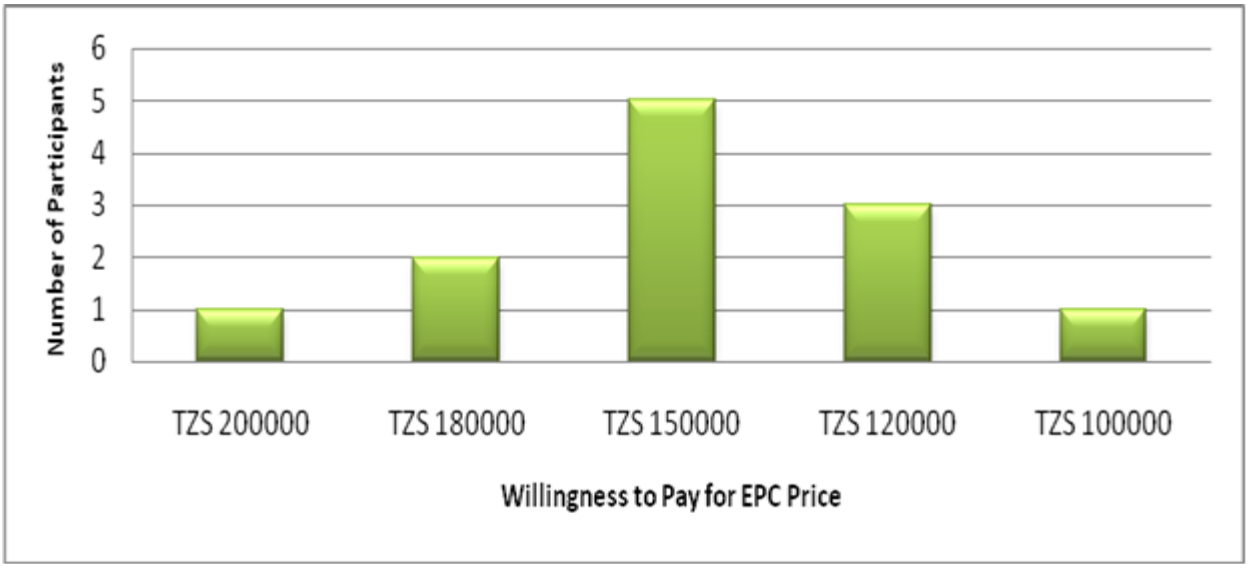

Chart 25: Payments Preferred by Participants by Buying EPC

The price preferred by most of the participants was TZS 150,000. The participants argued that this is the price which can be affordable to most of the middle income cluster in the urban communities.

7.0 Evaluation of the Study

The cooking diaries study has been a way of assessing how and what people are cooking in the new city of Dodoma in Tanzania. This commenced with existing cooking practices and what will happen if the modern energy cooking services using EPCs will be introduced in the diverse community in that city.

User feedbacks on the cooking diaries survey started with doubt within participants on whether they could 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 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. The Chart 26 below shows feeling of the participants from asked questions, perception of other people in the households, the way trainings are conducted on existing cooking practices in phase 1 and phase 2 of how to use EPC, relevance of time used to visit their households, training on data collection (theory and practices) and their perception on the overall cooking survey. Duration of survey scored less than all other questions because at the end of the survey, participants were anxious 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:

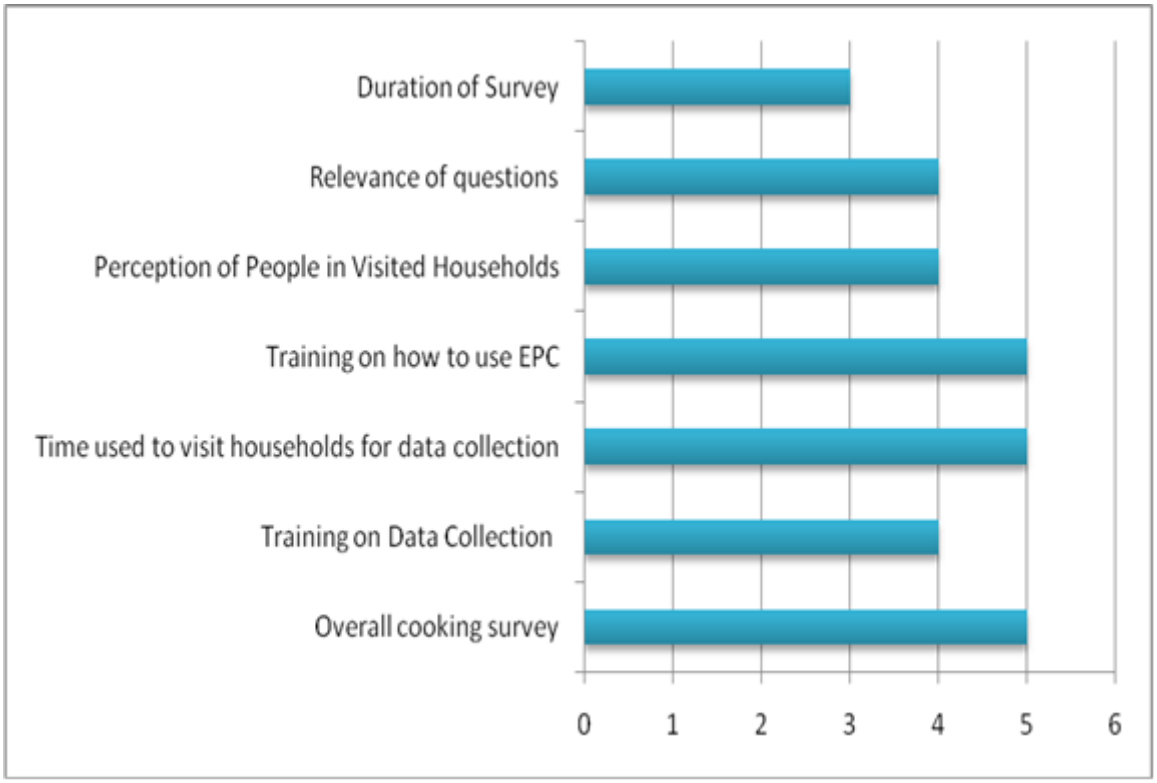

Chart 26: Responses on Study Evaluation (0 = Low, 6 = High)

However, at the end of the 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 to take back their EPCs. One of them claimed that my dog is aggressive towards strangers, if you come to take your EPC, I will let it bite you.

7.1 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 Dodoma is originating from different cultures and different ethnic tribes found in the city. Therefore, the data does not represent specific culture rather adopted cultural foods learned by staying together in the city.

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 bias 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 uncomfortable to provide answers 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 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 improve plan for the following study in Kilimanjaro.

7.2 Notes on Data Collection

7.2.1 Enumerator Visits for Data Collection

The survey started by bringing participants together and undertake training of the whole group at once at the beginning during phase 1 (existing cooking practices), at the middle of survey (transition to electricity workshop) and at the end of 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 four households but it was difficult due to time data were supposed to be collected. The data used to be collected from 4.00 pm onwards to 9.00 pm because it is when 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 during power cuts, which resulted into repeating those data at the end of the days planned for data collection and which extended duration of cooking diaries survey.

7.2.2 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 to the 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.

7.2.3 Sample Diversity

The cooking diaries study was undertake 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 city of Dodoma and similar places. The most of participants came from low to middle class cluster and all were from urban and peri-urban areas. The following study in Tanzania should seek to assess cooking practices from high, middle and low income clusters in rural households, and identify differences in cooking practices in other areas.

8.0 Conclusion

The cooking diaries study in the city of Dodoma, 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 Electric Pressure Cooker (EPC) was observed to be the future alternative of 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 areas of the city of Dodoma, the grid electricity is already strong enough for direct AC cooking, meaning there is an opportunity to promote these appliances in the city. However, Dodoma is situated in the area of high solar Insolation in Tanzania 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 Dodoma 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 under the project on promoting a Thriving Market of Modern Energy Cooking Services in Tanzania in order to build a more complete picture of the opportunities and challenges of modern energy cooking services in Tanzania.

9.0 References

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10.0 Appendices

Appendix 10.1: Information Sheet and Checklist

10.1.1 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.

10.1.2: 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 multi-plug 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.

Appendix 10.2: 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

Appendix 10.3: 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	Ugali☐ Chapati☐ Pilau☐ Wali☐ Mayai☐ Ndizi☐ Chips☐ Makande☐ Maharage☐ Nyama/Samak/Mboga Mchuzi☐ Nyama nyingine/Samaki☐ Mboga nyingine☐ Vingine_____		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	Ugali☐ Chapati☐ Pilau☐ Wali☐ Mayai☐ Ndizi☐ Chips☐ Makande☐ Maharage☐ Nyama/Samak/Mboga Mchuzi☐ Nyama nyingine/Samaki☐ Mboga nyingine☐ Vingine_____		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	Ugali☐ Chapati☐ Pilau☐ Wali☐ Mayai☐ Ndizi☐ Chips☐ Makande☐ Maharage☐ Nyama/Samak/Mboga Mchuzi☐ Nyama nyingine/Samaki☐ Mboga nyingine☐ Vingine_____		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	_____ _____ _____

Kwa maelezo zaidi, maoni na malalamiko, wasiliana na Jensen Shuma (0713-420387), Mary Swai (0789-345463) au Nelson Vilema(0762-507600). Huu utafiti umedhaminiwa na DFID/UK kupitia kwenye Programu ya MECS kupitia msaada wa kuvumbua Nishati kichocheo ya Uingereza.

Appendix 10.4: 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)?

……
……
……
……

Appendix 10.5: Form for Evaluating the Cooking Diary Study

How you feel about the survey

12. 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					

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

……
……
……
……

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

……
……
……
……

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

……
……
……
……

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

……
……
……
……

17. 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.