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Kenya National eCooking Baseline Study Report

August 2023

KENYA UK PACT
UKaid from the British people
MECS Modern Energy Cooking Services
Republic of Kenya
Ministry of Energy & Petroleum (MoEP)
GAMOS East Africa
Loughborough University
STEER – Centre for Sustainable Transitions: Energy, Environment and Resilience

Title: Kenya National eCooking Baseline Study Report

Date: 30 August 2023

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Supported by: The Government of the United Kingdom of Great Britain and Northern Ireland, acting through the Foreign, Commonwealth & Development Office (FCDO) and Loughborough University, under UK Partnering for Accelerated Climate Transitions (UK PACT) – Kenya

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This material has been funded by UKPACT, however, the views expressed do not necessarily reflect the UK government's official policies.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS ..... **iv**

LIST OF TABLES ..... **v**

LIST OF FIGURES ..... **vii**

ABSTRACT **1**

EXECUTIVE SUMMARY **3**

1. INTRODUCTION **18**

1.1. Background 18

1.2. Purpose of the Study 19

1.3. Approach and Methods 20

1.3.1 Analysis of existing datasets 20

1.3.2 Baseline study approach 21

1.3.3 Household Survey Methodology 22

1.3.4 Socio-demographic Indicators from the study sample 26

2 HOUSEHOLD ELECTRICITY SYSTEMS **32**

2.1 Introduction 32

2.2 Household Access to Electricity: Main and Backup systems 35

2.3 Profiling Household Access to Electricity: A Multi-Tier Approach 39

2.3.1 Household Access to Grid Electricity 42

2.3.2 Household Access to Mini-grid Electricity 44

2.3.3 Household Access to Off-grid Electricity 45

3 ECOOKING APPLIANCES AND COOKING PRACTICES **49**

3.1 eCooking Appliances Ownership 49

3.2 Electric Appliances Ownership and Household Electricity 52

3.3 Appliance Usage and Cooking Practices 56

3.3.1 The prevalence of eCooking 57

3.3.2 eCooking Appliance Usage 58

3.3.3 Cooking Practices for Typical Cuisines in Kenya 59

3.3.4 Frequency of Meals Preparation 61

3.3.5 Cooking Techniques used to Prepare Typical Dishes 62

3.3.6 Appliance choice 66

3.3.7 Willingness to Pay for eCooking Appliances 67

3.4 Knowledge, Attitudes, and Beliefs in Different Market Segments 69
3.5 Household stacking of cooking solutions 71
4 THE TRANSITION TO ECOOKING AS AN ALTERNATIVE COOKING SOLUTION 76
4.1 Profiling Households Access to Cooking Solutions: A Multi-Tier Framework Approach...... 76
4.2 The Relative Cost of eCooking in Kenya 80
4.3 The eCooking Transition: An Optimistic Scenario 83
5 THE ENABLING ENVIRONMENT FOR ECOOKING 86
5.1 The Supply Chain for eCooking Appliances 86
5.1.1 Importation of eCooking appliances 86
5.1.2 Local Manufacturing of eCooking Appliances 90
5.1.3 Local delivery models 93
5.2 Financing electric cooking 97
5.2.1 Consumer financing mechanisms 98
5.2.2 Supply-side financing mechanisms 103
5.3 After Sale Services, Repair and Maintenance 109
5.4 Energy Service Companies and Uptake of eCooking 112
5.4.1 Utilities 112
5.4.2 Minigrids developers 115
5.4.3 SHSs companies 117
5.5 Efficiency and Quality Assessment of eCooking Appliances 120
5.5.1 Standards for eCooking appliances 120
5.5.2 Testing and certification 122
6 THE POLICY ENVIRONMENT 126
6.1 Existing Policy and Regulatory Framework in eCooking 126
6.2 Opportunities to integrate clean cooking and electrification policy 129
6.3 Opportunities to embed eCooking within other national strategies 131
7 PATH FORWARD: RECOMMENDATIONS 135
7.1 Barriers in the eCooking ecosystem and recommendations 135
7.1.1 Electrification 135
7.1.2 Cooking practices and eCooking appliances use 137
7.1.3 Financing electric cooking 139
7.1.4 The supply chain 140
7.1.5 Appliance standards: testing, labelling and certification 142
7.1.6 Gender 143

7.1.7 The policy environment 144
7.2 Conclusion 145
APPENDICES 153
Appendix 1: Household Questionnaire 153

LIST OF ABBREVIATIONS

AC	Alternating current
AFD	Agence Francaise de Development
CCA	Clean Cooking Alliance
CCG	Climate Compatible Growth
CAPI	Computer Assisted Personal Interviews
BLEENS	Biogas, Liquified petroleum gas, Electricity, Ethanol, Natural gas and Solar
DC	Direct Current
EPC	Electric pressure Cooker
ESCOs	Energy Service Companies
FGD	Focus Group Discussion
GHG	Green House Gas
KES	Kenya Shillings
KIRDI	Kenya Industrial Research and Development institute
KNeCS	Kenya National electric Cooking Strategy
KOSAP	Kenya Off-Grid Solar Access Project
KPLC	Kenya Power & Lighting Company
KWh	Kilo watt Hour
LPG	Liquified Petroleum Gas
MECS	Modern Energy cooking Services
MoEP	Ministry of Energy and Petroleum
MTF	Multi-Tier Framework
NGOs	Non- Governmental Organizations
OBF	On Bill Financing
OBR	On Bill Repayment
RBF	Results Based Financing
RIAT	Ramogi Institute of Advanced Technology
ROSCA	Rotating Savings and Credit Association
SCODE	Sustainable Community Development Services
SEI	Stockholm Environment Institute
SHS	SHSs
SPA	Special Planning Area
UN	United Nations
VAT	Value Added Tax

LIST OF TABLES

Table 0.1 Household access tiers across the grid, mini grids and SHSs and eCooking capacity 4
Table 0.2 Cooking techniques for typical cuisines in Kenyan households and compatible appliances . 6
Table 0.3 Household stacking of cookstoves across regions and wealth 8
Table 0.4 Typical retail prices for selected eCooking appliances in Kenya. 9
Table 0.5 Consumer financing models for electric cooking appliances in Kenya.............................. 12
Table 0.6 Supplier financing models for electric cooking appliances in Kenya................................. 13
Table 0.7 Addressing barriers in the appliance standards ecosystem 15
Table 0.8 Addressing barriers in the policy environment 16
Table 1.1 Sampling in Murang'a county 24
Table 1.2: County selection.. 25
Table 1.3 Key Statistics 28
Table 1.4 Market segment descriptive statistics... 29
Table 2.1 The MTF classification used to categorise households in this study................................. 40
Table 2.2. Household access tiers on the grid and eCooking capacity 42
Table 2.3 Household access tiers in Mini grids and their eCooking capacity.................................... 44
Table 2.4 Household access tiers in SHSs and their eCooking capacity 47
Table 3.1 Summary of eCooking appliances, their functionality and brands available in Kenya......... 49
Table 3.2 Cooking methods 56
Table 3.3 Common Kenyan dishes, their cooking techniques, and compatible eCooking appliances. 63
Table 3.4: Public opinion on perceived differences between electric and traditional cooking methods based on taste, cost, speed of cooking, smell and cleanliness 70
Table 3.5 Household stacking of cookstoves across regions and wealth 71
Table 4.1 Profiling Household Access to Cooking Solutions: A Multi-Tier Framework 76
Table 4.2 Typical retail prices for selected eCooking appliances in Kenya. Source: Own data............ 81
Table 4.3 Monthly electricity consumption for cooking across different studies in Kenya 82
Table 4.5 Proportions of other fuel users with Tier 3+ electricity 84
Table 5.1. eCooking appliances brands imported and their origin and primary manufacturing countries 88
Table 5.2 Consumer financing models for electric cooking appliances in Kenya............................... 98
Table 5.3 Supply side financing mechanisms... 103
Table 5.4 Safety Standards for Electric Cooking Appliances in Kenya (KEBS, 2019) 121
Table 5.5 Performance Standards for Electric Cooking Appliances in Kenya (KEBS, 2019) 121
Table 6.1 National-Level Policies and Strategies that provide a supportive framework for promoting eCooking in Kenya: 128
Table 6.2 Policies and initiatives related to climate change, environmental conservation, air pollution, and gender equality in the energy sector... 129
Table 6.3 Potential areas for synergies between clean cooking and electrification policy............... 130
Table 6.4 Opportunities to embed eCooking within other national strategies 133
Table 7.1 Overview of Electrification Recommendations 135
Table 7.2 Addressing barriers to the use of electric cooking appliances in Kenya 137
Table 7.3 Addressing barriers to consumer financing for eCooking 139
Table 7.4 Addressing barriers to supplier financing for eCooking 139
Table 7.5 Addressing barriers to manufacturing, distribution and after sales service and warranties 140

Table 7.6 Addressing barriers in the appliance standards ecosystem 142
Table 7.7 Gender dynamics in electric cooking adoption... 143
Table 7.8 Addressing barriers in the policy environment.. 144

LIST OF FIGURES

Figure 0.1 Market segment descriptive statistics 4
Figure 0.2 Electric cooking appliances ownership.......... 5
Figure 0.3: Primary cooking solutions used in Kenya 5
Figure 0.4 How the most popular appliances are used in households.......... 6
Figure 0.5 Households' willingness to pay for an eCooking appliance price range 7
Figure 0.6 Household adoption of cooking services: a rural/urban comparison 9
Figure 0.7 The cost of eCooking relative to other fuels across various studies 10
Figure 0.8 Transition to eCooking based on Tier 3+ Electricity Access.......... 10
Figure 0.9. Stages in the supply chain for imported electric cooking appliances 11
Figure 0.10 Point of purchase for most recent electric cooking appliances by households 12
Figure 0.11 Source of support for eCooking appliance repair (urban/rural) 14
Figure 0.12 The Kenya Energy Label used on refrigerators. The more stars on the label, the more energy efficient an appliance is. Source: Energy Petroleum Regulatory Authority. 14
Figure 1.1: Distribution of Primary Fuel Used by Households in Kenya 20
Figure 1.2: Percentage of Households Owning Electric Cooking Appliances.......... 21
Figure 1.3 Map of the regional clusters and counties in each cluster 23
Figure 1.4 Murang'a county sublocations and segmentation of Mukwe-Thuita sublocation. 25
Figure 2.1 Kenya power sector infrastructure: electricity transmission and distribution network and minigrids. Source: Author's own representation 34
Figure 2.2: Typologies of eCooking in Kenya. Adapted from ESMAP (2020) 35
Figure 2.3 Distribution of household access tiers on the grid 43
Figure 2.4 Ownership patterns of Tier 3+ SHSs.......... 47
Figure 3.1 Electric cooking appliances ownership.......... 52
Figure 3.2 Electric Appliance Ownership in Kenya 53
Figure 3.3: Electric cooking appliance ownership-Female/Male-headed Households 53
Figure 3.4: Electric cooking appliance ownership-Urban/Rural Households 53
Figure 3.5: Electric cooking appliance ownership-Female/Male-headed Households 54
Figure 3.6 Household Wealth and Ownership of eCooking Appliances 55
Figure 3.7 Prevalence of cooking fuels 57
Figure 3.8 Most popularly used electric cooking appliances at the household level 58
Figure 3.9 How the most popular appliances are used in households.......... 59
3.10 Typical Household Meals in Kenya 59
Figure: 3.11 Typical Household Meals in Kenya: Breakfast, Lunch, Supper, Snacks 60
Figure 3.12 Frequency of households' meals preparation 61
Figure 3.13 Primary consideration for appliance choice 66
Figure 3.14 Primary consideration for appliance choice: a comparison between urban and rural households.......... 66
Figure 3.15 Primary consideration for appliance choice: a comparison between male-headed and female-headed households 67
Figure 3.16 Households' willingness to pay for an eCooking appliance: price range 68
Figure 3.17 Prevalence of different stoves across stacks 73
Figure 4.1 Household Access to Cooking Solutions: Urban vs Rural households.......... 79
Figure 4.2 Household Access to Cooking Solutions by Wealth Quintiles 79
Figure 4.3 Mapping adoption of cooking services to electrification tiers 80

Figure 4.4 Domestic electricity tariffs in Kenya 81
Figure 4.5 The cost of eCooking relative to other fuels across various studies 83
Figure 4.6 Transition to eCooking based on Tier 3+ Electricity Access 84
Figure 5.1 Source countries for electric cooking appliance imports into Kenya 86
Figure 5.2. Stages in the supply chain for imported electric cooking appliances 90
Figure 5.3 Point of purchase for most recent e-appliance 95
Figure 5.4 Point of purchase for the most recent electric appliance in female and male-headed households. 95
Figure 5.5 Payment method used when acquiring the electric cooking appliance. 99
Figure 5.6 Have you taken a loan to finance a big household item? 100
Figure 5.7 What institution provided the loan/instalment plan-Urban/Rural 101
Figure 5.8 Proportion of households who repaired appliances 109
Figure 5.9 Proportion of households who repaired appliances – Urban/Rural 109
Figure 5.10 Source of support for eCooking appliance repair 111
Figure 5.11 Source of support for eCooking appliance repair (urban/rural) 111
Figure 5.12. Solar eCooking examples 118
Figure 5.13 The Kenya Energy Label used on refrigerators. The more stars on the label, the more energy efficient an appliance is. Source: Energy Petroleum Regulatory Authority. 124
Figure 5.14 KEBS marks of quality 124

ABSTRACT

This report is the output of the Kenya National eCooking Study (KNeCS) which analyses the status of electric cooking in Kenya with the view of supporting the development of the Kenya National eCooking Strategy aimed at accelerating the adoption of electricity as a cooking fuel. This study examines the state of household electrification and access to eCooking in Kenya based on primary and secondary collected between December 2022 and April 2023. The primary data is based on a household survey that sampled 2,432 households across Kenya, key informant interviews, and focus group discussions.

The study analysed household electricity access in Kenya, revealing that 76.5% of households primarily use grid electricity, with Solar Home Systems (SHSs) being the leading off-grid source at 13.3%. Urban households predominantly use grid electricity, while rural households favour SHSs. The assessment suggests significant potential for eCooking adoption, with 68.9% of grid-connected households having suitable electricity for eCooking, and rural households showing higher compatibility (70.9%) than urban (66.6%).

Kenya's push for cleaner energy has driven the popularity of various electric cooking appliances, including Electric Pressure Cookers and Induction Cookers. From the data, 25.2% of households own at least one such appliance, with electric kettles and water heaters being the most common due to their task-specificity and affordability. The ownership and usage of these appliances heavily influenced by gender, wealth, and urban-rural divide. Further, the study found that owning an appliance does not ensure its use, as only 0.58% primarily use electric appliances for cooking, and 3.9% of households use these appliances for cooking, reheating food and preparing beverages.

Analysis of the relative cost of electric cooking found that, after the 2023 electricity tariff review by the Energy and Petroleum Regulatory Authority (EPRA), the cost of eCooking rose, making it less competitive compared to other options like LPG and firewood. A tariff reduction is vital to make eCooking cost-effective to stimulate further adoption.

The findings also show that fuel and stove stacking is common in Kenyan households, with Liquefied Petroleum Gas (LPG) stoves becoming significant as households use more stoves, and that wealthier households are more likely to own multiple stoves. Further, tastes and preferences in cooking are deeply rooted in cultural, economic, and social matrices, with a belief that traditionally cooked food tastes better, noted by 74.6% of households. Consequently, awareness campaigns and consumer education are pivotal in advancing the adoption of electric cooking.

The Kenyan eCooking appliance market is competitive and diverse, catering to various income levels and preferences. Electric cooking appliances in Kenya are imported from a range of countries, involving a complex supply chain and several stages from raw material extraction to end consumer. The appliances face challenges such as high upfront costs, fluctuating prices, rapid model changes, and quality concerns. There are potentials in local manufacturing like BURN Manufacturing's ECOA product line and assembly capabilities for solar PV eCooking systems, but realization requires significant investments in infrastructure, human capital, and policy frameworks. Further, retailers and distributors have adapted business models to emerging markets, offering products through various channels, with brick-and-mortar outlets being most popular. Marketing includes traditional methods and innovative approaches, reaching large audiences across Kenya, and there are regional eCooking hubs fostering local development.

Financing in the sector consists of demand-side and supply-side components, addressing affordability and operational challenges respectively. Although most households pay for appliances upfront, innovative consumer financing models like PayGo can be further leveraged to lower access barriers. Supply side financing includes equity investments, grants, and carbon credits, with potential enhancements through utility-led financing. Carbon financing has significant potential in Kenya's clean cooking sector to lower appliance costs and tariffs, with new methodologies simplifying verification processes that could capitalized on. Access to after-sales services in Kenya could also be expanded to

rural areas and awareness about warranties and continuous training for technicians. Finally, with regard to appliance standards and testing which currently predominantly focus on safety and voluntary testing, there is a need for more robust efficiency and quality assessments and mandatory requirements in the sector.

International and national policies play critical roles, driving electrification and clean cooking with varying financial, technical, and policy support. Kenya needs more explicit policy formulations for electric cooking that integrate within broader energy, environmental, health, and industrial policies to optimize benefits in multiple areas, including climate emissions mitigation and health outcome improvement.

In conclusion, eCooking in Kenya can address broader issues such as public health and environmental conservation and promote economic development. Realizing this potential necessitates overcoming challenges in electricity access, socio-cultural factors, and economic constraints, requiring multifaceted approaches, innovative financing models, robust standards, and supportive policy environment. Aligning eCooking with broader policy frameworks and emphasizing the roles of women are essential, alongside setting and revisiting clear, ambitious targets, for the success of eCooking initiatives in Kenya and achieving sustainable development goals.

EXECUTIVE SUMMARY

Introduction

This report is the output of the Kenya National eCooking Study (KNeCS) which analyses the status of electric cooking in Kenya with the view of supporting the development of the Kenya National eCooking Strategy aimed at accelerating the adoption of electricity as a cooking fuel. The study was commissioned by the Ministry of Energy and Petroleum, with technical assistance and funding from the Modern Energy Cooking Services (MECS), Climate Compatible Growth (CCG) and UK Partnerships for Accelerating Climate Transitions (UK PACT) programmes.

The Kenya Cooking Sector Study of 2019 showed that over 75% of Kenyan households relied on woodstoves as either their primary or secondary cookstove (GoK, 2019), yet household electrification levels currently stand at over 75% (IEA, 2019). The country aims to achieve 100% access to clean cooking by 2028 to improve heath and gender equity, whilst reducing deforestation and CO2 emissions to mitigate climate change (GoK, 2021). Historically, electricity has not been promoted as a clean source of energy for cooking in Kenya. As of 2019, only about 3% of households owned electric appliances[1] and still predominantly used charcoal, wood fuel, and LPG for cooking (GoK, 2019). However, increased electricity generation capacity and a nearly entirely renewable energy mix—standing at 86.98 percent (EPRA, 2022)—make electricity a potential game-changer for clean cooking in Kenya. With previously reported usage of electricity as a primary cooking source at only 0.9% of the population, electric cooking powered by renewable energy sources could significantly reduce deforestation and greenhouse gas emissions.

There has been considerable underreporting of forms of clean cooking, such as electricity for cooking in previous national surveys. These studies did not adequately capture e-cooking prevalence as part of cooking stacking strategies, or the use of task-specific electric cooking appliances such as kettles, hence the need to conduct a focused eCooking study to establish the status quo of e-Cooking in Kenya. This study therefore examines the state of household electrification and access to clean cooking, in particular electric cooking appliance adoption and usage; household cooking practices; the supply chain for electric cooking appliances; and the enabling policy environment for electric cooking in Kenya. It is based on primary and secondary collected between December 2022 and April 2023. The primary data is based on a household survey that sampled 2,432 households across Kenya, key informant interviews, and focus group discussions. The following sections summarise the findings of this report. See Figure 0.1 for a summary of the descriptive statistics for urban/rural distribution, types of connectivity and prevalence of fuels.

Household access to electricity

The assessment of household electricity access—guided by the Multi-Tier Framework (MTF)—examined connections to the grid (including public minigrids), and off-grid systems (including private minigrids, Solar Home Systems (SHSs), generators, and rechargeable batteries). In this study, 76.5 percent of households primarily used grid electricity. SHSs were the leading off-grid source at 13.3%, private mini-grids served 2.6 percent, and rechargeable batteries accounted for 0.3%. No household reported the generator as the main source of electricity, though 0.7 percent used then for back-up. Grid electricity is predominantly used by urban households while SHSs are dominant in rural areas.

Our analysis of household electricity access finds considerable potential for eCooking adoption as illustrated in Table 0.1. 68.9% of households on the main grid have electricity suitable for eCooking, and interestingly, rural households fare better (70.9%) than their urban counterparts (66.6%). 68.36% of households connected to mini-grids have electricity that can support eCooking. At present, a negligible 0.15% of households have SHS that can support eCooking, since the capacity of most SHS

[1] Only 4 electric appliances were included in this study, namely the mixed LPG-electricity stove, electric coil stove, induction cooker and microwave

lies within Tier 2 or below. Most of the households on SHSs will thus need to upgrade to higher capacity tiers prior to transitioning to eCooking.

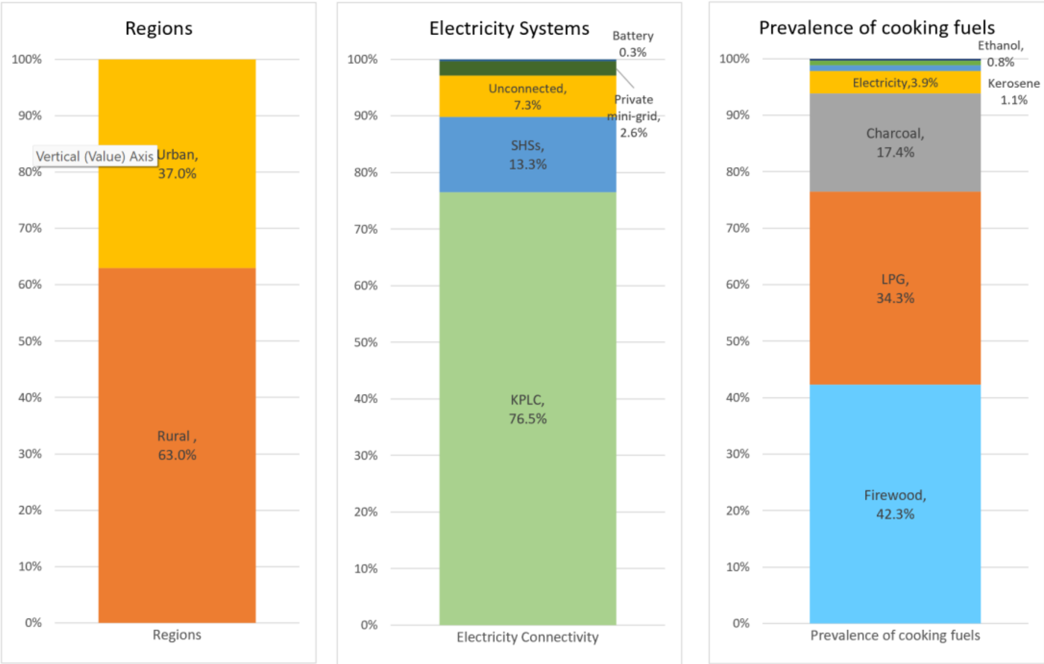


Figure 0.1 Market segment descriptive statistics

Table 0.1 Household access tiers across the grid, mini grids and SHSs and eCooking capacity

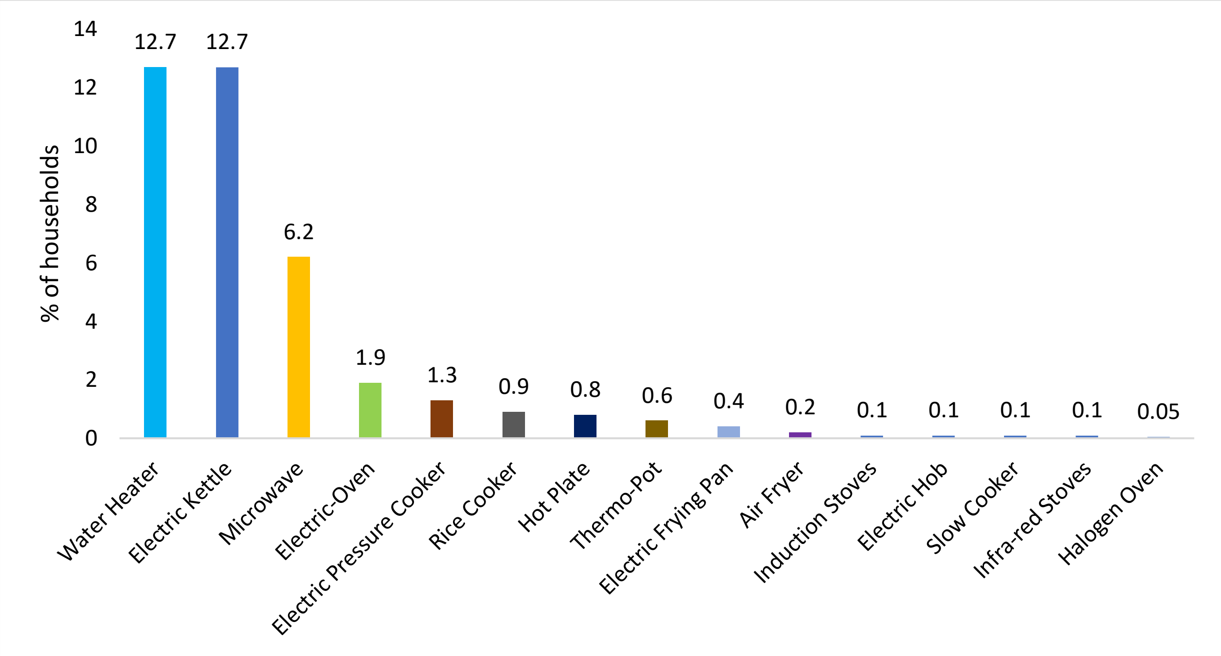
Household access (%)		**Tier 0**	**Tier 1**	**Tier 2**	**Tier 3**	**Tier 4**	**Tier 5**	**eCooking Capacity**
The grid	*National*	0.5	2.3	28.3	27.9	22.2	18.8	**68.9**
	Urban	0.1	2.1	31.2	25.6	21.5	19.5	**66.6**
	Rural	0.8	2.4	26.0	29.9	22.7	18.2	**70.9**
Mini grids	*Rural*	1.7	8.4	21.6	15.0	11.0	42.4	**68.4**
SHSs	*Rural*	34.5	58.1	7.2	0.13	0.02	0.00	0.15

eCooking Appliances Ownership

In Kenya, a variety of electric cooking appliances are gaining traction due to the country's drive for cleaner and more efficient energy. These appliances include Electric Pressure Cookers (EPCs), Induction Cookers, Rice Cookers, Air Fryers, Mixed LPG/Electric Standalone Cookers, Microwave Ovens, Electric Solid Plate/Coil Hobs, and Electric Kettles and Immersion Coil Water Heaters. Each appliance offers distinct advantages and challenges for Kenyan cooking styles and energy efficiency.

Ownership patterns from survey data reveal that **25.2%** of Kenyan households own at least one electric cooking appliance. Electric kettle and water heater are the most commonly owned appliances as illustrated in Figure 0.2, likely due to their task-specific nature and affordability. Rural households surprisingly reported higher ownership of eCooking appliances. Gender and wealth also play a significant role in eCooking adoption, with male-headed households being more likely to own eCooking appliances, and ownership skewed towards higher wealth quintiles, with some exceptions like the high prevalence of inefficient electric coil stoves among lower-income households. Households connected to the main grid own more electric cooking appliances.

Figure 0.2 Electric cooking appliances ownership



Appliance Usage and Cooking Practices

The study provides a more nuanced understanding of eCooking prevalence in Kenya by incorporating comprehensive definitions and accounting for stacking practices in households. This study found that **3.88%** of Kenyan households use eCooking as their primary solution for cooking, reheating food and preparing beverages (see Figure 0.3), a figure that may be more accurate than previous estimates due to the study's inclusive definitions. When considering cooking only, **0.58%** of Kenyan households primarily use electric appliances for this purpose.

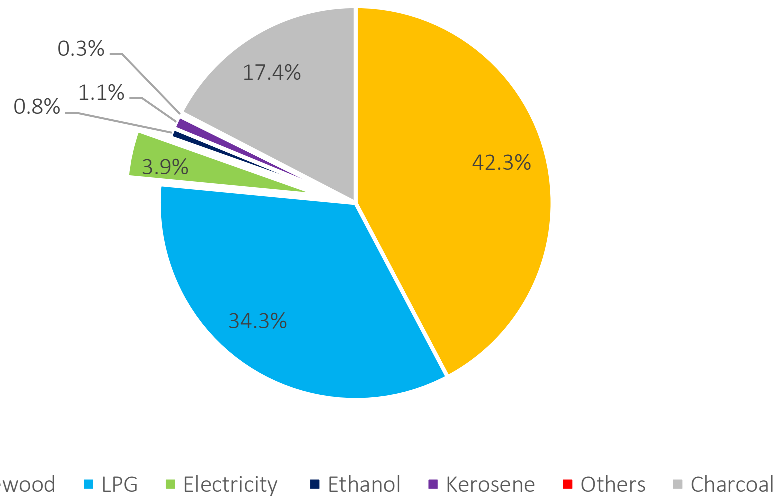


Figure 0.3: Primary solutions used in Kenya for cooking, reheating and preparing beverages

Despite the increase in appliance ownership, the data shows that owning an appliance does not necessarily mean it is used. This implies the need for educational initiatives alongside financial incentives like subsidies to encourage the adoption and effective utilization of electric cooking appliances.

The study also analyses appliance usage, cooking practices, and typical cuisines in Kenyan households. Most households use electric appliances mainly for boiling water (63.2%) and reheating food (12.7%) as shown in Figure 0.4. The study further explores typical meals in Kenyan households, finding that supper is the most frequently prepared meal, and fewer households prepare lunch regularly compared to breakfast and supper. Breakfast primarily consists of hot beverages and porridge, with the former being consumed by nearly twice as many households as the latter. Lunch and supper have similar constituent dishes Generally, household menus are narrow and include rice, ugali, vegetables, cereals, meat stews, and roots. Further, common meals vary by wealth and gender, with upper-class households showing a greater variety in dishes. Taste preferences are deeply influenced by a matrix of cultural, economic, and social factors.

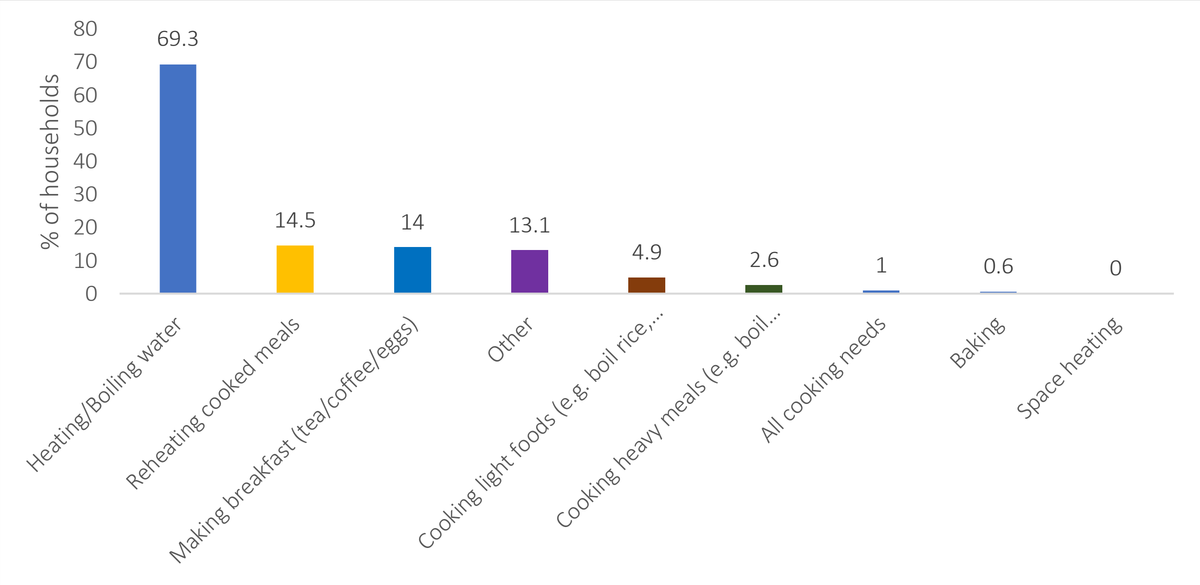


Figure 0.4 How the most popular appliances are used in households

Cooking techniques vary across dishes, with boiling and frying being dominant. Baking is least popular and mainly used for preparing snacks. Overall, modern electric cooking appliances like Electric Pressure Cookers, Induction Cookers, Rice Cookers, Air fryers and Electric Kettles are largely compatible with Kenyan cooking techniques and dishes, as shown in Table 0.2.

Table 0.2 Cooking techniques for typical cuisines in Kenyan households and compatible appliances

TYPICAL DISHES	COOKING TECHNIQUES (HOUSEHOLD PROPORTION %)	COMPATIBLE ELECTRIC COOKING APPLIANCES
PORRIDGE	Boiling	EPC, Induction Cooker, Electric Kettle *(to pre-boil water)*
HOT BEVERAGES	Boiling	Electric Kettle *(to pre-boil water),* Induction Cookers, Electric solid plate/coil hob
SNACKS	Deep Frying, Shallow frying, Baking	Air Fryer, Microwave Ovens, Electric oven
CAKES AND BREADS	Baking, Frying, Roasting	Electric oven, Microwave Oven
EGGS	Boiling, Shallow Frying	Induction Cookers, Electric solid plate/coil hob
SAUSAGES/BACON	Shallow Frying, Deep frying	Air Fryer, Induction Cookers, Electric solid plate/coil hob, Electric oven
CHAPATI	Shallow Frying, Baking, Roasting	Induction Cookers, Electric solid plate/coil hob, Electric Oven

ROOTS	Boiling, shallow frying, Deep frying, Steaming, Stir frying	EPC, Rice Cooker, Electric Kettle *(to pre-boil water)*
RICE	Boiling, Sautéing/stir frying	Rice Cooker, EPC, Induction Cookers, Electric solid plate/coil hob, Electric kettle *(to pre-boil water)*
CEREALS	Boiling, Sautéing/stir frying	EPC, Rice Cooker
UGALI	Boiling, Simmering	Electric Kettle *(to pre-boil water)*, EPC, Induction Cookers, Electric solid plate/coil hob
VEGETABLES	Stir Frying, Boiling, Steaming	Induction Cookers, Electric solid plate/coil hob, EPC
MEAT STEW	Sautéing/stir frying, Boiling, Simmering, Deep frying, Roasting	EPC, Induction Cookers, Electric solid plate/coil hob
SOUPS	Boiling, Sautéing/stir frying, Deep frying, Simmering	EPC, Rice Cooker, Electric Kettles *(to pre-boil water)*
DEEP FRIED MEAT	Deep Frying, Boiling, Sautéing/stir frying, Roasting	Air Fryer, Electric oven
ROAST MEAT	Sautéing/stir frying, Roasting, Boiling, Deep frying, Baking	Air Fryer, Electric oven, EPC
SHALLOW FRIED MEAT	Shallow Frying, Boiling, Roasting	Induction Cookers, Electric solid plate/coil hob, Electric oven

Willingness to Pay for eCooking Appliances

Households are asked to price a hypothetical eCooking appliance that can be used to prepare all the foods they currently cook. Households expressed a willingness to pay between KES. 3,000 and KES. 15,500 for that appliance as illustrated in Figure 0.5. This range gives an indication of how to best price an electric cooking appliance in Kenya. The study further found that the decision to purchase eCooking appliances is influenced by a variety of factors including recommendations from friends and family, affordability, and cooking speed. Urban and rural households, as well as male and female-headed households, prioritize different factors when choosing to purchase these appliances.

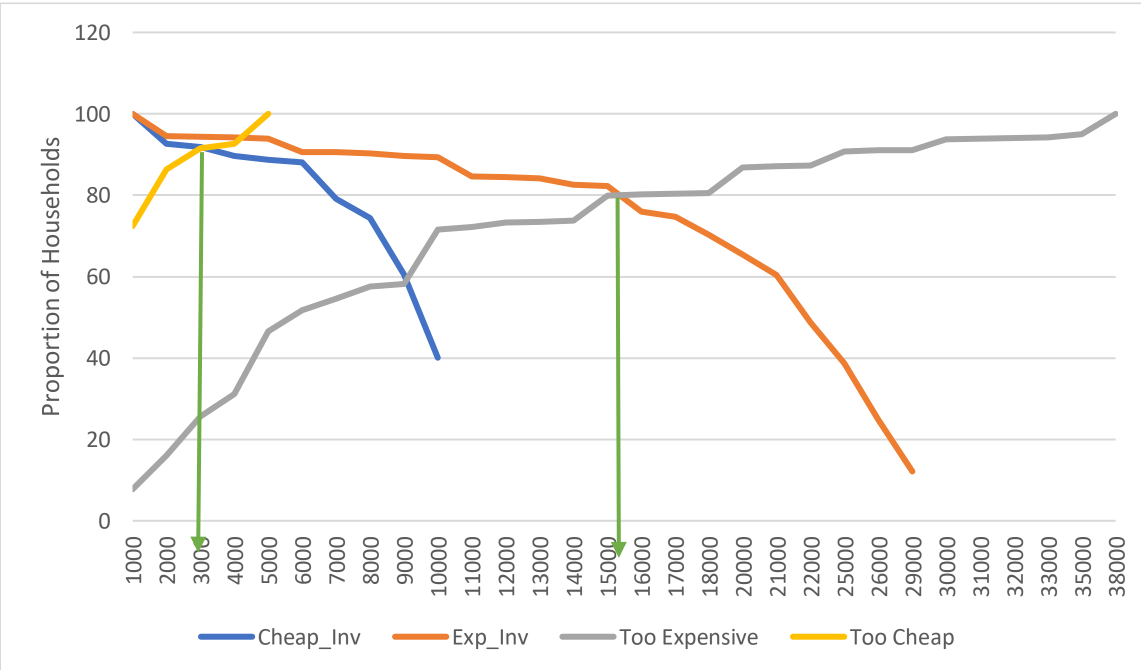


Figure 0.5 Households' willingness to pay for an eCooking appliance price range

Rural households seemed to rely more on recommendations from trusted parties such as friends and SACCOs. Urban households were more inclined to purchase an electric cooking appliance due to their affordability, availability, less electricity consumption, access to appliance financing options and versatility in food preparation compared to households in rural areas. Rural households were mainly influenced by the convenience of the appliance(s), lower pollution, aesthetic appeal, faster cooking times and lower electricity consumption compared to urban households.

Knowledge, Attitudes, and Beliefs about eCooking

Social cultural beliefs significantly shape the adoption of modern cooking appliances. Many view using these appliances as foreign and believe that food cooked traditionally tastes better. 74.6% of households believe there's a difference in taste between food cooked on electric appliances and those prepared using traditional methods. The major perceived differences between electric and traditional cooking are due to speed (77.9%), taste (66.3%), and cost (24.5%). Focus group participants deemed foods like chapati, pilau and ugali to be better tasting when cooked traditionally. The findings emphasize the importance of knowledge and cultural beliefs in the adoption of new technologies, and the role of behaviour change campaigns and consumer education on the benefits of electric cooking.

Stacking of cookstoves

Stacking refers to the use of multiple fuels and technologies in a household to meet their energy needs. A typical household "stack" includes at least a three-stone open fire, an LPG stove, and an improved charcoal stove. Around two-thirds of households use more than one type of stove, a practice common in both urban and rural areas (see Table 0.3). Further, wealthier households are more likely to own multiple stoves, with the wealthiest quintile showing the highest ownership of three stoves. Notably, as households transition from using a single stove to multiple stoves, LPG stoves become increasingly significant. Among households with three stoves, the LPG stove is the most commonly owned.

Table 0.3 Household stacking of cookstoves across regions and wealth

Categories		Zero Cookstoves	One Cookstove	Two Cookstoves	Three Cookstoves
Region	National	0.07%	36.61%	42.64%	20.68%
	Urban	0.19%	36.05%	42.46%	21.29%
	Rural	0.00%	36.94%	42.74%	20.32%
Wealth Quintiles	Poor Quintile	0.00%	53.17%	33.34%	13.49%
	Lower Middle Quintile	0.00%	52.12%	33.58%	14.30%
	Middle Quintile	0.00%	36.06%	47.33%	16.61%
	Upper Middle-Class Quintile	0.35%	28.17%	52.38%	19.10%
	Wealthy	0.00%	16.51%	45.88%	37.61%

Profiling household cooking – A Multi-Tier Approach

The Multi-Tier Framework (MTF) analysis uncovers complex trends in cooking practices across urban and rural areas and among various wealth quintiles. While traditional cooking solutions (TCS) are notably more prevalent in rural areas (87%), urban regions are more open to improved cooking solutions (ICS) and modern energy cooking services (MECS), with 42% and 9% adoption rates respectively (see Figure 0.6). Interestingly, poorer households tend to use ICS more frequently, whereas middle to wealthy households not only rely more on TCS but also have higher adoption rates for MECS. The MTF data also reveal that over 70% of households with grid connections capable of supporting eCooking are currently using TCS or ICS, suggesting a ripe market for promoting eCooking adoption with minimal intervention costs.

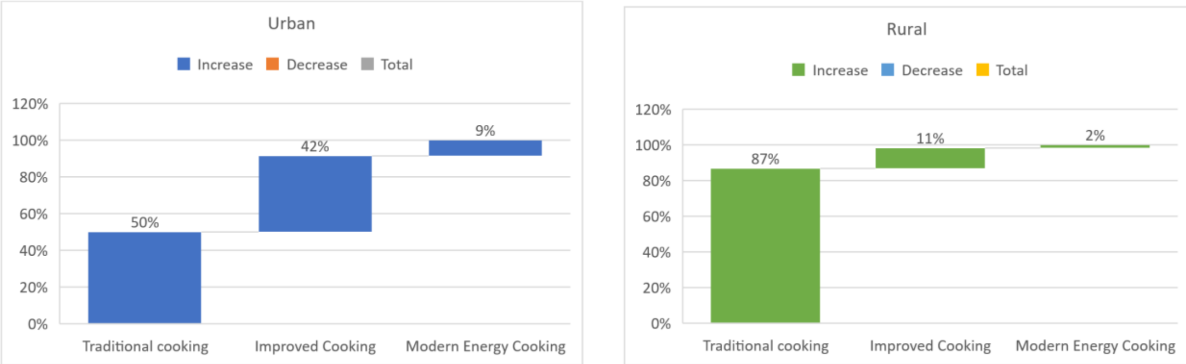


Figure 0.6 Household adoption of cooking services: a rural/urban comparison

Relative cost of eCooking

The Kenyan eCooking appliance market is diverse and highly competitive, with a variety of products catering to different income levels and preferences. Consumers have numerous options to choose from, with brands ranging from expensive (>100k KES) to more affordable (<5k KES) alternatives (see Table 0.4). As the market continues to evolve, it is expected that more innovative and cost-effective solutions will emerge, further promoting the adoption of eCooking appliances.

Table 0.4 Typical retail prices for selected eCooking appliances in Kenya.

Cooking Appliance	Approximate Min Price[2]		Approximate Max Price	
	KES	USD	KES	USD
Mixed LPG/electric standalone cooker	22,995	177	204,995	1577
Microwave	6,499	50	222,600	1712
Air fryer	5,999	46	42,219	325
EPC	5,663	44	25,995	200
Induction/infrared cooker	4,469	34	162,300	1248
Rice Cooker	2,999	23	19,500	150
Electric Hotplate	945	7	11,850	91
Electric Kettle	759	6	7,995	62

In early 2023, after public consultation on the electricity tariff review, EPRA introduced an intermediate tariff band (Domestic Ordinary 1) to balance the costs. However, this intermediate tariff was still higher than the 2022 tariffs. We analysed multiple studies that explored the relative costs of cooking with electricity versus other fuels like LPG, charcoal, and kerosene. These studies used different methodologies and came up with varied energy consumption figures, ranging from 19.2 to 85 kWh/month for different appliances and cooking habits. On applying the intermediate tariff, eCooking was found to be cost-effective before new tariffs were introduced. However, the revised tariffs made eCooking more expensive than some other options like LPG and firewood, as per several other studies.

For eCooking to be a competitive option, a tariff reduction in line with pre-review levels is necessary, particularly to make it cost-effective compared to LPG.

[2] Most prices are sourced from online retailers such as Kilimall, Jumia, ZuriCart and Quest, and from websites of distributors such as Hotpoint.

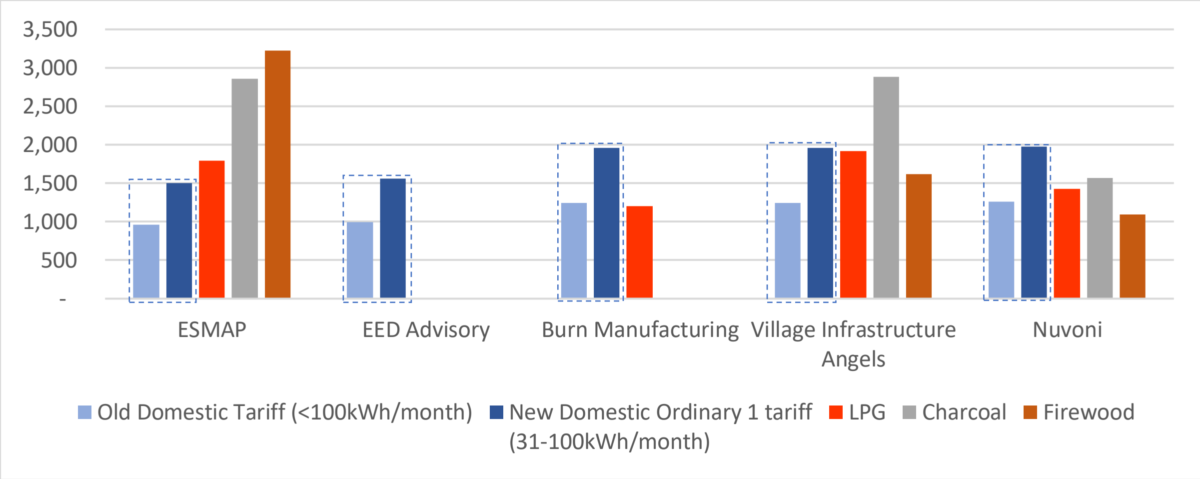


Figure 0.7 The cost of eCooking relative to other fuels across various studies

The transition to eCooking: An optimistic Scenario

The study finds that a considerable 64.9% of Kenyan households are ready to transition to electric cooking immediately, given their current Tier 3+ electricity access (see Figure 0.7). This readiness, when added to the existing 3.88% of eCooking households, implies that as much as 68.7% of Kenyan households could potentially adopt electric cooking, demonstrating a significant opportunity for interventions aimed at scaling up eCooking technologies.

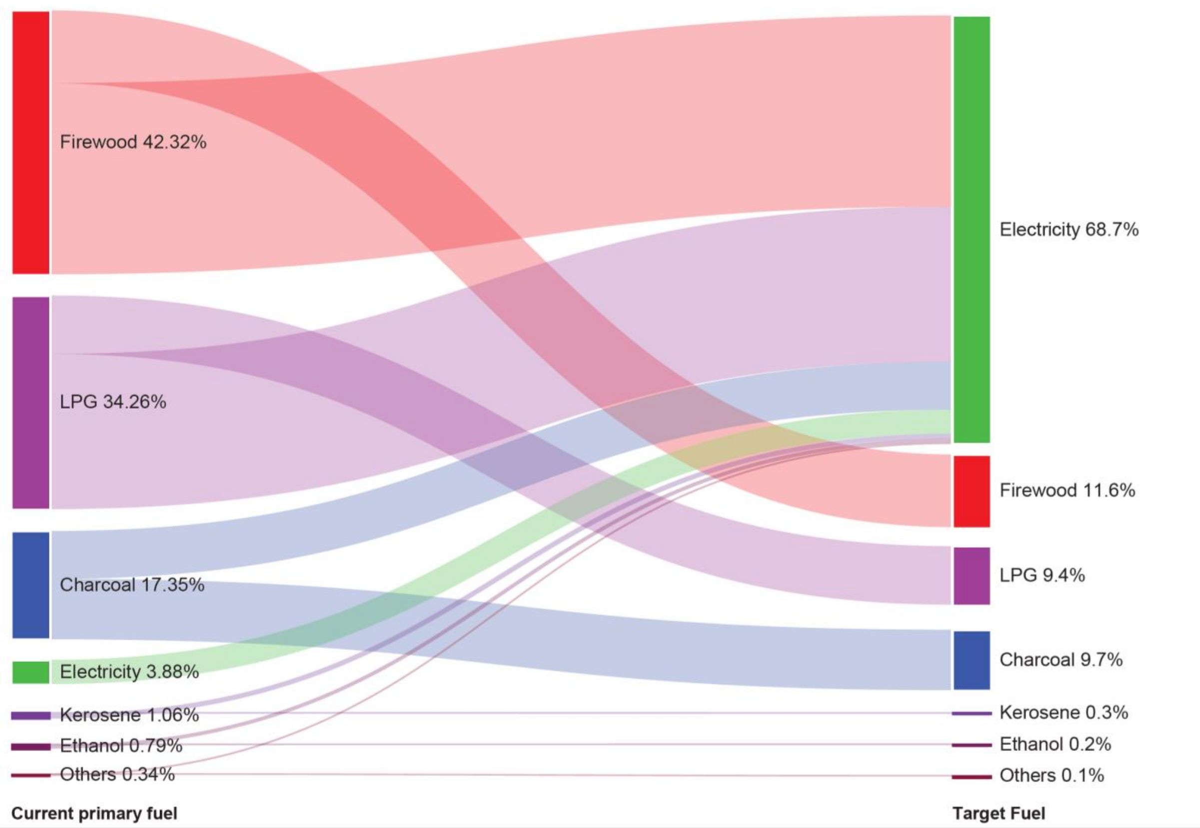


Figure 0.8 Transition to eCooking based on Tier 3+ Electricity Access

The supply chain for eCooking appliances

Electric cooking appliances are imported from various countries. Key source countries include China, India, Vietnam and Taiwan in Asia, France, The Netherlands, Germany, Turkey, Czech Republic, United Kingdom and Italy in Europe, United Arab Emirates and the United States. The supply chain for electric appliance imports is complex and involves multiple stages, from raw material extraction to the end consumer. Lead times for importing electric cooking appliances can range from a few weeks to several months, depending on factors such as the source country, shipping method, and customs clearance. Retailers highlights some challenges in the international supply chain for eCooking appliances, among them, high upfront costs, fluctuating prices, rapidly changing appliance models, the risk of importing poor quality appliances, and the lack of customization for local cuisines and languages.

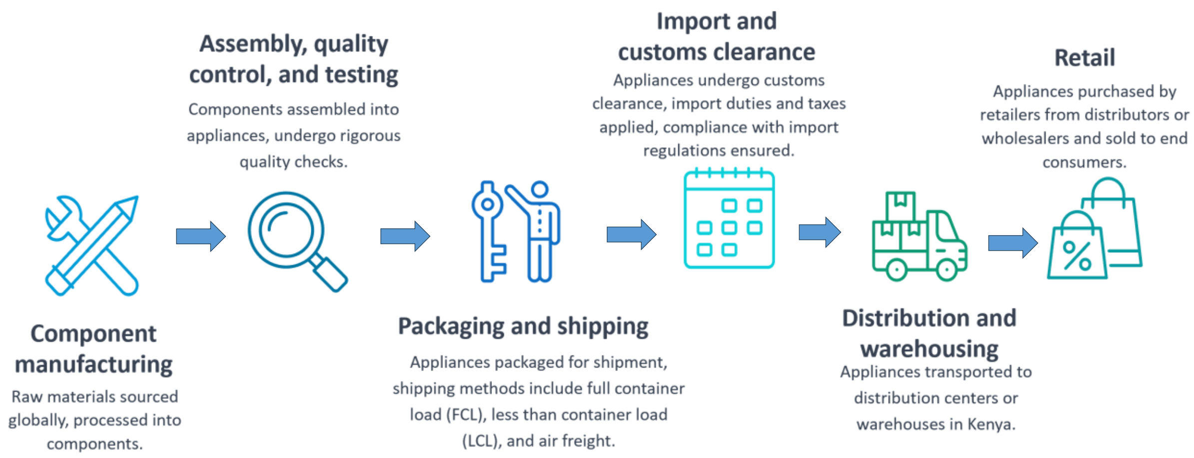


Figure 0.9. Stages in the supply chain for imported electric cooking appliances

Manufacturing of e-cooking appliances in Kenya is still nascent, but recent developments have shown that there is potential to further develop local manufacturing. Key among them are BURN Manufacturing's ECOA product line, informal sector manufacturing of electric coils, and solar PV eCooking system assembly capabilities. However, to fully realize this potential, targeted investments in infrastructure, human capital, policy framework, and logistics will be necessary.

With regard to delivery models for eCooking, retailers and distributors have adapted their business models to cater to the emerging market segments. They offer a variety of electric cooking appliances through physical retail outlets, authorized dealers and distributors, online shops, door-to-door sales, agency models, and revolving funds (Chamas). Brick-and-mortar outlets remain the most popular point of purchase, with 42.1 percent of households purchased electric cooking appliances from supermarkets, followed by wholesale/retail shops (18.5 percent), and small retail stores and specialist shops (9.3 percent).

Marketing efforts have evolved to include both traditional advertising methods such as radio, TV, print media, and innovative approaches such as social media campaigns, influencer marketing, and reality TV shows such as *Shamba ShapeUp* which reaches upwards of 11 million people across Kenya. Of the 92% of the population that knew about e-cooking in the household survey, traditional media is still king in marketing of appliances (31.2%), followed by social media (24.8%), given the high level of internet connectivity and smartphone access in Kenya. These strategies are achieving some success in increased awareness and demand for electric cooking appliances. Regional eCooking hubs, established through collaborative efforts between various stakeholders, can further support retailers by promoting the eCooking agenda locally and fostering the development of context-relevant business models, financing mechanisms, and favourable local policies.

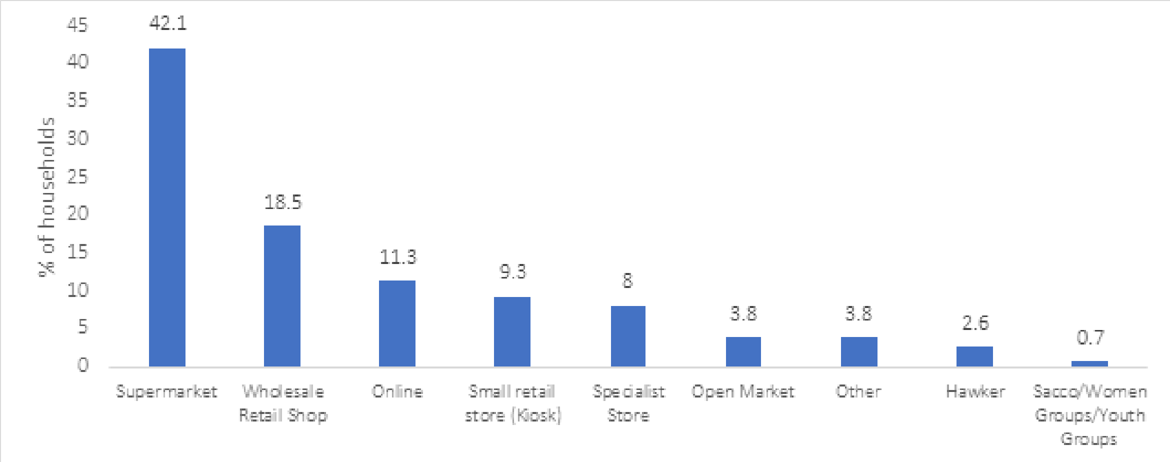


Figure 0.10 Point of purchase for most recent electric cooking appliances by households

Financing eCooking

Financing electric cooking comprises two key related components: demand-side or consumer financing, and supply-side financing. To address the affordability constraints related to the upfront costs of electric cooking appliances and costs of appliance ownership, innovative consumer financing models are being introduced into the market. Models include cash and carry, asset financing loans, PayGo, layaway savings, chamas and microfinance. 96.1 percent of appliance owners in the survey report that they paid full upfront cash when purchasing their electric appliances. 5.8 percent of the households indicate to have secured the loan to purchase a big household item. Many asset financing loans came from Chama/ROSCA at 32 percent. Whilst still in its infancy in Kenya, utility-enabled financing offers new opportunities for consumer financing of clean cooking devices, as energy service companies are uniquely placed to facilitate the sale of eCooking appliances to their customers. Mini-grid developers such as PowerHive and the national utility, Kenya Power, are already offering financed appliances to their customers under ongoing pilot projects, with the potential to scale going forward.

Table 0.5 Consumer financing models for electric cooking appliances in Kenya

Consumer financing mechanism	Description
Cash and Carry Model:	Upfront cash payments are the most common method for purchasing electric appliances. Many households save up or use existing cash reserves to make one-time payments. Preferred payment method across income levels.
Asset Financing Loans	Kenya's microfinance sector offers formal and informal institutions for loans. Savings and Credit Cooperatives (SACCOs) provide savings and borrowing options. Limited adoption of loans for household electric appliances. Rural households more reliant on microfinance institutions and commercial banks.
PayGo Models	Pay-as-you-go models allow consumers to pay for appliances in installments. Initial deposit followed by regular payments until full cost is covered. Mobile money payments, like M-Pesa, support these models. Successful for entities like Powerhive, BURN Manufacturing, and Bidhaa Sasa.
Layaway Savings	Customers make a deposit and regular instalments over a fixed period. Once full payment is made, the customer owns the appliance. Offered by supermarkets like Naivas and Carrefour.ere Limited adoption, preferred by middle-class households.
Chamas/ROSCA (Self-Help Groups)	Social networks like chamas and merry-go-rounds facilitate appliance ownership. Group liability eliminates the need for individual credit checks. Members finance each other and support acquiring appliances. Dominant source of borrowing for both rural and urban households.

Gifts	Some households receive electric appliances as gifts from friends and family. Particularly common among poor households. Financing structures and business models can be tailored to address financial constraints of these households.

Supply side financing helps to address the financial and operational challenges faced by businesses in the sector. Mechanisms that have been tested in the Kenyan electric cooking sector include equity investments, grants, subsidy programmes using results-based financing mechanisms, and carbon credits. Carbon financing is already a strong driver for the clean cooking sector in Kenya, however the increasing use of smart metres, and PayGo business models mean that there is significant potential to streamline the process of obtaining carbon finance for the eCooking sector as Gold Standard recently endorsed a new methodology which simplifies the validation of carbon finance data by utilizing smart meter data. Utility-led financing could also address some of the supply-side financing challenges by drawing upon the much more substantial investment going into the electricity access sector.

Table 0.6 Supplier financing models for electric cooking appliances in Kenya

Supply-side financing models	Description
Grants	• These are funding mechanisms provided by development partners for research, development, and market expansion. • Grants support pilot projects and risky ventures with potential for significant impact. • Grants are disbursed through competitive processes or partnerships with local organizations. • Examples include MECS, EnDev, and Efficiency for Access Coalition.
Equity and Impact Investments:	• These are investments made by private investors, venture capitalists, and development finance institutions. • They provide patient capital for scaling operations and expanding reach. • Active investors in clean cooking enterprises include Acumen, Engie, Circle Gas, and FMO.
Results-Based Financing (RBF):	• RBFs link fund disbursement to predefined performance outcomes. • They lower market entry barriers and incentivizes clean cooking adoption. • Usage data from pay-as-you-go (PAYGO) or Pay-as-You-Cook (PAYC) models can inform impact metrics. • Examples include EnDev RBF, NEFCO, Kenya Higher Tier Cookstoves Market Acceleration project, and ABPP.
Smart-Meter-Enabled Carbon Financing	• Smart meters monitor energy consumption and calculates carbon emissions reductions. Carbon credits generated can then be sold to offset carbon emissions. • KOKO Networks and BURN Manufacturing have implemented this model. • There is untapped potential for accessing global carbon finance and promoting energy-efficient appliances.
Utility-Led Financing	• This mechanism allows consumers to spread appliance costs over time through monthly instalments. • Options include On-bill financing, on-bill repayment, and co-marketing/data-sharing. • It may involve partnership between utility companies and third-party financiers. • Viability in Kenya needs stakeholder engagement and potential donor support.

After sales service

The after-sales service landscape for electric cooking appliances in Kenya is multifaceted, with authorized service centres, independent repair shops, and appliance retailers providing various services. The growing demand for these services in rural areas highlights the importance of expanding access and raising awareness about warranties. Continuous skill development and training for technicians are essential to keep pace with technological advancements and customer needs.

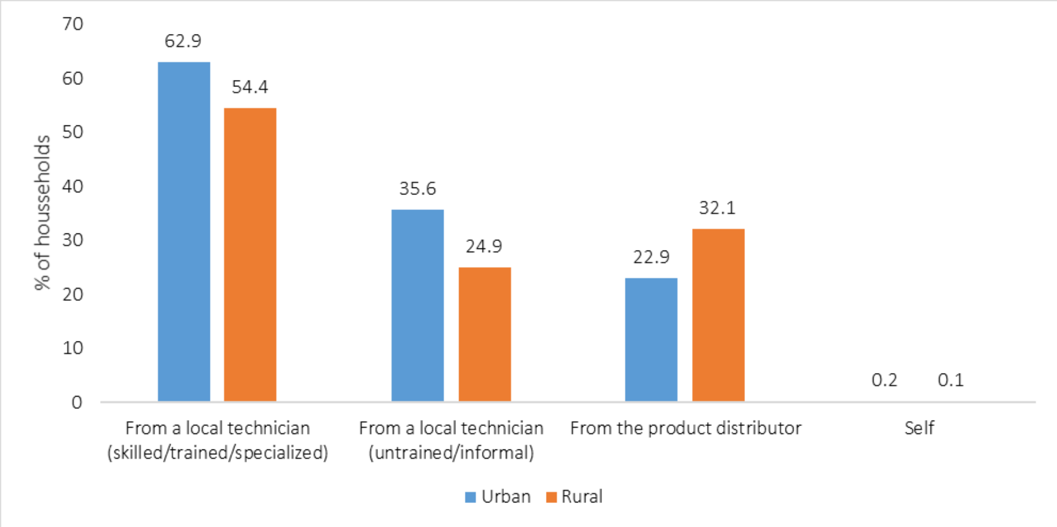


Figure 0.11 Source of *support for eCooking appliance repair* (urban/rural)

Appliance Standards and Testing

The ecosystem for efficiency and quality assessment for electric cooking appliances in Kenya is still at its infancy. Kenya currently has a safety and performance standard for electric cooking appliances, both adapted from international standard, with a larger focus on safety. There is still no national test method requirement for electric cooking appliances in Kenya. Thus, tests are done voluntarily at Kijani Testing Lab, Strathmore Energy Research Centre (SERC) and University of Nairobi. There is a need for support and capacity building for eCooking testing in these facilities, including KIRDI which is currently focused on ICS testing.

Only one kitchen appliance—refrigerators—has the Kenya Energy Label which is specific to Kenyan national standards issued by EPRA (See Figure 0.11). Other appliances may have labels from other jurisdictions, but there's no requirement for labels on these products. KEBS also has mandatory standardization marks for all manufactured products, whether local or imported, which are also applied to eCooking appliances.

Table 0.7 below summarises these barriers and provides recommendations.

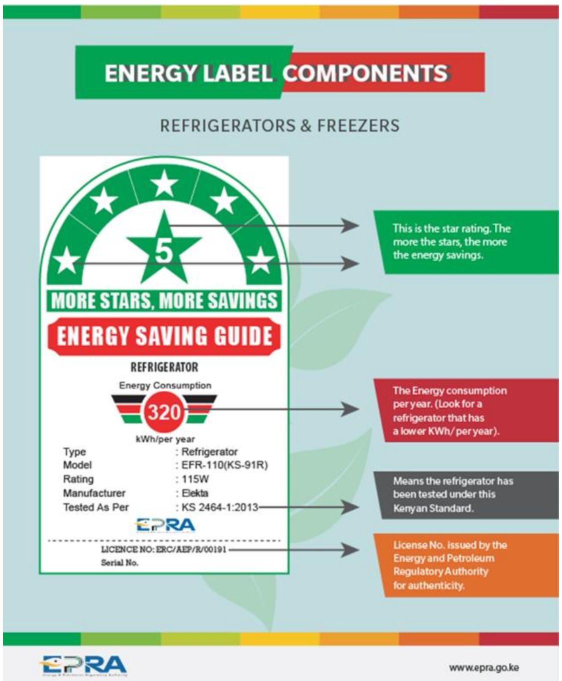


Figure 0.12 The Kenya Energy Label used on refrigerators. The m*ore stars* on the label, the *more energy efficient* an appliance is. Source: Energy Petroleum Regulatory Authority.

Table 0.7 Addressing barriers in the appliance standards ecosystem

Barriers	Recommendations
No national test method requirement for electric cooking appliances.	Establish a standardized national test method requirement to ensure consistent product quality.
Electric cooking appliances are currently not a priority for testing unless they pose a safety risk. Thus, testing is done voluntarily based on retailer demand rather than being mandatory.	Implement mandatory testing for electric cooking appliances to ensure safety and quality. Allocate specific resources and attention to test DC appliances, considering their use in off-grid areas. As the market grows, introduce voluntary standards for eCooking equipment, paving the way for more comprehensive regulations in the future. This can also serve as a base for national-level market development initiatives, like reduced tariffs and subsidies.
Challenges exist in defining and contextualizing performance requirements.	Collaborate with industry experts and stakeholders to set clear efficiency parameters and benchmarks. Setting benchmarks can help improve the quality of products in the market.
There's limited capacity in testing facilities.	Invest in capacity building, including infrastructure, equipment, and training in the testing facilities. Support institutions like Kijani, SERC, and the University of Nairobi in developing their testing capacities, ensuring knowledge transfer and localization of tests. Provide better resources to KEBS for them to acquire the necessary equipment and skills to expand their capacity for standardization, testing, and labelling of appliances.
There's no requirement for labels on many electric cooking appliances.	Introduce mandatory labelling for electric cooking appliances, highlighting energy efficiency and safety. Expand EPRA's Kenya Energy Label to cover a wider range of kitchen appliances, including eCooking products
Consumers struggle to distinguish between appliance quality due to a lack of labelling and information. ***Consumers may perceive labelled products as more expensive.***	Increasing consumer awareness and education about the benefits of energy-efficient appliances and the role of labelling in making informed choices can help drive demand for higher-quality products and lead to market growth.

The policy environment

International policies, strategies and initiatives such as the Sustainable Development Goals (SDGs), Sustainable Energy for All (SE4All), the Paris Agreement and the Clean Cooking Alliance (CCA) and the African Development Bank's (AfDB) New Deal on Energy for Africa play a critical role in driving electrification and clean cooking by providing financial, technical, and policy support. Kenya has a raft of legislation, policies, strategies and plans in the energy sector that support electrification, but need more explicit formulation for clean cooking, and electric cooking by extension. To create a more integrated policy framework for electric cooking in Kenya, there are areas for synergies and opportunities to embed clean and electric cooking within broader energy sector policies, as outlined in Table 0.8. Further, clean cooking and electrification goals are referenced directly or indirectly in other policy spheres, such as climate change and environmental policies, health policies, innovation and industrial policies. By aligning electric cooking with these policy frameworks, the country can optimize the benefits of electric cooking in multiple areas, such as mitigating climate emissions, improving health outcomes, and stimulating innovation.

Table 0.8 Addressing barriers in the policy environment

Barriers	Recommendations
There's no clear linkage between clean cooking and electrification goals across various policy and planning documents.	Develop a coherent policy framework that links clean cooking and electrification goals across different policy and planning documents. This involves creating a clear narrative that connects electric cooking with broader objectives such as improving public health, reducing deforestation, and achieving climate change targets.
The targets and objectives related to clean cooking and electrification are not harmoniously integrated and aligned across different policy and planning frameworks.	Harmonise targets and objectives by ensuring that clean cooking and electrification goals are consistently integrated and aligned across all these policy and planning frameworks. This includes setting specific, time-bound, and ambitious targets for electric cooking adoption.
Lack of coordination and collaboration among different stakeholders responsible for implementing aspects of energy policy and planning, resulting in potential redundancy and inefficiency.	Foster coordination and collaboration among different stakeholders responsible for implementing various aspects of energy policy and planning. Co-opted existing cross-sector or interministerial committees for this purpose. Alternatively, establish a central coordination body or a multi-stakeholder platform can facilitate information sharing, joint planning, and resource mobilization.
Electric cooking is not currently aligned with various other policies like those related to climate change, environment, health, and innovation. This results in missed opportunities to optimize benefits across multiple sectors.	Align electric cooking with climate change and environmental policies, health policies, innovation and industrial policies to optimize the benefits of electric cooking in multiple areas such as reducing mitigating climate impacts, improving health outcomes, and stimulating innovation. A coordinated policy approach that fosters collaboration between relevant government agencies and stakeholders, leverages resources and expertise, supports development of the innovation system, and raises public awareness will be instrumental in driving the widespread adoption of electric cooking in Kenya.

Conclusion

The eCooking sector in Kenya has significant potential to address not just cleaner cooking but broader issues like public health, environmental conservation, and economic development. However, this potential can only be realized by tackling various challenges, including electricity access, socio-cultural factors, and economic constraints. A multi-faceted approach is needed that goes beyond just technology adoption and includes addressing cultural and socio-economic nuances, streamlining supply chains, introducing innovative financing models, and implementing robust standards and certifications. A supportive and adaptive policy environment is crucial for scaling eCooking and must align with broader objectives like public health and environmental conservation. Emphasizing the needs and roles of women in this transition is also vital. The key takeaway is the need for adaptability; setting clear, ambitious targets and revisiting policies and strategies as the market evolves will be crucial for the success of eCooking initiatives in Kenya, with broader implications for the country's sustainable development goals.

1. INTRODUCTION

1.1. Background

Over the past decade, Kenya has made remarkable strides in electrification, with coverage surging from a mere 19% to an impressive 75% in 2022 (IEA, IRENA,UNSD, World Bank, WHO, 2023). Most of the nation's grid electricity now comes from renewable sources, primarily geothermal and hydro. However, despite these achievements, most Kenyans still rely on polluting fuels such as firewood, charcoal, and kerosene for cooking. With 0.9%[3] of the population using electricity as their primary cooking fuel, a vast untapped potential lies dormant, waiting to be harnessed.

The clean cooking challenge in Kenya is immense. A staggering 81% of the population continues to depend on polluting fuels such as firewood (65%), charcoal (10%), and kerosene (6%) for their cooking needs (Government of Kenya, 2019), leading to a range of interconnected development challenges. Biomass fuels significantly contribute to Household Air Pollution (HAP) and major sources of Greenhouse Gas (GHG) emissions, accounting for roughly 26.5% of Kenya's total GHG emissions. The Ministry of Health has linked indoor air pollution to 21,500 premature deaths annually (Government of Kenya, 2019). The continued reliance on traditional biomass energy, coupled with population growth, places a strain on agricultural land, leading to reduced fuelwood supply (approximately 20 million tonnes per year). This, in turn, contributes to deforestation, famine, desertification, and land degradation (Government of Kenya, 2019; Schreiber, Waceke, Blair, Grant, & Ireri, 2020). Women and girls are disproportionately impacted, facing higher exposure to cooking smoke and the burden of collecting fuel—sacrificing educational and economic opportunities in the process. The government and non-governmental organizations have strongly advocated for Improved Cookstoves (ICS) as a solution to the clean cooking crisis. However, achieving long-term adoption has proven challenging, as many users abandon the cookstoves soon after initially accepting them (Government of Kenya, 2019). Moreover, recent studies indicate that the health advantages of ICS are not as significant as once believed (Government of Kenya, 2019).

In light of the environmental, social, economic and health impacts of traditional cooking practices, there is need for a paradigm shift towards clean cooking solutions. Liquefied petroleum gas (LPG) is cleaner than biomass and other fossil fuels like kerosene, as it burns completely and produces fewer carbon emissions, thereby mitigating climate change impacts. However, the reintroduction of VAT on LPG in 2021 and rising international fuel prices moderate LPG adoption as a primary fuel, which currently stands at 20%[4]. Bioethanol which burns cleanly, emitting fewer pollutants and providing a healthier cooking environment, is another solution that has been gaining ground rapidly in Kenya. Electric cooking also presents a potentially transformative opportunity for Kenya's clean cooking sector.

There has been considerable underreporting of forms of clean cooking, such as electricity for cooking in national surveys, with the latest statistics showing that 1% of households use it as a primary cooking

[3] KNBS. (2019). *The 2019 Kenya Population and Housing Census Volume IV: Distribution of Population by Socio-Economic Characteristics.* Nairobi: Kenya National Bureau of Statistics.

[4] Shupler, M., Pope, D., Puzzolo, E., Menya, D., Mwitari, J., Muchiri, E., … Wandera, F. (2022). *COP26 and SDG7 goals under threat: 16% VAT on LPG reverses progress made in clean cooking adoption in Kenya*. Retrieved from https://www.ucl.ac.uk/bartlett/construction/sites/bartlett_construction/files/policy_report_dec_2021_v3.pdf

fuel, and 3% of households own an electric cooking appliance such as mixed LPG-electric stove, electric coil stove and microwave (Government of Kenya, 2019). These studies did not adequately capture e-cooking prevalence as part of cooking stacking strategies, or the use of task-specific electric cooking appliances such as kettles, hence the need to conduct the Kenya National eCooking Study (KNeCS) to establish the status quo of e-Cooking in Kenya.

1.2. Purpose of the Study

The study aims to assess the status of electric cooking in Kenya to support the development of an eCooking Strategy that will accelerate the uptake of electricity as a cooking fuel. Among the evidence needed are the mapping and synthesis of the status quo of eCooking in Kenya, i.e., existing and ongoing research that has implications for eCooking—both local and international, and primary data. This data is analysed to understand household electrification and its relation to the current landscape of eCooking appliances.

Previous study findings are inconclusive in explaining the prevalence of e-cooking in Kenya especially when electricity for cooking is examined as the “primary” fuel. The Kenya National eCooking Study (KNeCS) is unique in mapping and synthesis of the status quo of eCooking and eCooking appliances in Kenya through a particular lens on household stacking. Understanding household and institutional cooking practices, including the rationale behind household decision processes around their current cooking fuel stack, access to appliance finance, and appliance repair services, will go a long way in informing strategies to stimulate adoption of eCooking in those households.

Beyond household behaviour and available cooking technologies, an evaluation of the enabling environment and the emerging eCooking sector, both on the demand side and the supply side, and how it is evolving, and could potentially evolve, is core to developing propositions for policy intervention. The study considers the opportunities and barriers that exist in stimulating the adoption of eCooking by households.

The components outlined in the Terms of Reference resulted in the development of a 10-module questionnaire crosscutting across aspects of household: identification and demographics, electricity, cooking practices, fuel stacking, electric-cooking appliances, willingness to pay, risk management, perceptions and finance. These modules then informed the themes delineated in this report.

The report first explores the current situation of electrification and eCooking in Kenya at the national and county level across key market segments, including on-grid/mini-grid/off-grid users, firewood/charcoal/kerosene users, rural/urban dwellers and low/middle/high-income households. It subsequently assesses the use, ownership and financing of eCooking appliances at the county and national level based on the Kenyan popular cooking solutions and cuisine, household income level, urban/rural dynamics and gender.

The report then outlines the supply chain aspects of eCooking appliances including: distribution channels/delivery modes; appliance retail, after-sale services, repair and maintenance; the role of energy utility services companies; their efficiency and quality assessment; possibilities of appliance local manufacturing; barriers to electricity supply and mitigation measures and women the linkage between women entrepreneurship in eCooking. Lastly, the report illuminates the enabling environment surrounding eCooking such as existing policy and regulatory frameworks, policy gaps and synergies and the nexus between clean cooking and electrification.

1.3. Approach and Methods

1.3.1 *Analysis of existing datasets*

The sampling approach and methodology in the baseline survey builds on the previous studies on household energy use in Kenya. Specifically, the baseline survey is guided by Kenya Integrated Household Budget Survey (KIHBS) of 2015-2016, Kenya Population and Housing Census (KPHC) of 2019, Ministry of Energy Sector Study of 2019, Kenya Continuous Household Survey Program (KCHP) of 2020. In addition, the baseline survey is guided by Dubey et al. (2019) who apply the Multi-Tier Framework in the assessing household access to electricity accounting for both grid-connected and off-grid households. The guiding reports examine energy use based on the main type of fuels used by households and cooking technology/appliances. The trend in the types of primary cooking fuel used by households constructed from previous studies is presented in Figure 1.1.

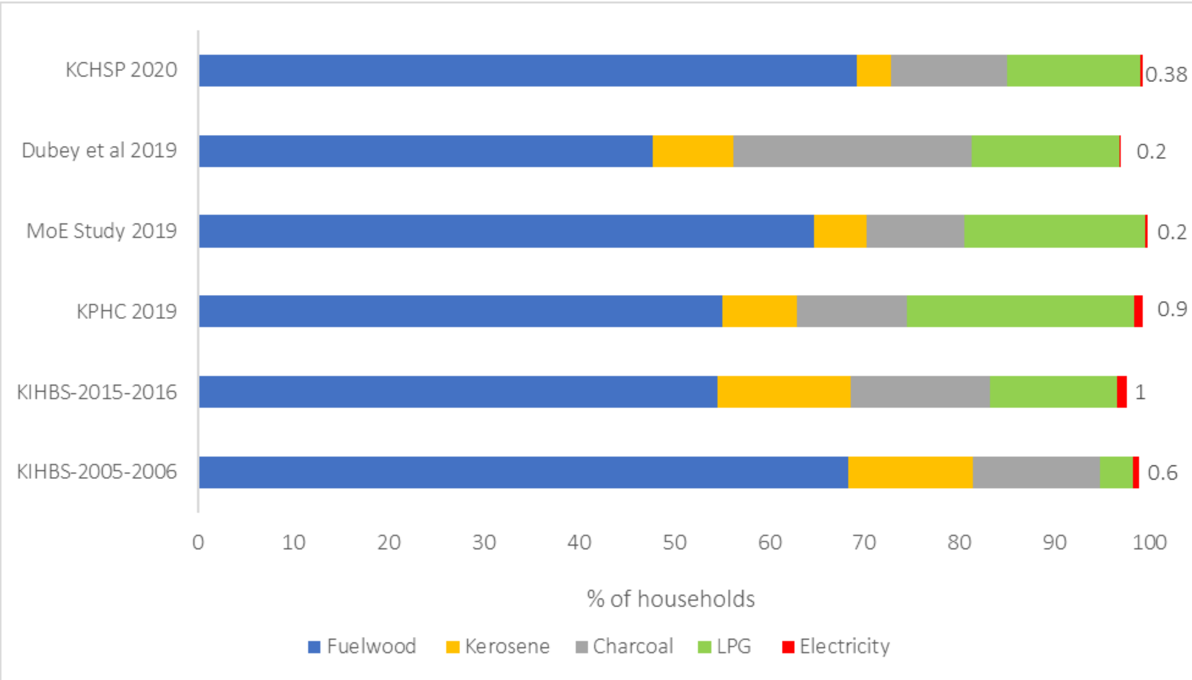


Figure 1.1: Distribution of Primary Fuel Used by Households in Kenya

It is evident that electricity accounts for a minimal proportion of households using it as primary cooking fuel. There is limited coverage on electric appliances in the referenced studies. In particular, the Kenya Population and Housing Census does not report on electric appliances. The Kenya Integrated Household Budget Survey (2015-2016) focuses on primary types of cooking appliances and is limited to electric cookers and combined electric-gas cookers. The same approach is adapted in the Kenya Continuous Household Survey which is a scaled down version of Kenya Integrated Household Budget Survey conducted at a relatively higher frequency. The Government of Kenya (2019) energy sector study is concerned with ownership of electric appliances. While the sector study considers electric cooking appliances such as the dual LPG-electric stove, electric induction stove, electric coil stove and microwave, the study reports aggregated statistics. As such, it is impossible to gain insights on electric appliances and their relative distribution among households in Kenya. Dubey et al. (2019) consider several electric appliances, though only the microwave and electric kettle fall under the category of eCooking appliances. Therefore, the reference studies are incomparable due to differences in the definition of eCooking and the appliances considered. Cognisant of the incomparability of the studies and the associated data limitations, we present a rough estimate of the household ownership of eCooking appliances in Kenya in Figure 1.2.

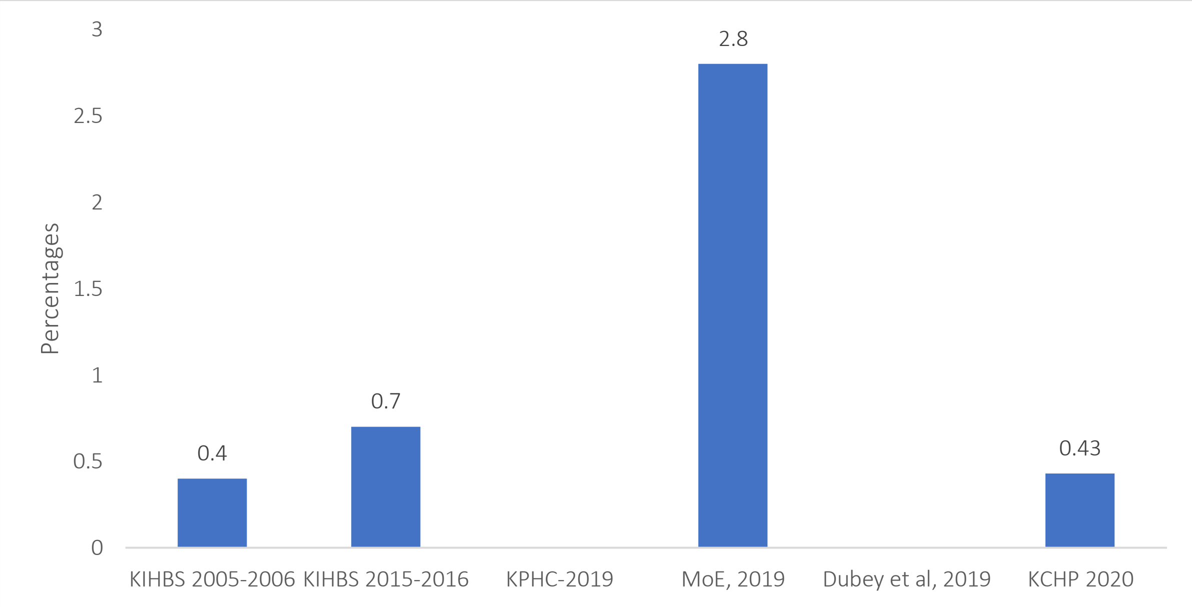


Figure 1.2: Percentage of Households Owning Electric Cooking Appliances

The lack of information on electric cooking in some of these past studies and reports could be attributed to the primary goals of those research efforts. The focus of the studies is on energy use and as such, they do not provide granular data on appliances. It is thus plausible that the statistics under-report eCooking in Kenya. The KNeCS baseline survey provides a relatively accurate depiction of the prevalence of eCooking and ownership of eCooking appliances. This is achieved through the adoption of a more encompassing definition of eCooking. More specifically, by considering the usage of various fuels and eCooking appliances in heating or boiling water, cooking food, reheating food, and preparing hot beverages such as tea and coffee, the baseline survey achieves a reasonably high level of accuracy. In addition, the baseline survey builds upon existing evidence on fuel stacking to broaden the question of household fuel use. Whereas most surveys limit the question to primary and secondary fuels, the eCooking baseline survey is designed to gather data on three options. The decision to include three options is guided by the observed differences in fuel use for cooking food, reheating food, and heating water (Lambe & Senyagwa, 2015) (Leary, Menyeh, Chapungu, & Troncoso, 2021)

1.3.2 Baseline study approach

The study adopted a mixed-method approach to gather information, interpret, summarize and present findings. The initial phase of the study conducted a scoping literature review to identify knowledge gaps, clarify concepts and establish the current state of affairs in the eCooking space in Kenya. Below are the techniques used for primary data collection:

Key Informant Interviews: Expert knowledge was obtained through in-depth semi-structured interviews with relevant individuals and organisations active in eCooking and, where necessary, the clean cooking sector. Actors interviewed include Bidhaa Sasa, SCODE, KIRDI, Kijani Testing, Jikoni Magic, Kakamega Renewable Energy Network, Ramogi Institute of Advanced Technology (RIAT), SNV, Powerhive, Powergen and Burn manufacturing, KOSAP, Village infrastructure Angels, Kenya Power, and a representative involved in the Mukuru SPA project (See Appendix 1 for a comprehensive list of interviews).

Household survey: The study adds to and extends the National Cooking Sector Study (2019) through its uniqueness in covering topics geared towards understanding the penetration and use of eCooking appliances in Kenya. To develop the baseline survey, NUVONI reviewed other questionnaires, datasets, and reports available related to e-cooking, among them, the Kenya Cooking Sector Study 2019, the Kenya Integrated Household Budget Survey 2005/2006 and 2015/2016, among others to identify data gaps.

Based on the insights drawn from the scoping literature review, review of existing datasets and developments in the electrification and eCooking sector, we modified the questionnaire used in the 2019 survey by developing modules which focus on e-Cooking. The survey collected data to estimate current adoption levels of e-Cooking at the national and country levels, considering heterogeneity related to grid/off-grid electrification, gender, regions, and population density/urbanisation, among other aspects. The study included questions related to costs involved in eCooking, financing, efficiency, demand for electricity, health outcomes, environmental outcomes and time savings, and the barriers and drivers of eCooking uptake at the household level. A pilot study was conducted in Nairobi before the complete survey to ensure that all the required information was included in the questionnaires or interview guide.

Focus group discussions: Discussions and narrations generate rich insights in any study, particularly where the focus is on a specific population or market segment's attitudes, belief systems, norms and values. Qualitative data from focus group discussions (FDGs) complement findings from the household survey. FGDs were conducted in four geographical regions: Bungoma, Kilifi, Nairobi and Garissa, to represent rural, urban, western, coastal and pastoral regions. The FGDs comprised 15-20 male and female community members, with a community leadership representative. Different age groups were also represented.

1.3.3 Household Survey Methodology[5]

The survey adapted and modified the comprehensive survey methodology employed in the Ministry of Energy (2019) Kenya Household Cooking Sector Study. Specifically, the survey primarily focused on eCooking, and as a result, the prevalence of eCooking served as the primary sampling criterion. Due to resource and time constraints, and following consultative meetings, the study used nationally representative archetypes.

Archetypes were formulated using cluster analysis, a multivariate statistical procedure that categorized the 47 Counties in Kenya into 10 groups with internal homogeneity and external heterogeneity. A total of 15 variables drawn from an extensive literature review were considered in developing the archetypes. These variables encompassed a wide range of factors, including regional groupings (e.g., western, coast) to serve as proxies for cooking practices, the total number of households in each county, the average household size, population density, and other demographic variables such as the total male and female populations. Additionally, the number of rural and urban households, the proportion of the population with completed education, and the Gross County Product for 2019 as reported by the Kenya National Bureau of Statistics were considered. Energy-related aspects, such as the proportion of households with grid and solar connectivity, as well as those

[5] The methodological framework is available on request.

relying on rechargeable batteries and generators for electricity, and the prevalence of households using electricity as their primary cooking fuel within each county were taken into account.

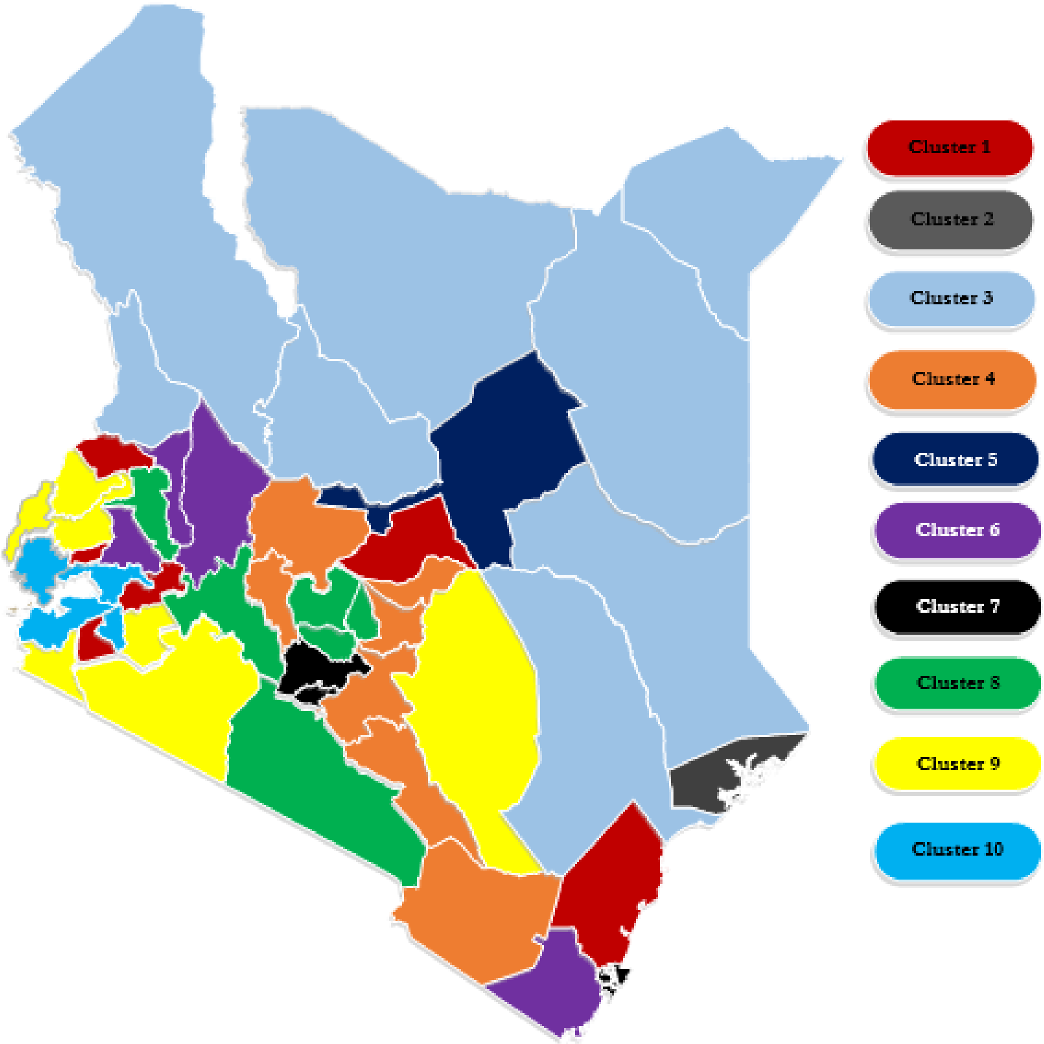


Figure 1.3 *Map of the regional clusters and counties in each cluster*

To gauge the similarity among the counties, the Euclidean distance was utilized. The grouping of counties followed the hierarchical agglomerative clustering method, which initiates the process by identifying the two most similar counties based on the Euclidean distance similarity matrix and subsequently merging them. The study employed single linkage clustering to incorporate additional counties into existing groups. Under single linkage clustering, a county is added to an existing cluster if it shares at least one member with a similar level of similarity to the county under consideration. The choice of single linkage is advantageous over other methods due to its invariance to monotonic transformations of the similarity matrix and its immunity to data ties, where certain cases have identical similarity coefficients. This makes single linkage an effective and reliable method for county grouping in this context.

The clustering algorithm did not cluster two counties, namely Isiolo and Lamu as they did not fit into any grouping and were consequently treated as outliers and individually included in the sample to ensure comprehensive representation of the entire country in the survey. Subsequently, a single representative county was chosen at random from each of the eight clusters. In addition to the two outlier counties, these selected counties constituted a total of the ten clusters considered in the survey. Figure 1.3 illustrates the spatial distribution of the resulting county clusters.

Sample Size Determination

The objective of the Kenya National eCooking Survey is to evaluate the status of eCooking in Kenya, with a particular emphasis on scaling up the adoption of energy-efficient eCooking technologies. To achieve independent representation at both the national and county levels with a 5 percent margin of error and 95 percent confidence interval, a carefully determined sample of 2432 households was obtained. The sample was allocated to the 10 selected cluster representative counties using a power allocation method, ensuring that counties with smaller populations had an adequate sample size. The counties chosen as cluster representatives were stratified into sub-counties, and the sample size allocated using a power allocation method to guarantee a sufficient sample representation at the sub-county level. Refer to Table 1.1 below for an illustration of sub-county distribution in Murang'a county in cluster 8.

Table 1.1 Sampling in Murang'a county

County	Household (2019 Census)	Sub-County	Target Households	Actual Interviews
Murang'a	34650	Murang'a East	40	32
	25283	Kangema	20	29
	28372	Mathioya	40	54
	26778	Kahuro	20	16
	55878	Murang'a South	40	32
	55340	Gatanga	40	50
	40528	Kigumo	40	42
	50657	Kandara	40	38
	10	Aberdare Forest	0	0

Sub-counties were further stratified into sublocations, which were in turn divided into segments. Households were selected from these segments for interview. The survey oversampled grid-connected households to account for the low prevalence of eCooking in Kenya. To execute the oversampling, a list frame of KPLC step-down transformers was used to randomly select segments within the sub-location, and also act as the starting point from which a cluster of four households was chosen for interview. To ensure uniformity in household selection, data was collected from the four households corresponding to the cardinal directions (West, North, East, and South). Figure 1.4 illustrates the subdivision of Murang'a county into sublocations and the subsequent segmentation of Mukwe-Thuita sublocation.

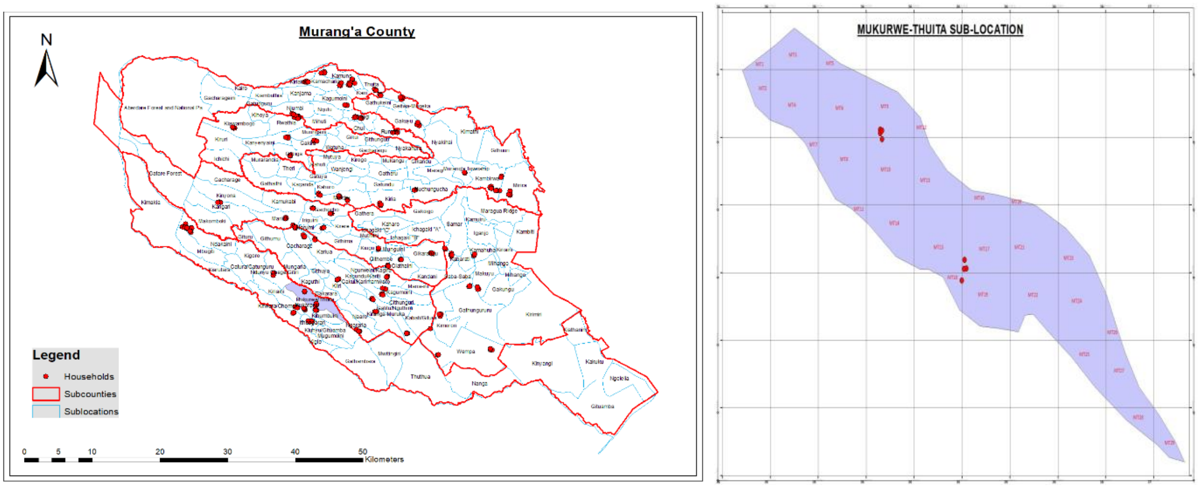


Figure 1.4 Murang'a county sublocations and segmentation of Mukwe-Thuita sublocation.

The sampling approach of the mini-grid was purposive and aimed at gaining insights into mini-grid households. Mini grid households accounted for 2.8 percent of the sample.

A multistage area probability sampling approach was employed, thus necessitating the use of multiple frames in selecting households based on Akinbami, et al. (2022), Heeringa, West, and Berglund (2017), and United Nations (2008). The households' selection procedure employed a two-stage hierarchical probability sampling design. The selection of households is based on the modified segment design outlined in Turner, Magnani, and Shuaib (1996) and UNICEF (2006). To increase reliability, a small sample 'take' of non-compact clusters of four households within each selected segment are interviewed (UNICEF, 2006). The overall selection probability of each household in sublocation i of subcounty h is the product of the selection probabilities at the cluster and sublocation levels taking into accounts the weights of households per sublocation.

Post-stratification was implemented to achieve unbiased statistical estimates and enable the generalization of survey results to the broader population. Post-stratification ensured that the estimates closely mirrored the actual population characteristics by addressing both under and over-representation. For instance, due to security concerns, certain sub-counties in Garissa, Isiolo, and Lamu counties were not included in the survey. To rectify this under-coverage, post-stratification adjustments were made to the weights.

Table 1.2: County selection

Clusters	Cluster Members	Characteristics	Representative County	Interviewed Households
Cluster 1	Kericho (35), Kilifi (3), Meru (12), Trans-Nzoia (26)-Vihiga (38)-Kisii (45) cluster	High Crop Farming and Irrigation	Kilifi	**242**
Cluster 2	Lamu	Outlier	Lamu	**200**
Cluster 3	Tana River (4)-Turkana (23)-Wajir (8)-Mandera (9)-Garissa (7)-Marsabit (10)-West Pokot (24)-Samburu (25) cluster	high household size, Grid eCooking, Solar eCooking, and Genertor use. low education, urbanization,	Garissa	**201**

		grid connectivity and battery use		
Cluster 4	Taita Taveta (6)-Machakos (16)-Embu (14)-Nyandarua (18)-Laikipia (31)- Tharaka Nithi (13)-Makueni (17) cluster	High irrigation and Generator use. low grid eCooking	Makueni	**241**
Cluster 5	Isiolo	Outlier	Isiolo	**180**
Cluster 6	Nandi (29)-Elgeyo Marakwet (28)-Kwale (2)-Baringo (30) cluster	high household size Low urbanization, grid eCooking, and Generator use	Elgeyo Marakwet	**179**
Cluster 7	Mombasa (1)-Kiambu (22)-Nairobi (47) cluster	High education, urbanisation, grid eCooking, highest grid connectivity low household size, solar eCooking, solar connectivity, battery and generator use	Nairobi	**439**
Cluster 8	Nyeri (19)-Kirinyaga (20)-Murang'a (21)-Kajiado (34)-Uasin Gishu (27)-Nakuru (32) cluster	low household size high livestock highest irrigation, grid connectivity	Murang'a	**293**
Cluster 9	Kitui (15)-Narok (33)-Bomet (36)-Migori (44)-Bungoma (39)-Kakamega (37)-Busia (40) cluster	high crop, livestock, solar connectivity, and battery use low grid eCooking and connnectivity	Bungoma	**240**
Cluster 10	Siaya (41)-Homa Bay (43)-Kisumu (42), Nyamira (46) cluster	high fishing, solar connectivity, and battery use	Homa Bay	**217**

Enumerators were selected and trained on the overall objectives of the survey, the structure of the questionnaire, definition of terms, interviewing etiquette, and best practices in asking questions. They were also trained on the survey tool, Survey CTO. Upon the completion of the training, a pilot was conducted in Nairobi. The aim of the pilot was to assess the expected duration of the interview, respondents' comprehension of the questions, logical flow of the questionnaire and structure of each question, appropriateness of the answer options, use of Computer Assisted Personal Interviewing (CAPI) technique, household selection approach among other survey protocol.

1.3.4 Socio-demographic Indicators from the study sample

The demographic characteristics of the baseline survey respondents are analysed below. Understanding respondents' individual and household characteristics as well as cooking practices can help provide valuable insights to inform interventions aimed at increasing the uptake of eCooking in Kenya. Quantitative data analysis was conducted using Stata 17. The analysis of the survey data included basic descriptive statistics such as graphs and tables, and statistics testing mean differences to different variables such as gender, location and market segments. The study also examined household characteristics based on different market segments which can influence the uptake of eCooking such as gender (male/female), urban/rural segments, wealth quintiles categorised as poor/lower middle class/ middle class/ upper middle class/ wealthy households, electricity connectivity, i.e., on-grid electricity (including public minigrids)/ private minigrids/ SHSs/ battery power systems), and fuels used for cooking (firewood/ charcoal/ LPG/ kerosene/ ethanol/ electricity etc).

Table 1.2 below shows some statistics based on the study sample. The table is split into two sections. The initial section outlines the general characteristics of the study sample, while the second section delves into the distribution of specific factors that are presumed to impact households' selection of cooking solutions.

The total number of households interviewed was 2,432, distributed based on the clustering analysis. Due to security concerns, household interviews in clusters 2, 3, and 5 primarily took place in more secure urban and peri-urban areas. This could lead to potential overestimation of socio-demographic indicators for these specific regions.

In all clusters, the majority of respondents were female, except for Cluster 6 (represented by Elgeyo Marakwet) , where male respondents constituted 52.4 percent of the interviewed households. Nevertheless, concerning the gender of the household head, the sample was predominantly composed of male-headed households, underscoring the prevailing patriarchal structure of the society. A typical household in the sample had an average size of 5 members, three adults, one child and one youth. However, as expected there is a lot of heterogeneity based on the clusters with clusters 3 and 5 having the largest household size of 6 members The average age of household heads was 45.7 years. Notably, Cluster 7 (represented by Nairobi) exhibited the lowest mean age for household heads, standing at 37.5 years. It is important to recognize that cluster 7 comprises predominantly urban counties. This observation suggests that younger individuals are primarily concentrated in urban environments, a factor that might influence the selection of cooking solutions. Regarding education, most households in the sample had achieved some degree of formal education. Nevertheless, Cluster 3 (represented by Garissa) (represented by Garissa) displayed the lowest percentage of households with any level of formal education, standing at 44.7 percent. This finding is intriguing, considering that interviews within cluster 3 were concentrated in urban and peri-urban areas. This observation holds importance, as education is a significant factor that strongly influences the selection of cooking solutions *(World Bank, 2021)*. Lastly, the dispersion of monthly household expenditures in the sample was impacted by security considerations. As evident, the three clusters affected by security issues exhibited greater monthly expenditures, as the survey was centred on urban and peri-urban areas within these clusters. Nevertheless, barring this circumstance, it is unsurprising that cluster 7 boasts the highest expenditure, considering its composition primarily consists of urbanized counties.

Table 1.3 Key Statistics

Key Statistics	National	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Baseline Survey sample (selected households)	2,432	240	160	200	220	180	180	420	280	260	200
Number of Households with completed interviews	2,432	242	200	201	241	180	179	439	293	240	217
Average number of Adults	2.9	3.2	3.4	3.7	3.0	4.0	3.2	2.1	2.7	3.3	2.8
Average number of Children between 5-18	1.2	2.0	0.5	1.2	1.4	1.0	1.2	0.8	1.0	1.0	1.5
Average number of children under 5	0.7	0.7	0.7	1.1	0.7	1.1	0.8	0.4	0.7	1.0	0.8
Proportion of male respondents (%)	37.1	39.3%	27.5%	44.2%	34.4%	32.2%	52.4%	39.5%	32.1%	34.3%	30.9%
Proportion of female respondents (%)	62.9	60.7%	72.5%	55.8%	65.6%	67.8%	47.6%	60.5%	67.9%	65.7%	69.1%
Average Household Size (number)	4.7	5.8	4.5	6.0	4.9	6.1	5.2	3.2	4.2	5.2	5.1
Average age of the household head (years)	45.7	46.6	42.1	41.8	49.7	41.5	45.6	37.5	52.9	47.4	46.2
Married/Living with partner household heads (%)	66.0	59.9%	66.5%	71.6%	70.2%	75.0%	81.3%	56.8%	68.3%	69.1%	69.5%
Formal education household heads	89.3%	82.1%	92.5%	44.7%	95.2%	84.4%	94.2%	97.4%	95.5%	88.1%	97.0%
Total Household Expenditure monthly (KES)	13,401	14,967	18,173	25,337	11,029	14,524	11,589	15,335	12,495	7,319	12,885

1.3.5 Market segments

Market segments in this study are delineated along gender, urban-rural segment, wealth quintiles, main electricity system and primary cooking sfuel. Wealth quintiles are considered as an indicator of households' overall economic welfare as they offer greater comprehensiveness compared to income. This is particularly valuable due to non-response issues associated with income questions, where households often perceive income questions as sensitive. The survey thus applied the Demographic and Health Survey wealth index in determining the wealth quintiles. Finally, Market segmentation based on household cooking fuel focusses on the primary fuel used for cooking purposes. In this study, "primary cooking fuel" denotes the main fuel used for cooking meals, as well as for tasks such as reheating and preparing beverages. Therefore, this study adopts a more comprehensive understanding of cooking, covering not only meal preparation but also reheating and preparation of hot beverages. The assessment of eCooking prevalence is grounded in this expanded conception of cooking.

Table 1.4 provides a summary of the descriptive statistics related to the market segments.

Table 1.4 Market segment descriptive statistics

Market segments		National (%)
Gender of the household Head	Female	29.8%
	Male	70.2%
Urban/Rural Segments	Urban	37%
	Rural	63%
Wealth Quintiles	Poor	18.5%
	Lower-middle class	20.3%
	Middle class	19.2%
	Upper-middle class	20%
	Wealthy	22%
Main Electricity type	KPLC	76.5%
	SHSs	13.3%
	Unconnected	7.3%
	Private mini-grid	2.6%
	Rechargeable Battery	0.3%
Prevalence of Cooking Fuels	Firewood	42.3%
	LPG	34.3%
	Charcoal	17.4%
	Electricity	3.9%
	Kerosene	1.1%
	Ethanol	0.8%
	Others	0.3%

The market segments are carefully selected to guide the analysis in the sections that follow. For instance, gender of the households' head is important in analysis of the choice of cooking solution. Commonly, the gender of the household head holds significance as it reflects traditional roles in decision-making. While women primarily use cooking solutions, men wield considerable influence in cookstove purchases (World Bank, 2021). By comparing tables 1.2 and 1.3, it is apparent that the survey mainly engaged female respondents, who are primary users of cooking solutions. However, the households interviewed are led mainly by males. Examining decision-making roles regarding expenditure, household heads predominantly hold authority (44 percent), with joint decisions making up 35 percent. Given that most household heads are male, gender emerges as a notable factor in the transition to eCooking. Similarly, income plays a crucial role in households' transition to eCooking. However, due to the challenges of accurately capturing income through surveys, the study uses wealth quintiles. The wealth quintiles divide households into five (5) distinct categories: poor, lower middle class, middle class, upper middle class, and wealthy. On this basis, a relatively small percentage of interviewed households—18.5%—fall within the poor category, whereas a more substantial proportion belong to the wealthy category, at 22%. The distribution of poor households is most pronounced in Cluster 3 (represented by Garissa) (represented by Garissa), constituting 58.6%, followed by Cluster 2 (represented by Lamu) at 37% and Cluster 7 (represented by Nairobi) at 26.3%. Within the lower middle-income class, the majority, 32%, come from Cluster 3 (represented by Garissa) (represented by Garissa) , while the highly urbanized areas account for 15.53%. Interestingly, although Cluster 5 (represented by Isiolo) boasts the highest number of middle-class households, this outcome should be understood in the context of the survey's focus on urban-peri regions due to security concerns. This is because cluster 5 is classified as a high-poverty region (Kenya National Bureau of Statistics, 2023). Cluster 8 (represented by Murang'a) contains the highest percentage of households classified as wealthy, with 35% while clusters 3, 2, and 1 feature the fewest number of wealthy households, at 0%, 7.5%, and 9%, respectively.

Household electricity connection is based on the following categories: grid-connected households — which are referred to as 'Kenya Power', private mini-grid, Solar Home System (SHS), rechargeable battery and unconnected. The distribution of the main sources of household electricity is dominated by the national grid (Kenya Power), which accounts for 76.5 percent. SHSs accounted for the second largest proportion of households at 13.3 percent. The unconnected households form the third largest portion of households at 7.3 percent. The unconnected households are important to consider, as the selection of households was based on KPLC step-down transformers; thus, unconnected households are within a 600 metres radius of the transformers. Further, since the transformers were randomly selected, the unconnected households replicate the natural ordering of unconnected households. The households dependent on mini-grids are their main source of electricity accounted for 2.6 percent of the households considered in the study. However, the sampling approach of the mini-grid was purposive and aimed at gaining insights into the behaviour of mini-grid households. Households dependent on rechargeable batteries[6] as their main source of electricity were 0.4 percent. The household survey dataset did not have any households whose main source of electricity is a generator. However, generators featured as backups to Kenya Power or mini-grid power.

Households were also segmented based on their primary cooking fuels for cooking meals, reheating, and preparing hot beverages. Using this approach, firewood emerges as the predominant primary cooking fuel in Kenya, used by 42.3 percent of households. Subsequently, LPG is used by 34.3 percent of households, while charcoal is the choice for 17.4 percent of households. Notably, around 3.9 percent of households rely on electricity as their primary cooking fuel. The prevalence of electricity as

[6] A total of 9 household used rechargeable batteries. This would significantly influence results like the 63.8% in the other region

a primary cooking fuel in this study marks a substantial increase compared to prior assessments like the Kenya Household Cooking Sector study of 2019, as well as the 2019 Kenya Population and Housing Census. However, it is crucial to account for the differences in the meaning of "cooking" when making comparisons between these studies. Therefore, this rate serves as a baseline rate due to its pioneering definition of cooking, which encompasses cooking food, reheating food, and preparing hot beverages.

2 HOUSEHOLD ELECTRICITY SYSTEMS

2.1 Introduction

Kenya has made significant progress towards universal electrification. Since 2010, access to electricity has increased by more than 7% annually across the country. The government set a target of 100% electricity access by 2026 (Ministry of Energy, 2022). Kenya's household electrification rate hit 75% in 2021, up from 53% in 2016 and 19.2% in 2010, and progress continues. Kenya has connected approximately 9 million households to electricity as of December 2022, up from 4.89 million in March 2013[7,8]. The steady rise in the electrification rates in the last decade are attributed to integrated approaches outlined in the Kenya National Electrification Strategy. They include main grid intensification, investment in mini-grids and off-grid SHSs. The Last Mile Connectivity Project launched in 2014 to connect an additional 47% of the population to the national grid, mostly composed of low-income and rural populations, has also been key to these developments. The African Development Bank, the World Bank and the European Union have supported the project with a loan of $135 million (African Development Bank, 2023a). The Kenya Power and Lighting Company is using its over 45,000 distribution transformers across the country to ensure that anyone within 600 meters can gain access to electricity, and that public schools, health centres and other institutions are connected to the grid. In 2020, the African Development Bank extended a second loan to connect at least 285,000 additional individuals and 15,000 businesses via low-voltage lines and transformers (African Development Bank, 2023b). Independent impact evaluation of phase 1 of the project revealed low electricity consumption among newly connected low-income households and limited benefits for women and girls. Households may not have transitioned from traditional biomass fuels to eCooking, likely due to the high upfront cost of acquiring eCooking appliances and high tariffs, among other socio-cultural factors. Electricity demand could be stimulated by, among other things, lowering appliance costs and tariffs to benefit both households and the utility's revenues[9].

At the same time, Kenya continues to invest in renewable energy, particularly wind and solar, to ensure the country's energy self-sufficiency. Kenya's installed interconnected power generation capacity by mid-2022 was 3,321 MW, but only 3,074.34 is considered 'effective' capacity (see Table 2.1 below). The bulk of electricity is generated from renewable sources. Effective capacity, compared to maximum peak demand of 2,149 MW (energy used), implies a surplus capacity of 925 MW, or 30%. However, surplus capacity should be interpreted carefully as some power sources such as solar and wind are intermittent. Peak demand is also understated due to frequent power outages. Additionally, Kenya's unserved demand, i.e., pending paid-up connection applications previously estimated at between 300-400MW (2021 Taskforce report), suppressed demand due to outages and transmission network constraints, and system losses moderate the calculation of peak demand for power.

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[7] Energy and Petroleum Regulatory Authority. (2023). *Biannual Energy and Petroleum Statistics Report for the Financial Year 2022/2023*. Retrieved from https://www.epra.go.ke/biannual-energy-and-petroleum-statistics-report-for-the-financial-year-2022-2023/

[8] World Bank. (n.d.). Access to electricity (% of population)—Kenya. Retrieved November 5, 2022, from World Bank Open Data website: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=KE

[9] IDEV (2022). Impact Evaluation of the AfDB-supported Kenya Last Mile Connectivity Project, Phase I. Retrieved from https://idev.afdb.org/sites/default/files/documents/files/IE%20of%20the%20AfDB-supported%20Kenya%20Last%20Mile%20Connectivity%20Project%20Phase%20I%20-%20Report.pdf

Therefore, the actual available capacity in Kenya might be slightly less than what is reported, implying that the excess capacity is similarly lower[10].

Table 2.1 Installed, Effective and Captive Power Capacity as at 31st December 2022. Source: EPRA (2023)

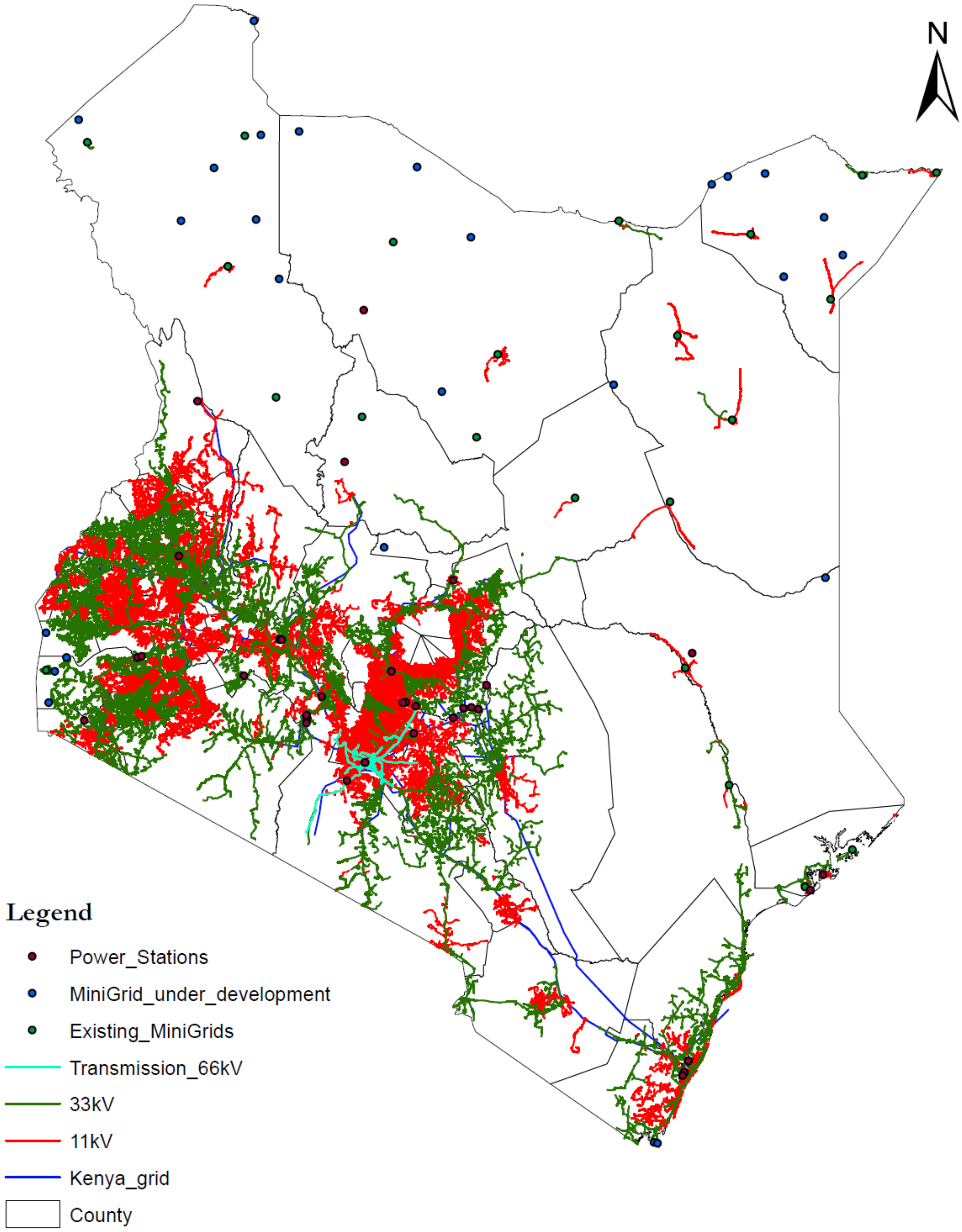
Technology	Interconnected Capacity (MW)		Captive Capacity (MW)	Total Installed Capacity	% Total Installed
	Installed	Effective			
Hydro	838.5	809.6	29.04	867.54	25.50%
Geothermal	950	871.1	3.7	953.7	28.04%
Thermal	681.9	645.4	21.33	703.23	20.67%
Wind	436.1	425.5	-	436.1	12.82%
Solar	212.6	212.2	53.71	266.31	7.83%
Bioenergy	2	2	89.48	91.48	2.69%
Imports	200	75	-	200	-
Waste Heat Recovery	-	-	83.5	83.5	2.45%
Total	**3,321**	**3,041**	**280.76**	**3,601.76**	**100.00%**

The dynamics of power planning in Kenya have implications for demand stimulation and any demand forecasts for e-cooking. Power planning in Kenya, largely focused on generation capacity, is guided by a 20-year LCPDP that is revised every two years. The LCPDP process has the objective of guiding "generation capacity development and provide the required signals to investors to participate in the power supply value chain in the country" (LCPDP 2021-2030, pg1). The current plan, which modestly forecasts Kenya's energy demand growth between 5.28% and 5.38% annually, projects that installed generation capacity will increase to 3,529 MW in 2025, 5,152 MW in 2030, and 8,8770 MW in 2041 (LCPDP 2020-2040) (Government of Kenya, 2020b). The potential demand for electricity for cooking was recently incorporated in these plans, however, some stakeholders believe that these forecasts are conservative.

Household electrification in Kenya can be categorized into Grid Electricity, Mini-grid Electricity, and Off-grid Electricity. In this study, this study, public mini-grids are treated as part of the national grid; and thus, reference to mini-grid means private mini-grids[5]. In addition, the focus of the study is on capturing the household experience as users of electricity, thus both the national grid and public mini-grids are consolidated for analysis. Figure 2.1 below illustrates the current state of development of Kenya's power infrastructure. The Off-grid Electricity options considered in the study are Solar Home Systems (SHSs), Generators, and Rechargeable Batteries. Further, as outlined in the methodology section, eCooking in Kenya assumes the form of a rare event. Thus, the household selection process was based on the Kenya Power and Lighting Company (KPLC) step-down transformers. This approach ensured that the study obtained a statistically significant number of households for eCooking analysis. In addition, this study focused on the main systems of household electricity.

[10] Pieterse, D. (2021). Power Africa in Kenya: Why Power Planning in Kenya Should Lead Economic Development—Not Follow It. Retrieved November 10, 2022, from RTI International website: https://www.rti.org/insights/power-africa-in-kenya

Figure 2.1 Kenya power sector infrastructure: electricity transmission and distribution network and minigrids. Source: Author's own representation



2.2 Household Access to Electricity: Main and Backup systems

In order to assess the current status and potential for households in Kenya to cook with electricity, we must first determine their main source of electricity, and how households are distributed across the existing electricity systems. Households in Kenya can cook with electricity in three ways, as illustrated in Figure 2.2. These include Grid-supported eCooking (both national and mini grid), Solar-supported eCooking, and Battery-supported eCooking. A household facing grid or mini-grid electricity supply challenges such as unscheduled blackouts may augment their electricity with a battery.

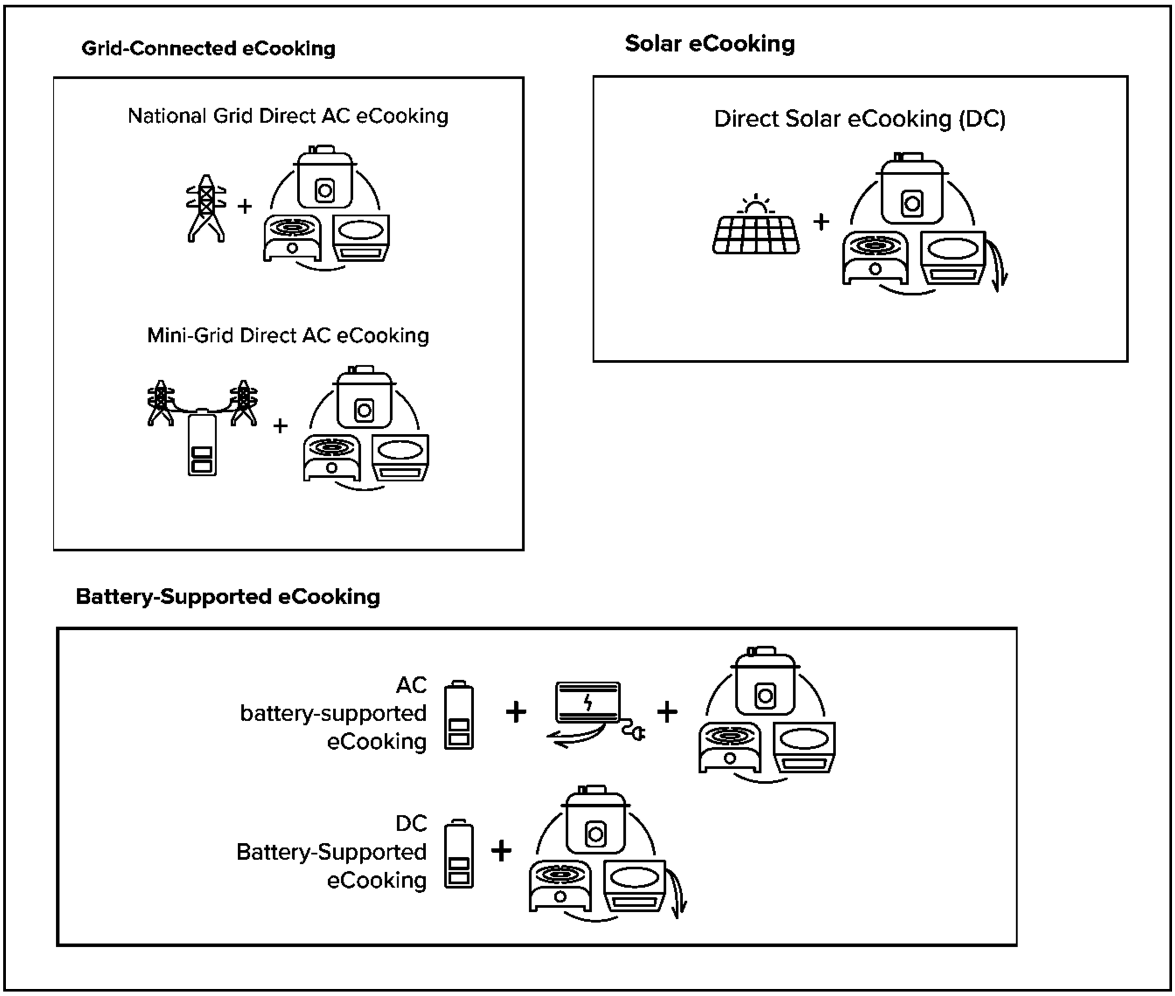


Figure 2.2: Typologies of eCooking in Kenya. Adapted from ESMAP (2020)

The distribution of household electricity is predominantly dominated by the Grid, as indicated by the weighted distribution of households' primary sources of electricity. Specifically, the distribution of the main sources of household electricity is dominated by the national grid (Kenya Power), which accounts for 76.5 percent as shown in Figure 2.2 below. SHSs accounted for the second largest proportion of households at 13.3 percent. The unconnected households form the third largest portion of households at 7.3 percent. The unconnected households are of significance, as the selection of households was based on Kenya Power Step-down transformers and as such, the unconnected households are within the 600 metres radius of the transformers. Further, since the transformers were randomly selected, the unconnected households replicate natural ordering of unconnected households. The households dependent on mini-grids as their main electricity system accounted for 2.6 percent of the households considered in this study. However, the sampling approach of the mini-grid was purposive and aimed at gaining insights into the behaviour of mini-grid-connected households.

As shown in Figure 2.3, there is variation within the urban and rural areas. For instance, households in urban areas almost entirely rely on grid-electricity as their main electricity system at 93.7 percent, while the proportion is about 66.3 percent in rural areas. Rural areas had more households relying on private mini-grid (4.1 percent), solar users (18.6 percent), unconnected households at 10.6 percent and rechargeable battery users at 0.3 percent. Private mini-grids and solar systems serve as alternatives to main grid connectivity in rural areas. It is however equally important to note that several major towns especially in the northern part of Kenya are served by diesel power stations owned by Kenya Power which are categorised under the main grid in this study.[11] The dominance of solar electricity systems in rural areas alludes to grid connectivity challenges in rural areas as opposed to household preference patterns. The concentration of unconnected households in the rural area supports this assertion.

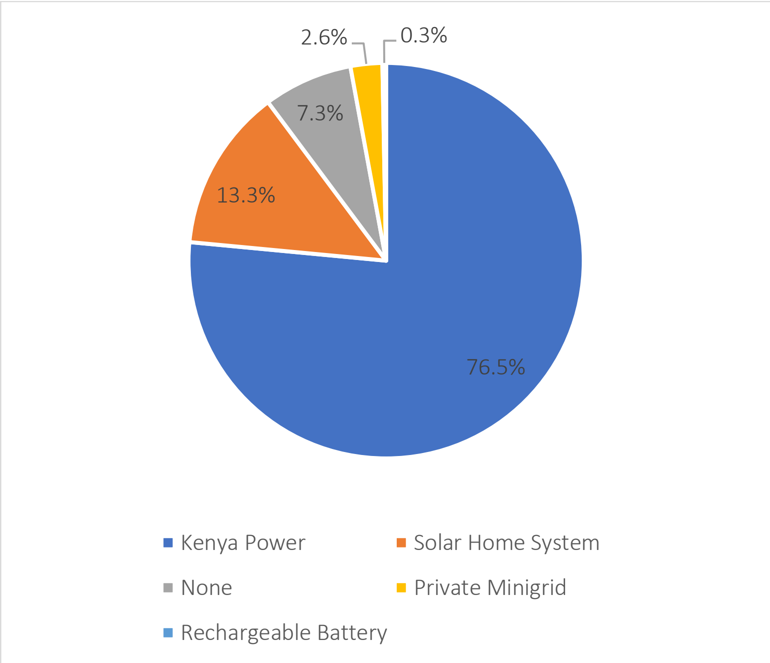


Figure 2.2: Main Sources of Household Electricity

[11] Hybrid Power System Options for Off-Grid Rural Electrification in Northern Kenya: https://www.researchgate.net/publication/276495679_Hybrid_Power_System_Options_for_Off-Grid_Rural_Electrification_in_Northern_Kenya

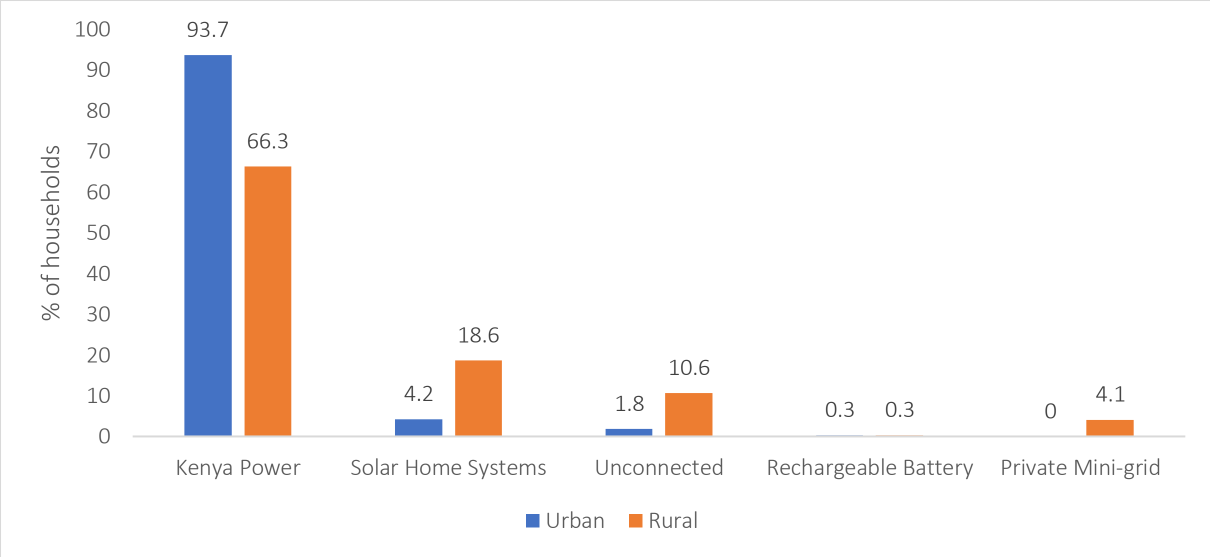


Figure 2.3 : Urban-Rural Segments and Main Source of Electricity

Household connectivity by wealth level shows minimal variations as shown in Figure 2.4. For example, the connectivity to the national grid among poor households is 75.5 percent which compares favourably to lower-middle (75.2 percent), middle class (70.5 percent), upper-middle (75.8 percent) and wealthy (84.3 percent). In fact, connectivity in the lowest income segment is higher than that of the lower-middle income households by 0.3 percent, which may be a consequence of the Last Mile Connectivity Project that targeted low-income and rural population (IDEV, 2022).

Households' main system of electricity exhibited gender disparities in the study. However, this is not unique to this study as other studies such as Rathi and Vermaak (2018) report similar results. Notably, within urban areas, there is a 1.5 percent higher connection rate to the national grid among female headed households. This trend is mirrored in rural settings, where the connectivity to the grid is 1.1 percent higher for female-headed households. This could likely be attributed to the impact of initiatives like the last mile connectivity project, which specifically aimed to extend services to low-income and rural communities. Likewise, within urban areas, a greater proportion of female-headed households are served by solar electricity systems in comparison to their male-headed counterparts. Conversely, in rural regions, a slightly higher percentage of male-headed households (18.9 percent) have access to solar electricity, relative to female-headed households at 18.1 percent. Similarly, a higher proportion of male-headed households in rural areas are connected to mini-grids, which are predominantly available in rural contexts. While urban areas show a higher percentage of male-headed households without electricity access, in rural areas, the situation is reversed – a 1.9 percent greater share of female-headed households lack electricity connections.

The gender and household electricity pattern suggest a complex interplay of gender dynamics. While initiatives such as last mile connectivity may be associated with positive outcomes for female-headed households, disparities still exist in both urban and rural areas. The gender dynamics exhibit broader socio-economic and empowerment consideration. For instance, more female-headed households in urban areas being served by solar electricity systems relative to male-headed households may be suggestive of women empowerment which in turn result in more female headed households affording the solar home systems. On the hand, the higher prevalence of male-headed households connected to mini-grids in rural areas may imply that male-headed households might have more influence or involvement in the adoption of mini-grid solutions. Further, the high percentage of unconnected female-headed households in rural areas is suggestive of challenges in ensuring electricity access for rural women. There is, therefore, the need to ensure inclusivity that does not necessarily involve gender trade-off in electricity access.

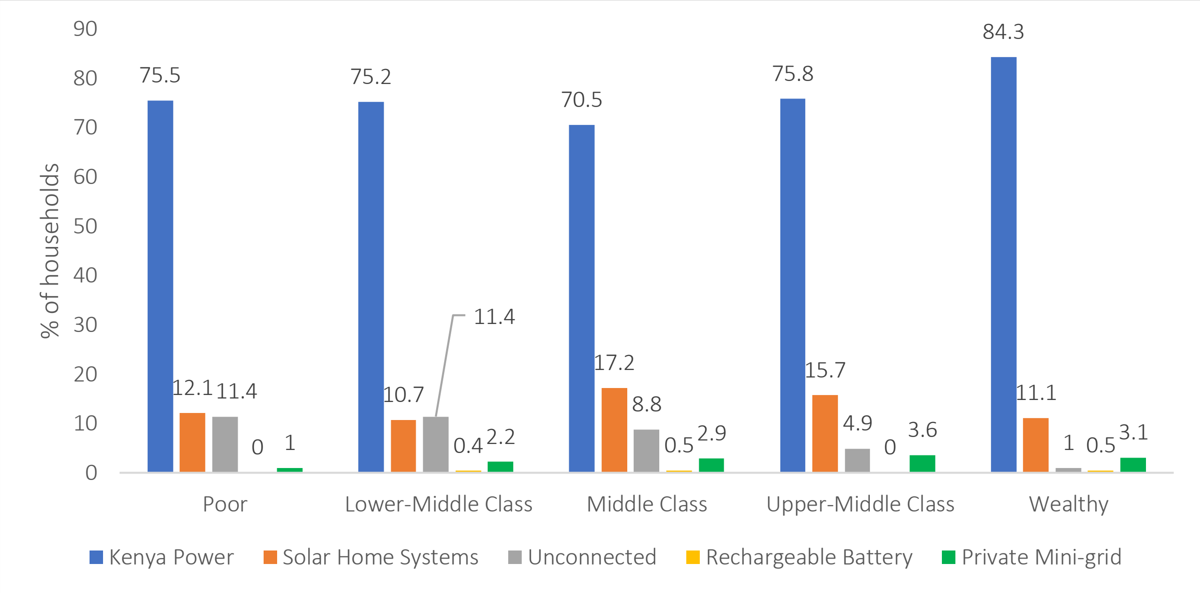


Figure 2.4: Main Source of Electricity and Wealth

Assessment of household backup electricity systems reveals a prevalent absence of backup electricity solutions for most households. For example, among households using solar home systems, 66.6 percent lack backup, while 63.6 percent of those dependent on the grid and 52.4 percent of mini-grid households lack backup systems. Among households with backup solutions, solar lighting systems emerge as the primary choice at 19.6 percent, as depicted in Figure 2.5. This underscores the prominence of lighting as the primary electricity service used by households. The significance of lighting and the absence of backup options could play a crucial role in shaping interventions targeted at stimulating electricity demand. For instance, shifting households' primary electricity service focus from lighting to cooking, which holds greater importance, could yield a positive effect on electricity demand.

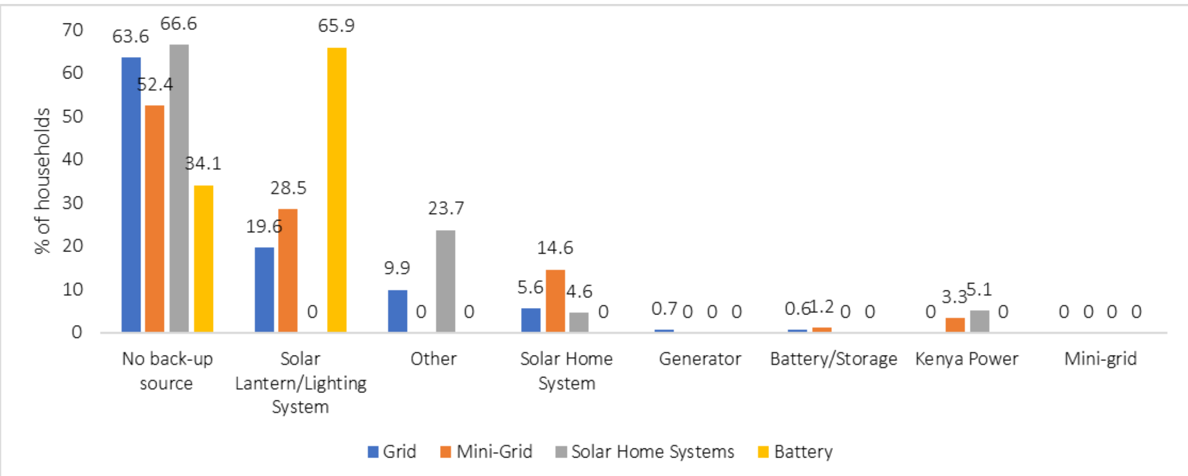


Figure 2.5 : Backup Sources of Electricity

While the absence of backup electricity systems is intriguing, households may lack backups due to factors such as their perceived reliability of the existing electricity system, the high cost of backup solutions, or limited awareness about available solutions. The following section provides a comprehensive evaluation of household electricity systems based on the perspective of households as users of electricity.

2.3 Profiling Household Access to Electricity: A Multi-Tier Approach

Access statistics for households often combine grid-connected and mini-grid connected figures when measuring electricity connectivity. However, considering the heterogeneity in grid and mini-grid connectivity, this method may not be suitable for assessing eCooking access. Further, access alone does not guarantee that eCooking is supported. As a remedy, this study adopts the Multi-Tier Framework (MTF), as developed in Bhatia and Angelou (2015) and World Bank and World Health Organization (2021), to profile and assess the suitability of households' connectivity for eCooking.

The MTF profiles access to energy based on seven attributes that affect user experience, as illustrated in Figure 2.6. These attributes are:

- Capacity, which captures the ability of the electricity system to support different appliances;
- Availability which refers to the amount of time during which electricity is available;
- Reliability which measures the frequency and duration of unscheduled outages;
- Quality defined as the requisite voltage for powering electric appliances and voltage stability, as fluctuations may damage appliances;
- Affordability which captures households' ability to pay for electricity;
- Formality which determines whether households are legally connected;
- Health and Safety which captures risks to user health and safety, such as electrocution or fire.

	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Capacity	No electricity	1-50W	50-500W	500-2000W	>2000W	
Duration	<4hrs	4-8hrs		8-16hrs	16-22hrs	>22hrs
Reliability	Unscheduled outages				No unscheduled outages	
Quality	Low quality			Good quality		
Affordability	Not affordable		Affordable			
Legality	Not legal			Legal		
Health & Safety	Not convenient				Convenient	

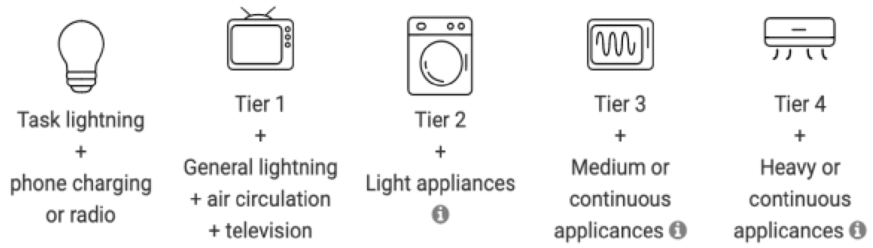


Figure 2.6. MTF Classification of energy access and their attributes. Source: Village Infrastructures Angels

The Multi-Tier Framework yields 6 tiers, with tier 0 representing no access and tier 5 full service. The threshold for eCooking is set at tier 3, i.e., only households with electricity connection of Tier 3+ have the potential for eCooking.

The application of the MTF in our assessment accounts for the unique context of Kenya. Household electricity is categorized into Grid Electricity and Off-grid Electricity. Grid Electricity encompasses the national grid and mini-grids. Further, public mini-grids are treated as part of the national grid; as such, reference to mini-grid in this study relates to private mini-grids[12]. The Off-grid electricity options considered in the survey are Solar Home Systems (SHSs), Generators, and Rechargeable Batteries. The resultant MTF classification is illustrated below in Table 2.1.

Table 2.1 The MTF classification used to categorise households in this study

Attributes	*Classification*
Capacity	The capacity of household electricity supply is assessed based on the ability to power electric appliances. This study assumes that grid electricity and mini-grid electricity can power all electric appliances in line with World Bank and World Health Organization (2021) MTF framework guideline. Consequently, all households on grid and mini-grid electricity are assigned Capacity Tier 5.
Availability/Duration	Availability or duration of grid electricity is assessed based on the amount of time/duration that electricity is available to households. However, households' demand for electricity is not uniform throughout the day. As the survey findings will show, supper is the meal that is prepared by most households. Given the tendency to prepare supper in the evening, the demand for electricity for eCooking will likely peak in the evening. As a result, the MTF divides availability Tiers into the availability of electricity in a 24-hour period and availability in the 4-hour evening (6-10 pm), deemed the period for peak demand. In line with the MTF guidelines, this study measures the availability of electricity as follows: Availability/Duration in 24-Hour Period: $Tier\ 1: hrs < 4$ $Tier\ 2: 4 \leq hrs < 8$ $Tier\ 3: 8 \leq hrs < 16$ $Tier\ 4: 16 \leq hrs < 23$ $Tier\ 5: hours > 23$ Availability/Duration in 4-Hour Period in the evening: $Tier\ 0: hrs < 1$ $Tier\ 1: 1 \leq hrs < 2$ $Tier\ 2: 2 \leq hrs < 3$ $Tier\ 3: 3 \leq hrs < 4$ $Tier\ 5: hours > 4$
Reliability	The reliability of household grid electricity captures the frequency and duration of unscheduled outages. Reliability assesses the extent and need for a backup source of electricity. In the original MTF formulation, a household is assigned the reliability tier as follows:

[12] This classification is based on the feedback from the technical working group which advised that it would be difficult for a household to distinguish electricity supply from public mini-grids and the national grid.

	i. Tier 3 if in the last 7 days the household experienced more than 14 unscheduled outages or blackouts. ii. Tier 4 if in the last 7 days the household experienced fewer or 14 unscheduled outages or blackouts. iii. Tier 5 if in the last 7 days the household experienced fewer or 3 unscheduled outages or blackouts, and the duration of unscheduled outages or blackouts were less than 2 hours. The MTF guidelines from the World Bank and World Health Organization (2021) overlook certain households, particularly those experiencing 3 or fewer unscheduled outages lasting 2 hours or more. Given this omission in the guidelines, our study reallocates these unclassified households to Tier 4.
Quality	In this study, the quality of household electricity is assessed based on voltage stability. Instability in voltage causes damage to electric appliances and slows down the cooking process. The tiers of quality of electricity are assigned based on previous incidences of voltage fluctuation that damaged household electric appliances. Quality tiers are binary depending on whether a fluctuation in voltage caused damage to electric appliances or not. A household is assigned Tier 3 if there was an incident of damage to an electric appliance due to fluctuation in voltage in the previous 12-month period. Otherwise, a household is assigned tier 5 if there was no incident of damage to an electric appliance. The resulting estimates can be considered conservative given that some households own devices such as fridge guards that protect against voltage instability.
Affordability	Households' ability to pay for electricity in this study is assessed based on electricity bill payments. The definition of affordability excludes connection costs, assuming that they have already been paid, and that the only cost relevant to eCooking is the regular bill payment. Specifically, this study determines the affordability of household electricity based on a threshold expenditure of electricity of 5 percent of the household's total monthly expenditure. Contrary to the MTF guideline, which designates households spending less than 5 percent of their household expenditure on electricity to Tier 2, and those spending over 5 percent to Tier 5, this study reverses the order. Electricity is deemed affordable if a household spends less than 5 percent of its monthly expenditure on electricity.
Formality	The informality of household electricity refers to using electricity service without paying, or paying a person with no verifiable link to the utility company. These include households that make informal electricity bill payments to a relative or a neighbour. However, electricity bill payment included in a household's rent is considered formal. A household is assigned to Tier 3 if the electricity connection is informal and Tier 5 if the connection is formal.
Health and Safety	The health and safety aspects of household electricity are assessed based on the occurrence of fire, electrocution, injury, bodily harm, or death of a household member related to electricity. A household is assigned Tier 0 if there was a health and safety incident in the past 12-month period and Tier 5 if there was no incident. Considering that survey responses rely on households' past experiences, this study places households in Tier 3 if they reported any health or safety incidents in the past. If no incidents were reported, households are assigned to Tier 5 (refer to the guideline provided by the World Bank and World Health Organization, 2021).

The MTF guideline assigns households an overall tier classification based on the lowest tier across all seven attributes. Households classified as Tier 3+ are recognized as having access to electricity capable of supporting eCooking[13].

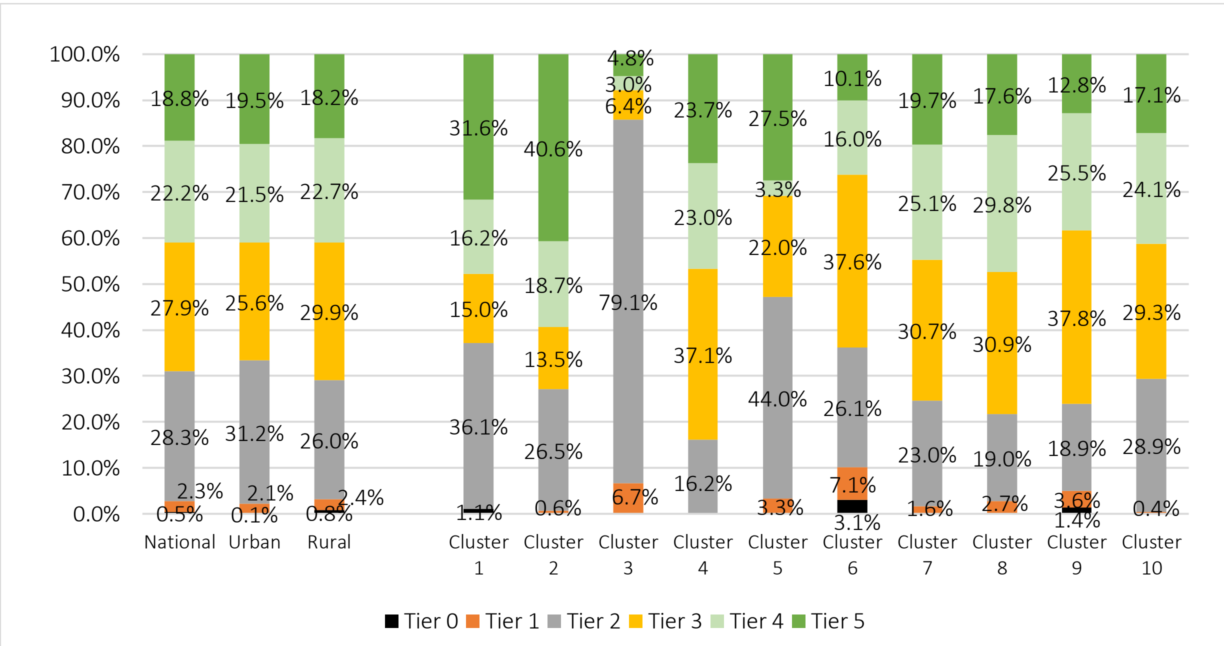
2.3.1 Household Access to Grid Electricity

As illustrated in Table 2.2, on a national scale, 68.9 percent of households have access to electricity that can support eCooking. Rural households exhibit a higher prevalence of electricity access suitable for eCooking (70.9 percent) compared to their urban counterparts (66.6 percent).

Table 2.2. Household access tiers on the grid and eCooking capacity

Household access (%)		**Tier 0**	**Tier 1**	**Tier 2**	**Tier 3**	**Tier 4**	**Tier 5**	**eCooking Capacity**
The grid	*National*	0.5	2.3	28.3	27.9	22.2	18.8	**68.9**
	Urban	0.1	2.1	31.2	25.6	21.5	19.5	**66.6**
	Rural	0.8	2.4	26.0	29.9	22.7	18.2	**70.9**

However, a more detailed analysis at the cluster level reveals that households in Cluster 3 (represented by Garissa) encounter significant challenges in accessing electricity appropriate for eCooking. Specifically, a mere 14.2 percent of households in this cluster have the requisite electricity to support eCooking. The majority of these households fall within Tier 2 electricity access, indicating that the electricity they have access can solely accommodate lighting and the operation of devices such as televisions, computers, printers, and fans, as outlined in the World Bank and World Health Organization (2021) guideline. Although not as stark as in Cluster 1 (represented by Kilifi), the proportions of households in clusters 5 (Isiolo) (52.7 percent), and Cluster 6 (represented by Elgeyo Marakwet) (63.8 percent) with access to Tier 3+ electricity are all below the national average.



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[13] For a range of electric appliances that can be powered by Tier 3 and the rationale behind Tier 3 electricity access as the minimum requirement for eCooking, refer to the World Bank and World Health Organization (2021) guideline.

Figure 2.3 Distribution of household access tiers on the grid

In-depth analysis of Cluster 1 (represented by Kilifi) shows that cost is a major constraint in the capacity of household electricity to support eCooking. As shown below, 84 percent of households report electricity expenditure above the monthly threshold cost of 30 kWh. Since MTF assigns the overall tier based on the lowest tier, this implies that all these households are assigned tier 2. While the MTF may seem overly punitive, it is important to note that affordability is a critical determinant of eCooking. A similar analysis shows that in clusters 1 (Kilifi), 5 (Isiolo), and 6 (Elgeyo Marakwet), which have overall tier scores below the national average, cost is the main factor undermining overall scores.

A comprehensive examination of cluster 1 reveals that the cost factor is the primary hurdle impeding household electricity's capacity to support eCooking. As depicted below, a significant 84 percent of households report costs exceeding the threshold cost of 30 kWh per month for electricity. The implication is that all these households are assigned an overall tier score of 2 per the MTF guideline. While this approach might appear stringent, it is crucial to acknowledge that affordability plays a pivotal role in determining the feasibility of eCooking. Thus, in some respects, this highlights the significance of ensuring affordability. A parallel analysis conducted for clusters 1, 5, and 6—each exhibiting overall tier scores lower than the national average—indicates that cost remains the predominant factor undermining their overall scores.

In summary, excluding Cluster 3 (represented by Garissa) (represented by Garissa) , most households possess electricity access capable of supporting eCooking, regardless of whether in urban or rural settings. Consequently, the limited prevalence of eCooking is primarily attributed to factors beyond electricity access. The outcomes underscore the potential influence of cost-related aspects, exemplified by cluster 3. Moreover, the significant challenges households face in this cluster, with just 14.2 percent having access to electricity suitable for eCooking, highlight the need for focused interventions. It is imperative to implement policies that tackle the affordability of electricity. Such strategies could encompass implementing tariff structures that consider household income, introducing flexible payment alternatives, and promoting energy-efficient eCooking appliances to curtail electricity consumption and costs.

While cost is frequently mentioned as a significant obstacle to adopting eCooking, this study reveals that costs act as a restricting factor for most households in clusters 1, 3, 5, and 6. In contrast, assuming other factors remain constant, most households have access to electricity to support eCooking. This suggests that educational and awareness initiatives can yield substantial progress in altering households' perceptions of their electricity services. Furthermore, promoting energy-efficient eCooking appliances can contribute to alleviating cost-related concerns, whether perceived or actual.

While a notable portion of households currently have access to Tier 3+ electricity (68.9 percent), it is still essential that the government continues to enhance electricity services for all households. Equally important is addressing the over 30 percent of households with below Tier 3, particularly considering that the transition to eCooking presents a promising avenue toward achieving a net-zero emissions scenario. Potential interventions could involve upgrading transmission and distribution infrastructure, as well as affordable energy storage solutions for households. This becomes particularly significant as this study demonstrates that majority of households lack backup systems. This means that households will have high expectations of reliability when transitioning to eCooking. The lack of backup electricity systems implies that households are susceptible to loss aversion, wherein even a minor disruption in any aspect of their electricity provision would lead to disproportionate negative psychological impacts that could roll back gains from the transition.

Finally, while the MTF highlights the importance of cost, household access to electricity is a complex issue that demands a multi-faceted strategy. Such an approach should encompass policy interventions, infrastructure enhancement, behaviour change initiatives, and other complementary measures.

2.3.2 Household Access to Mini-grid Electricity

The Multi-Tier Framework (MTF) approach is employed to evaluate the capacity for eCooking within mini-grid systems. The table presents the MTF assessment of mini-grids within the two clusters examined in this study.

Table 2.3 Household access tiers in Mini grids and their eCooking capacity

Household access		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	eCooking Capacity
Mini grids	*Rural*	1.7%	8.4%	21.6%	15.0%	11.0%	42.4%	68.4%
Cluster 8	*Rural*	2.8%	14.1%	34.5%	21.1%	10.3%	17.3%	48.6%
Cluster 10	*Rural*	0.0%	0.0%	3.0%	6.1%	12.1%	78.8%	97.0%

The prevalence of households in tier 2 within Cluster 8 (represented by Murang'a) can be attributed to the availability of electricity, which is relatively worse for a larger portion of households considering the 24-hour period. Specifically, approximately 33.9 percent of households in cluster 8, fall within Tier 2 and lower when considering a 24-hour period. This indicates that these households have electricity for less than 8 hours in a 24-hour period. Similarly, 22.1 percent of households are categorized as Tier 2 and lower during the 4-hour evening period, signifying that they have access to electricity for less than 3 hours within this timeframe. In contrast, only about 3 percent of households in cluster 10 have electricity access below Tier 3. This indicates that mini-grids in cluster 10 show distinct patterns and should be assessed individually. It is notable that the mini-grids are exclusively situated in rural areas, aligning with the common notion that mini-grids are primarily deployed in regions that lack access to the national grid.

Varying distribution of electricity access tiers in two clusters highlights the nuanced nature of mini-grid performance. The clusters' disparities in electricity access underscore the importance of tailored analyses for each mini-grid case. Moreover, the mini-grids' exclusive presence in rural areas aligns with the typical focus of mini-grids on extending electricity access to regions not covered by the national grid. A comparison between grid and mini-grid electricity systems is inconclusive. For instance, within cluster 8, approximately 78.3 percent of households have access to Tier 3 grid electricity, while only about 48.6 percent of mini-grid households have the same access level. This indicates a significant capacity for eCooking with grid electricity in cluster 8. On the contrary, in cluster 10, around 70.6 percent of grid-connected households have Tier 3+ electricity access, which is lower than the impressive 97 percent among mini-grid households. This suggests that mini-grids have a larger capacity for eCooking in this context. As a result, the comparison lacks a definitive conclusion, highlighting the need for a case-by-case assessment to determine the feasibility of mini-grids in supporting eCooking.

Analysing the cost aspect in cluster 8 shows that all mini-grid households have expenditures below the affordability threshold of 30 kWh for electricity, compared to 89.8 percent of grid-connected households. In cluster 10, approximately 97 percent of households are within the affordability limit of 30 kWh, whereas this is true for 81.9 percent of grid-connected households. This observation suggests that a larger proportion of households with mini-grid connectivity enjoy electricity affordability in comparison to those connected to the grid.

In summary, the inconclusive nature of the comparison between grid and mini-grid systems emphasizes the necessity of adopting customized approaches that are specific to clusters to facilitate the transition to eCooking. This underscores the importance of thoroughly assessing the unique characteristics and prerequisites of each cluster. It is important to engage in cluster-specific evaluations to determine the most suitable electricity system for supporting eCooking. This implies that a one-size-fits-all strategy is inadequate when it comes to implementing electricity systems for eCooking in clusters containing both grid and mini-grid systems. Instead, solutions should be tailored to the unique attributes and demands of each cluster. Consequently, both grid and mini-grid systems have potential that should be approached on a case-by-case basis. For instance, when grid connectivity demonstrates a substantial capacity for eCooking (as witnessed in Cluster 8 (represented by Murang'a)), it becomes a readily accessible option. Conversely, in scenarios such as cluster 10, where mini-grids showcase a greater eCooking capacity, households connected to mini-grids offer a more attainable opportunity. Further, the observation that mini-grids are primarily situated in rural areas implies that the success of mini-grid systems is closely tied to the influence of local communities. Therefore, understanding these communities' preferences, needs, and concerns becomes pivotal for facilitating a successful transition to eCooking.

2.3.3 Household Access to Off-grid Electricity

In this study, Off-grid Electricity options include SHSs, Generators, and Rechargeable Batteries. It is important to highlight that this section concentrates on solar home systems as the predominant solution for off-grid electricity. This emphasis is due to the limited sample size of rechargeable batteries, which is insufficient for robust statistical. However, if applying the appliances approach from the 2021 MTF guideline by the World Bank and World Health Organization to evaluate the capacity of rechargeable batteries shows that 70 percent of households fall under Tier 1. This implies that they use rechargeable batteries primarily for lighting and charging mobile phones. Meanwhile, the remaining 30 percent fall into Tier 2, meaning they can power additional devices alongside lighting, such as televisions, computers, printers, and electric fans. In addition, no household identified generators as their primary electricity system, though the generator featured as a backup electricity system. There were no significant variations in Tier classifications across clusters.

Solar home systems are the dominant primary off-grid electricity systems. Notably, 4.3% of households using a SHS as their primary electricity system have grid electricity as a backup. Yet, to transition to eCooking, households need SHSs capable of supporting eCooking requirements.

This study employed two measures to assess the capacity of SHSs. The first measure assessed the capacity based on the household's response to the question on electric appliances that are powered by their SHS. The second measure computed the capacity based on the formula provided in Bhatia and Angelou (2015). Based on this formula, the capacity of SHS is estimated as follows:

$$E = 1000 \times A_{pv} \times G_{std} \times n_{pv} \times n_{sys}$$

Where:

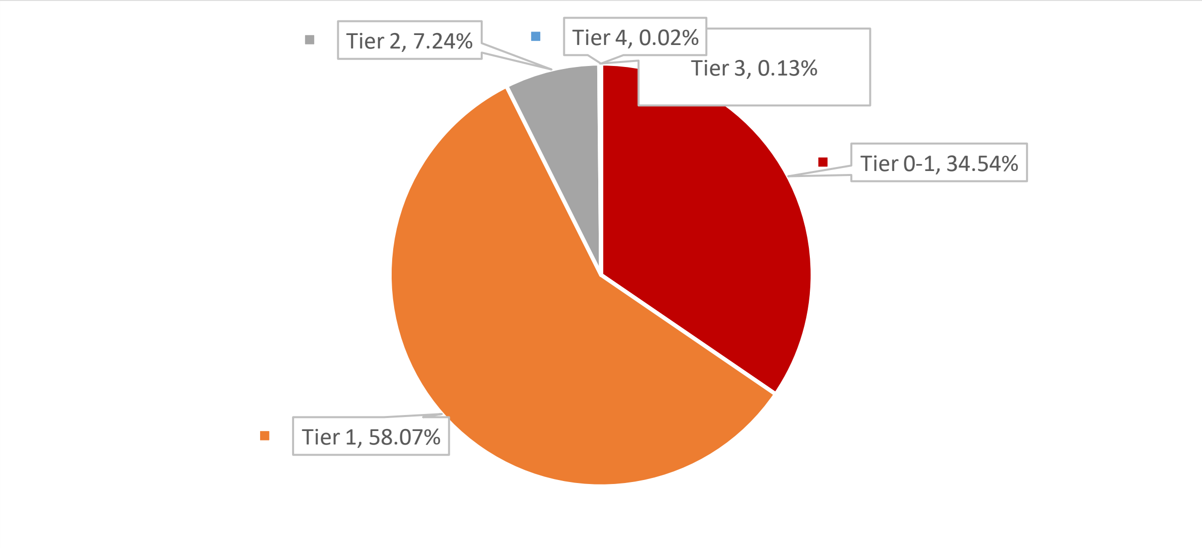
E is the typical daily energy available (Wh)

A_{pv} is the area of solar panel (m^2)

G_{std} is the solar resource (kWh/m^2/day) [assume 5 if no better local estimates].
n_{pv} is the solar panel efficiency (fraction) [assume 8%]
n_{sys} is other system level efficiency (fraction) [assume 60%]
The assumption on solar resource, panel efficiency, and other system level efficiencies are based on laboratory tests on typical solar panels (see Bhatia and Angelou (2015) for a comprehensive discussion on this approach).

The results of the two approaches were similar except for one household, which the first approach classified in Tier 5 while the second one classified the household in Tier 4. However, this study favoured the second approach as it is scientifically grounded. Further, the second approach measures capacity in units that are more informative to policy. Based on this approach, the MTF capacity tiers for SHSs are presented below.

Figure 2.11 Capacity of Solar Home Systems



The concentration of SHS capacity lies within Tier 2 and below. Notably, a significant proportion of households (34.54 percent) own pico-solar and other small-scale devices, which enhance lighting but might not meet Tier 1 standards. Such households are classified using fractional measurement, indicating their access falls between Tier 0 and Tier 1 (for details, refer to Bhatia and Angelou (2015) review of fractional measurement of access tiers). Consequently, these SHSs are primarily utilized for lighting and powering lightweight electric devices like mobile phone chargers and televisions.
However, considering the MTF guideline, eCooking becomes feasible only from Tier 3+. Based on the current assessment, a mere 0.15 percent of the SHSs market segment can support eCooking. Therefore, interventions should prioritize transitioning households to Tier 3+ SHSs. This would enable a larger share of households to access electricity suitable for eCooking appliances.

The distribution of Tier 3+ SHSs depicted in Figure 2.4 demonstrates a relatively consistent ownership pattern across the gender of the household head, urban-rural segments, and wealth quintiles. Notably, the typical household solar solution comprises either a pico-solar device that can power small LED lights, charge mobile phones, and sometimes run small radios or other low-power devices.

Table 2.4 Household access tiers in SHSs and their eCooking capacity

		Tier 0-1	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	eCooking Capacity (Tier 3-5)
Gender	*Male-Headed*	30.4%	61.2%	8.2%	0.2%	0.0%	0.0%	0.2%
	Female-Headed	45.3%	50.0%	4.7%	0.1%	0.0%	0.0%	0.1%
Region	*Urban Households*	41.2%	46.0%	12.9%	0.0%	0.0%	0.0%	0.0%
	Rural Households	33.7%	59.7%	6.5%	0.2%	0.0%	0.0%	0.2%
Wealth	*Poor*	49.4%	44.7%	5.9%	0.0%	0.0%	0.0%	0.0%
	Lower Middle Income	40.8%	58.7%	0.6%	0.0%	0.0%	0.0%	0.0%
	Middle Income	28.4%	64.7%	6.8%	0.1%	0.0%	0.0%	0.1%
	Upper Middle	26.3%	64.0%	9.6%	0.1%	0.0%	0.0%	0.1%
	Wealthy	34.0%	53.6%	11.8%	0.5%	0.1%	0.0%	0.6%

The assessment of eCooking capacity within the off-grid solar market segment showcases a minor wealth-related impact concerning the ownership of Tier 3+ SHSs as shown in Table 2.4. These higher-capacity systems are predominantly owned by households in the wealthier income brackets. Furthermore, households headed by males are more likely to have access to Tier 3+ SHSs.

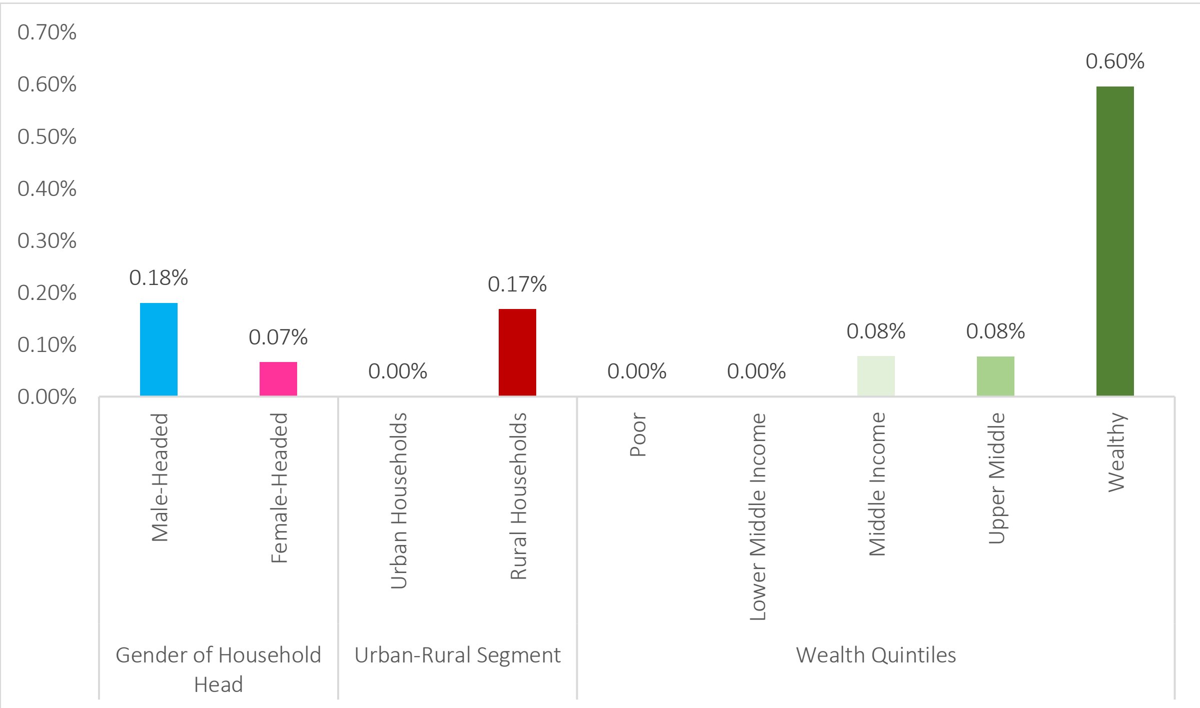


Figure 2.4 Ownership patterns of Tier 3+ SHSs

Based on the depicted distribution of off-grid solar solutions, which reveals consistent ownership patterns across various factors, and considering the assessment of eCooking capacity within the off-grid solar market segment, several interventions may enhance access to higher-tier SHSs and motivate households' transition to eCooking. Despite the consistent ownership patterns, efforts should be made to ensure equitable access to off-grid solar solutions, particularly targeting rural households. Awareness campaigns and financial incentives could be implemented to facilitate the adoption of SHSs across all wealth quintiles and gender categories. Further, recognizing the wealth-related concentration of Tier 3+ SHSs ownership, initiatives should be undertaken to extend access to these systems to lower-income households. This could involve subsidized pricing, affordable financing options, or partnerships with financial institutions to make Tier 3+ systems more accessible. Finally, acknowledging the higher proportion of male-headed households with access to Tier 3+ systems, efforts should be directed towards ensuring gender inclusivity.

3 ECOOKING APPLIANCES AND COOKING PRACTICES

3.1 eCooking Appliances Ownership

Kenya's culinary landscape is rich and diverse, encompassing a wide range of traditional and contemporary dishes. With the ongoing drive towards cleaner and more efficient energy, electric cooking appliances are gaining popularity within the country (See Table 3.1 for a summary of available appliances).

Table 3.1 Summary of eCooking appliances, their functionality and brands available in Kenya

Electric pressure cookers (EPC) 	An electric pressure cooker (EPC) is an appliance that uses electricity to quickly cook food under pressure. By sealing in steam, it raises the boiling point of the water inside, allowing food to cook more quickly at a higher temperature. EPCs offer features such as adjustable pressure levels, multiple cooking modes (e.g., sauté, steam, slow cook), and programmable timers, which can be beneficial for cooking Kenyan cuisine. EPCs have begun to gain traction in Kenya as more households have become aware of them, and availability in retail outlets has increased. EPCs available in Kenyan retail outlets typically have a capacity range of 4L to 8L. The most expensive brands of EPCs include Moulinex, Sencor, Von, and Nutricook, while more affordable brands include Dessini, TLAC, and Lyons. The initial investment in an EPC can be offset by potential savings on cooking time, energy usage, and fuel costs.
Induction cookers 	Induction cookers, with their ability to perform various cooking techniques such as simmering, boiling, frying, and sautéing, are well-suited for preparing Kenyan dishes. However, induction cookers need special cookware, and thus may not be compatible with traditional Kenyan pots and pans, which may create a barrier to adoption. In terms of cost, induction cookers may have a higher upfront cost compared to other types of cookers—also taking into account the need to acquire new specialized cookware. However, they can offer long-term savings in energy efficiency, which can translate to lower electricity bills and reduced overall energy consumption, making them cost-effective in the long run. These are gradually gaining favour as an alternative to LPG, which has already seen widespread adoption but whose costs have been rising. RAF, Ramtons, Sokany, Silvercrest, Baltra, Beko, and Hyundai are popular, while Bosch is among the most expensive brands and Silver Crest is among the cheapest among induction cookers. BURN manufacturing is currently introducing an induction cooker in the market bundled together with three different-sized cookware to lower adoption barriers.

Rice cookers 	A rice cooker is an appliance designed specifically for cooking rice, simplifying the process by automatically regulating the temperature and cooking time, resulting in consistently cooked rice. There are few brands available for rice cookers. SayonaPPs is more affordable and has previously collaborated on campaigns such as 'buy Solarmax panels and get a free SayonaPPs rice cooker', which may have increased its popularity. Marado, Panasonic, Moulinex, and GC retail single-function rice cookers. Interestingly, most EPCs double as rice cookers, and some retailers cite EPC multifunctionality as a selling point to peoples interested in rice cookers.
Air fryers 	An air fryer is a kitchen appliance that cooks food by circulating hot air around it, using a convection mechanism. It's designed to simulate deep frying without submerging the food in oil, hence it's often promoted as a healthier alternative to traditional frying methods. In terms of cost, air fryers can be a cost-effective option in the long run. While the initial investment may be higher compared to other cooking appliances, the savings on oil usage and potentially reduced electricity consumption can offset the cost over time. Moreover, air fryers are generally more energy-efficient compared to deep fryers, as they require less oil and shorter cooking times. Airfryers from generic brands imported from China are common, with major brands stocked at authorized distributors such as Hotpoint Appliances. Kenwood, Philips and Ramtons are among the most expensive brands. Some brands that are new to the market and a bit cheaper include Dessini, Amaze and RAF.
Mixed Liquefied Petroleum Gas (LPG) /Electric standalone cooker 	A mixed LPG/Electric standalone cooker is a versatile kitchen appliance that combines both Liquefied Petroleum Gas (LPG) burners and electric heating elements in one unit. This provides flexibility in cooking, allowing users to switch between gas and electric heating as needed. The gas burners offer immediate heat and are often used for quick frying or sautéing, a common need in preparing many Kenyan dishes. The electric stove top—often a solid metal or spiral hot plate—is often rarely used for daily cooking as it is perceived to be expensive. The unit often comes outfitted with an electric oven used for baking. For households that use the electric components, this cooker is especially convenient in areas where electric power might be unreliable, as the gas option can be used as a backup. The mixed LPG/Electric standalone cooker is one of the priciest appliances, with Beko being one of the most expensive brands, and Nunex and Sokany among the cheapest. These cookers are primarily purchased by affluent families as they are considered relatively expensive and are aspirational among lower income households.

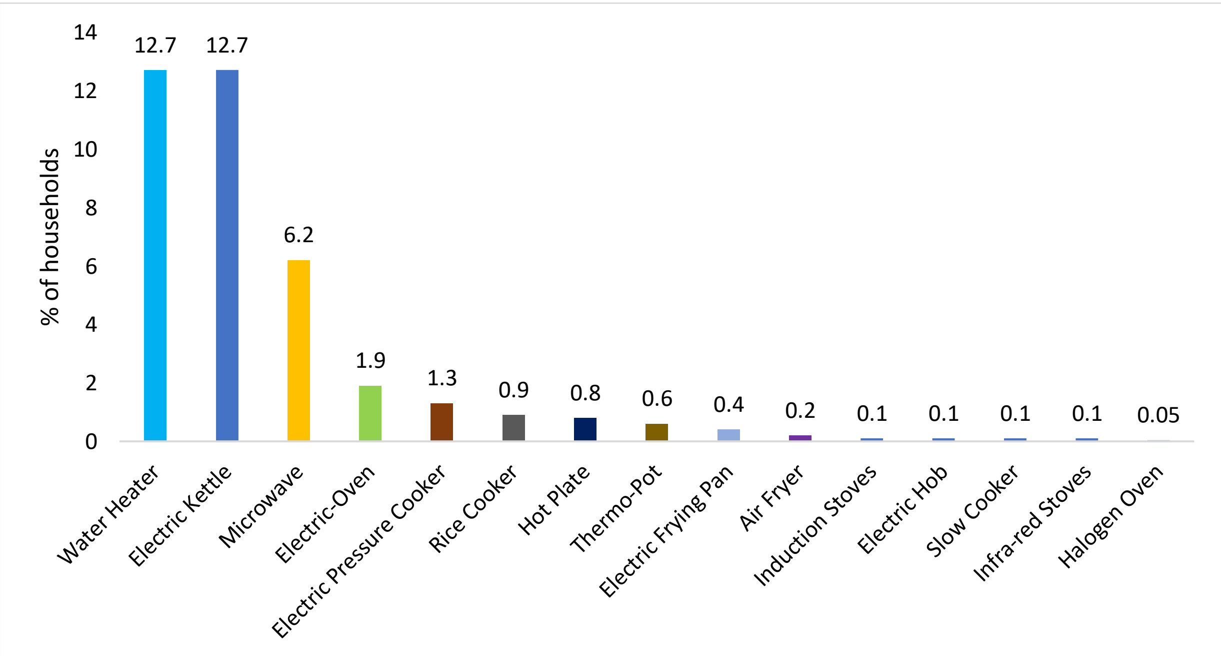
Microwave Ovens 	Microwave ovens are kitchen appliances that use microwave radiation to quickly heat and cook food. They are widely used for reheating leftovers, defrosting frozen foods, and preparing certain quick-cook items. While not necessarily central to the preparation of authentic Kenyan meals, microwave ovens are appreciated for their time-saving abilities and have found a place in modern Kenyan kitchens, especially in urban areas where fast-paced lifestyles are more common. Microwave ovens from Ramtons, Von, Haier, Samsung, and Mika dominate the market. Bosch, Ariston and LG are among the most expensive brands, while Nunix and Ailyons are cheaper.
Electric solid plate/coil hob  	Solid-plate electric hobs are made from a solid metal plate that is heated by electricity. Compared to induction hobs, they are less expensive, and they work with any type of cookware. Electric coil cooktops on the other hand are fashioned from spiral steel tubes housing a heating element. These cookers are relatively more inefficient and thus cost more to operate, can take long to heat up, and it can be more difficult to control the cooking temperature. Eurochef, Ramtons, Von, Duronic, Armco, Rasknik, Karnik, Sterling, Silver Crest, and Nunix are some of the common brands for electric hobs. They come as a single or double burner. Hotplates are included in some brands and versions of mixed LPG/electric tabletop and standalone cookers. Electric hobs are compatible with Kenyan stove top cooking. Electric hobs can be used with various types of cookware, including traditional Kenyan pots and pans, making them adaptable to different cooking techniques. However, due to their inefficiency, they are rarely used to cook heavy foods like cereals. These appliances are especially popular among college and university students who rely on electricity provided by their institutions and thus do not directly incur the cost of eCooking. Similarly, hotplates are prevalent in informal settlements where households share an energy meter with their landlords or are illegally connected to the grid, and thus they either pay a fixed rate for power or nothing at all.
Electric kettles and Immersion coil water heaters  	An electric coil water heater is a device that uses an electric coil to heat water. It typically consists of a metal coil that is heated through electrical resistance, and the heat is then transferred to the water surrounding the coil, raising its temperature. The electric kettle on the other hand consists of a metal or plastic container with a heating element at the bottom, a handle for easy handling, and sometimes an automatic shut-off feature that turns off the kettle when the water reaches a boiling point. As task specific appliances, the coil and kettle enjoy widespread appeal across socioeconomic groups, and is generally affordable. Electric kettles and coils are typically used to pre-heat water to expedite cooki. In informal settlements, electric coils have been fabricated into boilers for cooking cereals such as *githeri*. Philips, Mylong, Kenwood, Tefal and Beko are some of the more expensive brands of kettles, while Von, Ailyons and 4you brands are more affordable. Some brands that are newer to the market like Rashnik and Redberry mostly retail at less than KES 1,000. There are however generic brands on the extreme end of the price range, such

	as an electric glass kettle shipped from abroad selling at KES 4.4M on Jumia online selling platform.

3.2 Electric Appliances Ownership and Household Electricity

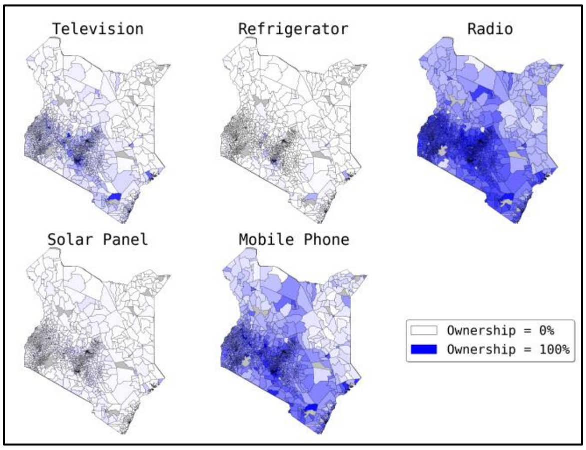
Interesting patterns have emerged from the survey data on the ownership of electric cooking appliances. Nationally, 25.2 percent of the households mentioned that they own an electric cooking appliances. As shown in Figure 3.4, an electric kettle and a water heater are the most owned appliances at 12.7 percent each. . As shown in Figure 3.5, households connected to the main grid have the highest electric cooking appliance ownership compared to other connection types, indicating a strong correlation between electrification and appliance ownership. As Fabini et al. (2014) demonstrate, the relationship between appliance ownership and electricity access reveals an 'appliance ladder' trend ranging from low-cost appliances such as radios and mobile phones often owned even without electricity access, with people using batteries or charging services instead, followed by refrigerator ownership, television ownership, as illustrated in Figure 3.1 and 3.2 below. Based on this rationale, it may be argued that cooking appliances are higher in the appliance ladder. However, there are a few instances where rural households demonstrate higher ownership of almost all electric cooking appliances under study. This could be attributed to the larger number of rural households surveyed and the slightly higher number of low-income urban households included in the sample. Interestingly, as shown in Figure 3.6, households without any form of electricity connection own some electric cooking appliances.

Figure 3.1 Electric cooking appliances ownership



This can be explained by the fact that most of these households may have moved from areas with electricity access to areas without electricity access. It is an also possible that some of these households may have been connected before and later disconnected from the main grid or owned other sources of electricity such as SHSs and batteries which they stopped using.

Figure 3.2 Electric Appliance Ownership in Kenya



Source: Fabini et al. (2014)

When it comes to the use of domestic electric cooking appliances, it is apparent that women benefit the most. These appliances serve women's practical needs and alleviate drudgery while also generating income. However, as seen in Figure 3.3 below, few female-headed families own these appliances compared to male-headed households. It is worth noting that male-headed families own most electric cooking appliances, despite Winther et al. (2020) finding that "women generally had less power than men to make decisions about electricity and appliances." Women-headed families are anticipated to possess more appliances since they have the authority to make all household decisions.

Figure 3.3: Electric cooking appliance ownership-Female/Male-headed Households

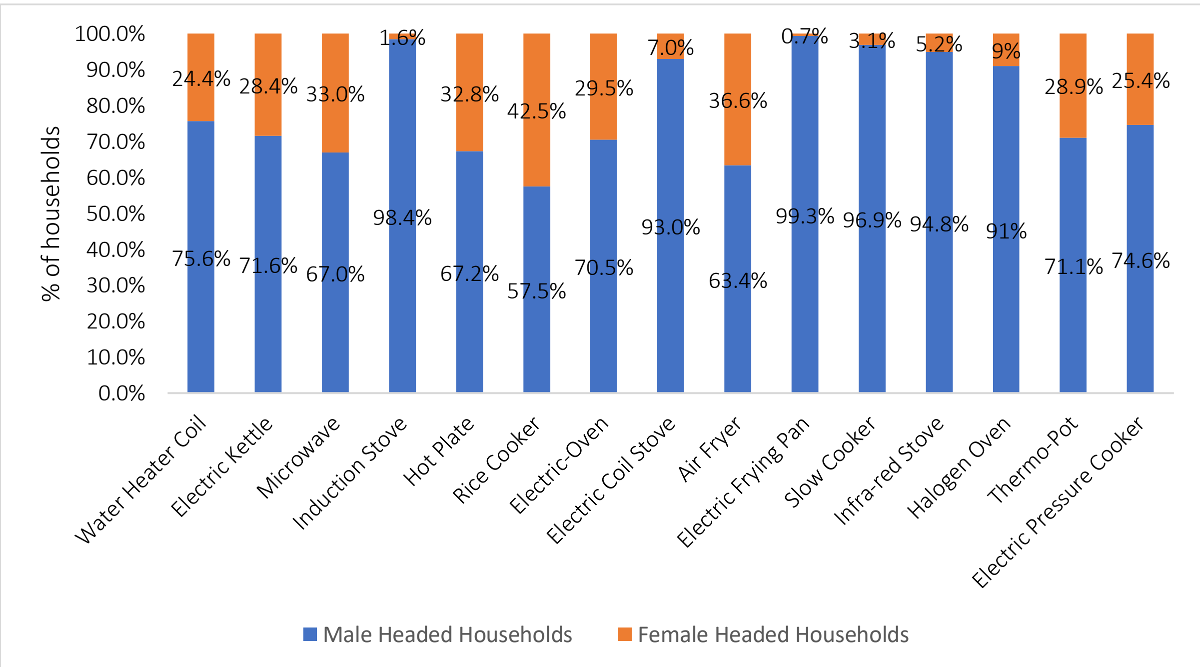
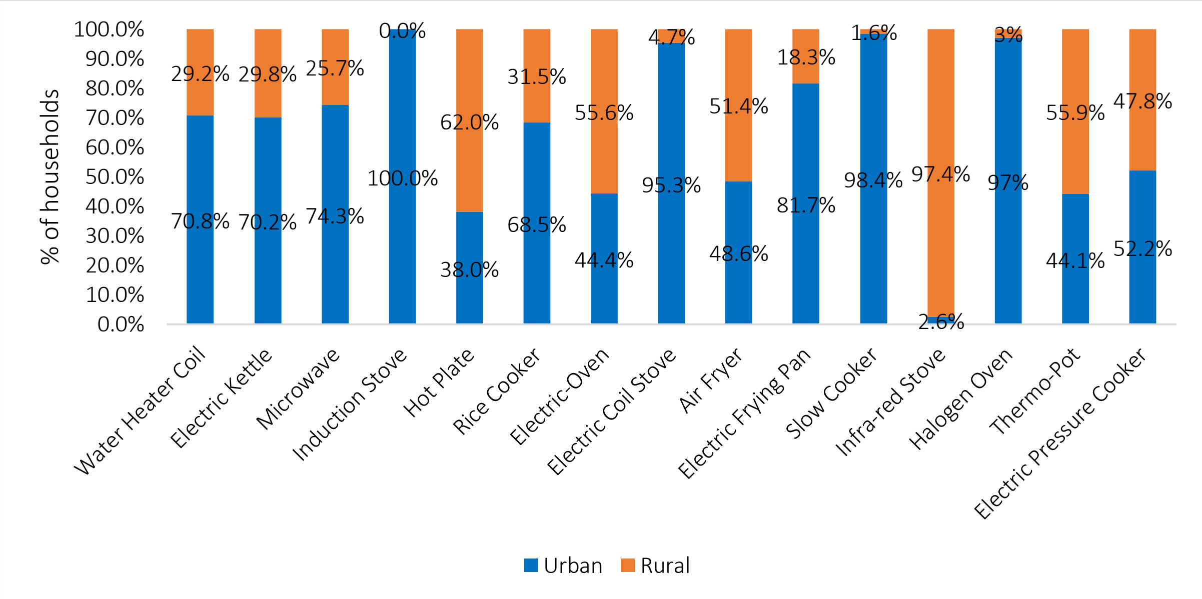


Figure 3.4: Electric cooking appliance ownership-Urban/Rural Households

There is uneven distribution of eCooking appliances ownership across the urban-rural market segments. Notably, eCooking appliance ownership is heavily concentrated in urban areas. Furthermore, ownership of eCooking appliances is in favour of male-headed households. This highlights the need for interventions that address this skewed distribution pattern. Addressing this ownership patterns will ensure an equitable transition in both urban and rural market segments and among the both male and female-headed households. For instance, targeted awareness campaigns in rural areas could effectively accelerate the adoption of eCooking. Financial incentives might also prove essential in overcoming cost barriers, particularly within the rural and female-headed household segments, which tend to have relatively lower incomes compared to male-headed households.

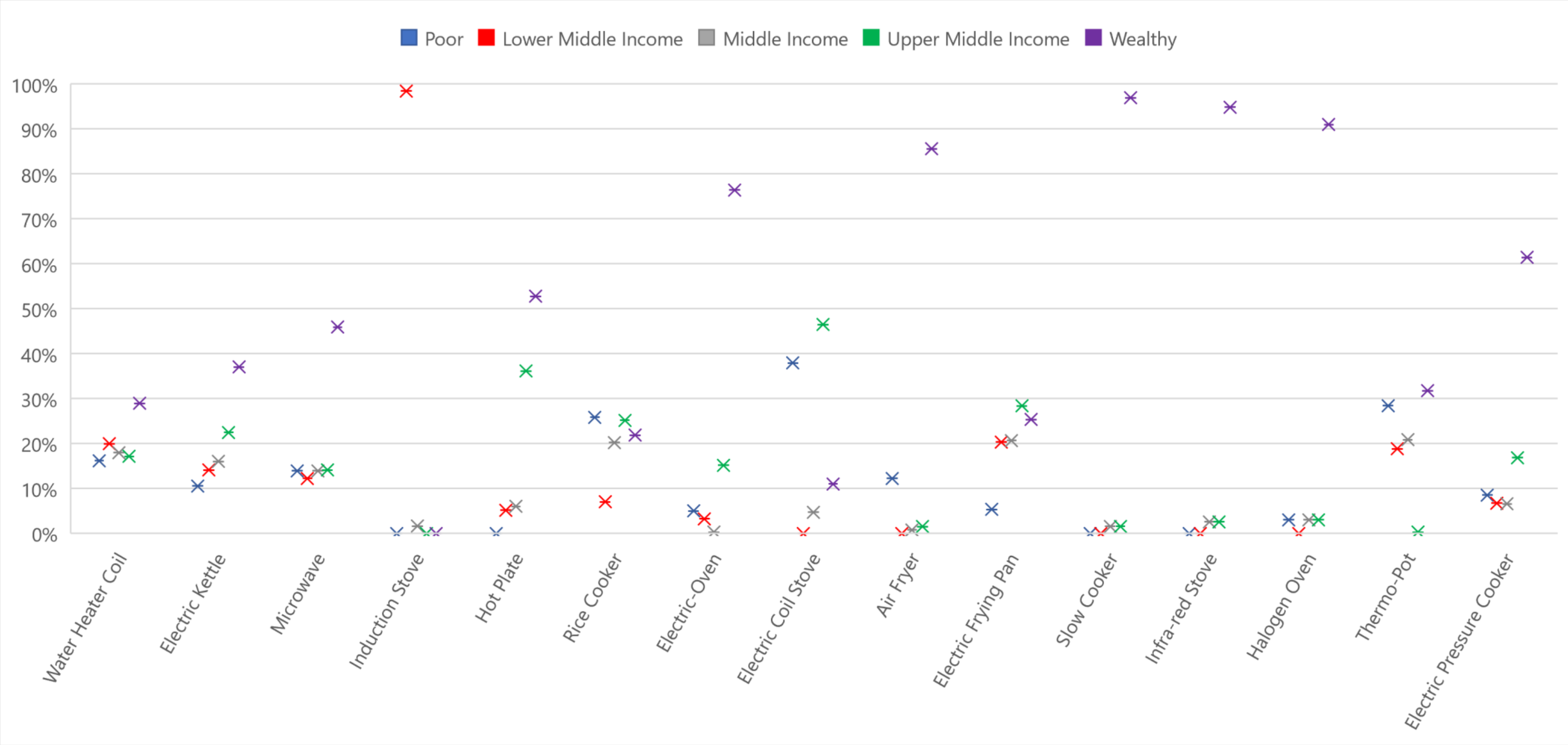
Figure 3.5: Electric cooking appliance ownership-Female/Male-headed Households



A highly positive correlation exists between household wealth and appliance ownership. Notably, the ownership of eCooking appliances is predominantly clustered within households belonging to the high wealth quintile. Interestingly, there is a relatively high prevalence of electric coil stoves among households in the lower wealth quintile. This observation is intriguing, as electric coil stoves are notably inefficient eCooking appliances. Potential explanations could include households being subject to fixed monthly electricity expenses or relying on informal electricity connections.

The concentration of eCooking appliances within the upper wealth quintiles suggests that implementing a subsidy program aimed at poorer households could effectively accelerate eCooking adoption. However, given that ownership doesn't always translate to usage as this study demonstrates, coupling subsidies with educational initiatives might yield more substantive outcomes. Such an approach could achieve the dual objectives of accelerating ownership and ensuring actual use. Further, the high prevalence of electric coil stoves among households in the lower wealth quintile indicates the potential for a utility-based financing intervention. This could prove to be an effective means of accelerating both ownership and utilization of eCooking appliances within economically disadvantaged households.

Figure 3.6 Household Wealth and Ownership of eCooking Appliances



Households with Tier 2 electricity access exhibit a notable concentration of eCooking appliance ownership. This observation could potentially explain the pattern of high ownership coupled with limited usage of household eCooking appliances, given that eCooking is comprehensively supported by Tier 3+, as per the MTF guideline. Remarkably, households with Tier 0 access have reported a lack of eCooking appliance ownership, whereas only a small fraction of households with Tier 1 access own such appliances. This implies that the composite attributes of electricity provision, i.e. capacity, availability, reliability, quality, and affordability, among other attributes, play a significant role in determining household eCooking appliance ownership. Thus, electrification should not only focus on connectivity and access, but also these attributes.

3.3 Appliance Usage and Cooking Practices

Cooking is defined as the act of preparing food for eating especially by heating[14]. Variations in the methods of heating food give rise to different ways of cooking. For instance, boiling entails cooking food by immersion in water that has been heated to near its boiling point (100 °C). Table 4.1 provides a description of other cooking methods.

To capture a wider scope of cooking methods, the study adopted a broader definition of cooking. Cooking as defined in this study encompasses subjecting food, beverage, and water to an electric heat source, either at the primary or secondary stage of heating food. Preparation of beverages is included in this definition as beverages are an important of part of the household menu in Kenya. Additionally, heating or boiling is included in the account of cooking methods such as blanching, boiling eggs, among others. This study additionally considered three cookstoves (Primary, Secondary, Tertiary) to account for household stacking. The implication is that a household using electricity in a second or third cooking option is deemed an eCooking household. Consequently, households were asked about their primary, second, and third cookstoves. All three cookstoves are reported to facilitate comparison with past studies that focus on primary cookstoves only.

Table 3.2 Cooking methods

	Cooking Method	Description
1	Boiling	Cooking food by immersion in water that has been heated to near its boiling point (100 °C).
2	Simmering	Involves subjecting food to heat from a liquid that is gently bubbling.
3	Poaching	Cooking food in a liquid held as close to boiling point as possible
4	Steaming	Subjecting food to heat from steam.
5	Stewing	Cooking food while in a minimum amount of simmering liquid or sauce)
6	Braising	Cooking food while enclosed in a container with liquid or sauce in an oven.
7	Roasting	Subjecting food to dry heat in an oven or on a spit
8	Baking	Subjecting food to dry heat in an oven
9	Grilling/Griddling	Cooking food using radiated heat while on grill bars
10	Shallow Frying	Cooking food in hot shallow fat or oil in a pan
11	Deep Frying	Completely submerging food in hot fat or oil);

[14] Merriam-Webster. (n.d.). Cooking. In Merriam-Webster.com dictionary. Retrieved March 21, 2023, from https://www.merriam-webster.com/dictionary/cooking

12	Blanching	Scalding food, typically vegetables, in hot water or steam for a short time and plunging into cold water

3.3.1 The prevalence of eCooking

Electric cooking presents a potentially transformative clean alternative household cooking solution. Yet, the absence of clear information regarding the prevalence of eCooking poses a barrier to implementing interventions aimed at accelerating the adoption of eCooking technologies. The prevalence of eCooking is significantly underreported in previous studies, and this can be attributed to the fact that only the *'primary'* cooking solution is often recorded. Additionally, task-specific electrical cooking appliances like kettles, as well as partial use of electrical cooking appliances in stacking practices during cooking events are often not accounted for in previous studies. Moreover, surveys on clean cooking fail to explicitly define the scope of the term "cooking." For instance, it remains unclear whether activities such as reheating food and making beverages were considered as part of household cooking.

In responding to the ToR, this study followed the World Bank and World Health Organization (2021) guideline on collecting household energy access data. The guideline provides for data collection on households' primary, secondary, and tertiary cooking solutions, thus addressing the underrepresentation and stacking concerns in the ToR. To address the scope of the term "cooking", this study defined eCooking as subjecting food and beverages to an electric heat source, either at the primary or secondary stage of heating food. While boiling water might be categorized as a part of cooking, particularly when the boiled water is used within the cooking event, distinguishing this proved to be challenging. Consequently, boiling water is not considered part of cooking in this study. The study presents the prevalence of eCooking based on using an electric heat source for cooking, reheating food, and preparing beverages. This heat source could serve as the primary, secondary, or tertiary means of heat for cooking. A household is classified as eCooking if it employs an electric cookstove as its primary, secondary, or tertiary source heat for cooking. Figure 3.7 presents the prevalence rate of eCooking as defined by this study.

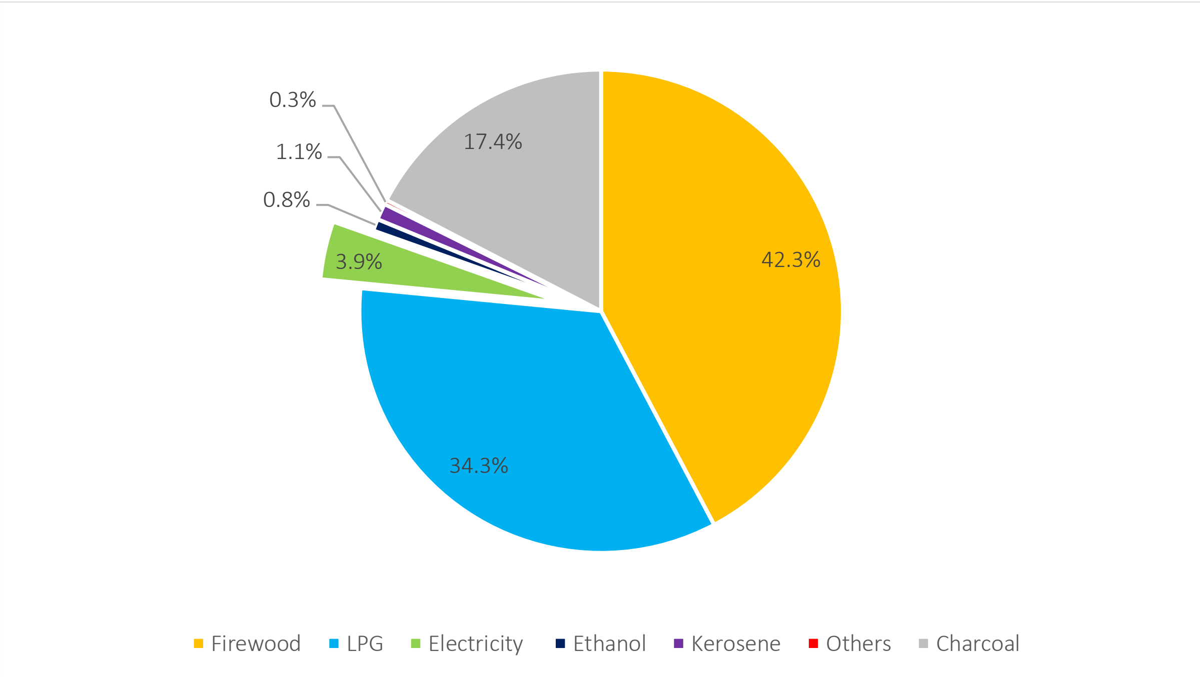


Figure 3.7 Prevalence of cooking fuels

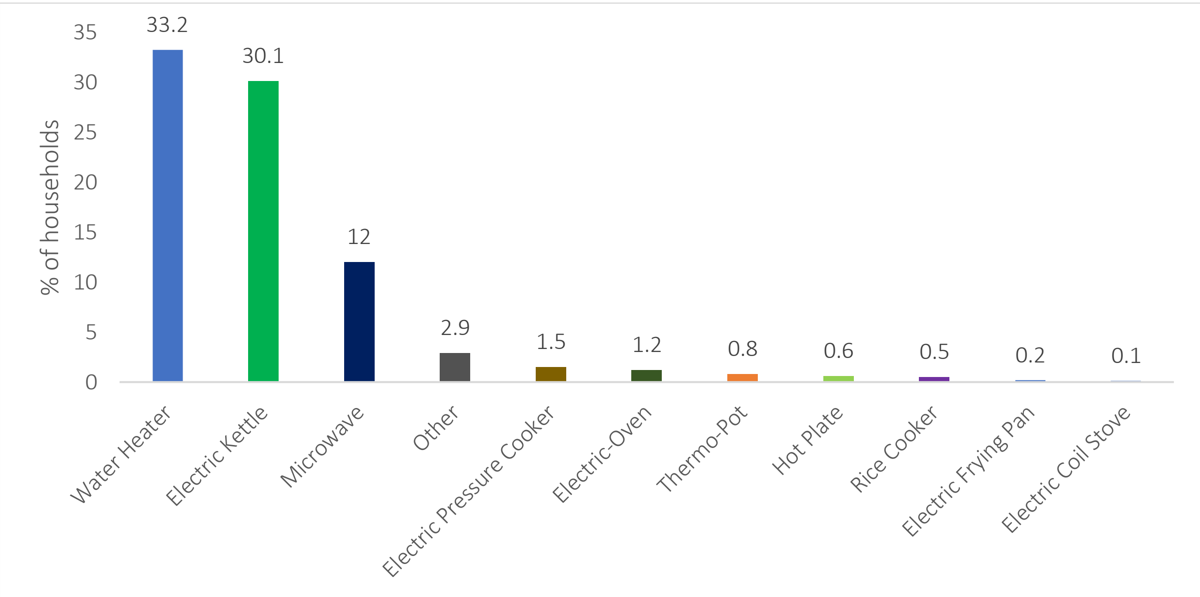
Using the more comprehensive definition of cooking in this study, which also incorporates the concept of household stacking, the prevalence of eCooking as the primary household cooking solution in Kenya stands at **3.9 percent**. Although this percentage might not be readily comparable to prior studies, it offers a more precise assessment of eCooking prevalence by encompassing the diverse energy uses employed for cooking within households.

However, if we only consider conventional primary cooking, without considering reheating food and preparing beverages, only **0.58 percent** primarily use electric appliances for this purpose.

3.3.2 eCooking Appliance Usage

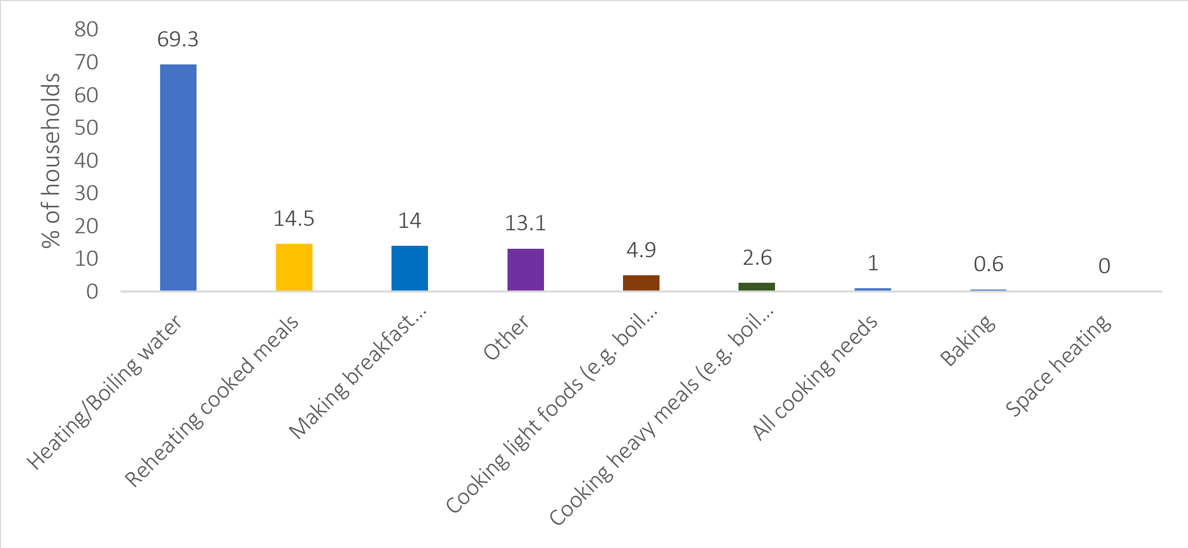
Another important observation from the survey is that 33.2 percent of the households who own electric cooking appliances mentioned a water heater as their most used electric cooking appliance, 30.1 percent of the households mentioned an electric kettle as their most used appliance. 12 percent of the interviewed households mentioned that they mostly use a microwave while 4.15 percent, 1.29 percent, 1.34 percent, 0.44 percent, 0.43 percent of the visited households mentioned that they mostly used a rice cooker, electric-oven, electric hob, thermo-pot, hot plate respectively. See Figure 3.8 below.

Figure 3.8 Most popularly used electric cooking appliances at the household level



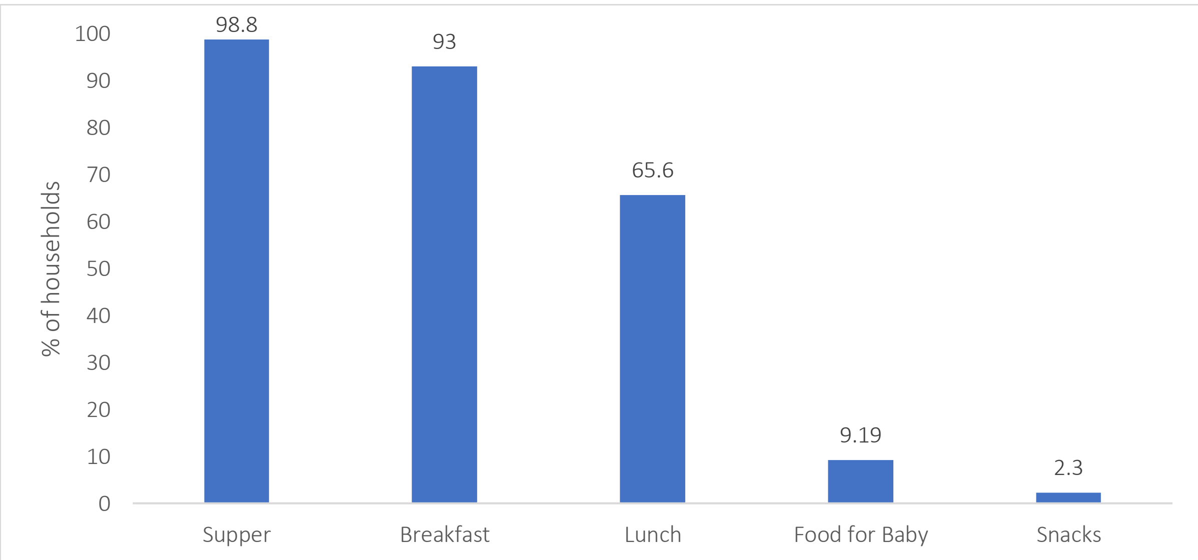
The survey found that at the household level, 63.2% primarily used their main electric cooking appliance for boiling water. Another 12.7% used it mainly for reheating food, while 15% used it for preparing breakfast items like tea, coffee, or eggs. Light cooking tasks like boiling rice accounted for 8.8%, and 4.7% used the appliance for cooking heavy meals, as illustrated in Figure 3.9 below. There are minor variations in how households used their main eCooking appliance across gender and wealth.

Figure 3.9 How the most popular appliances are used in households



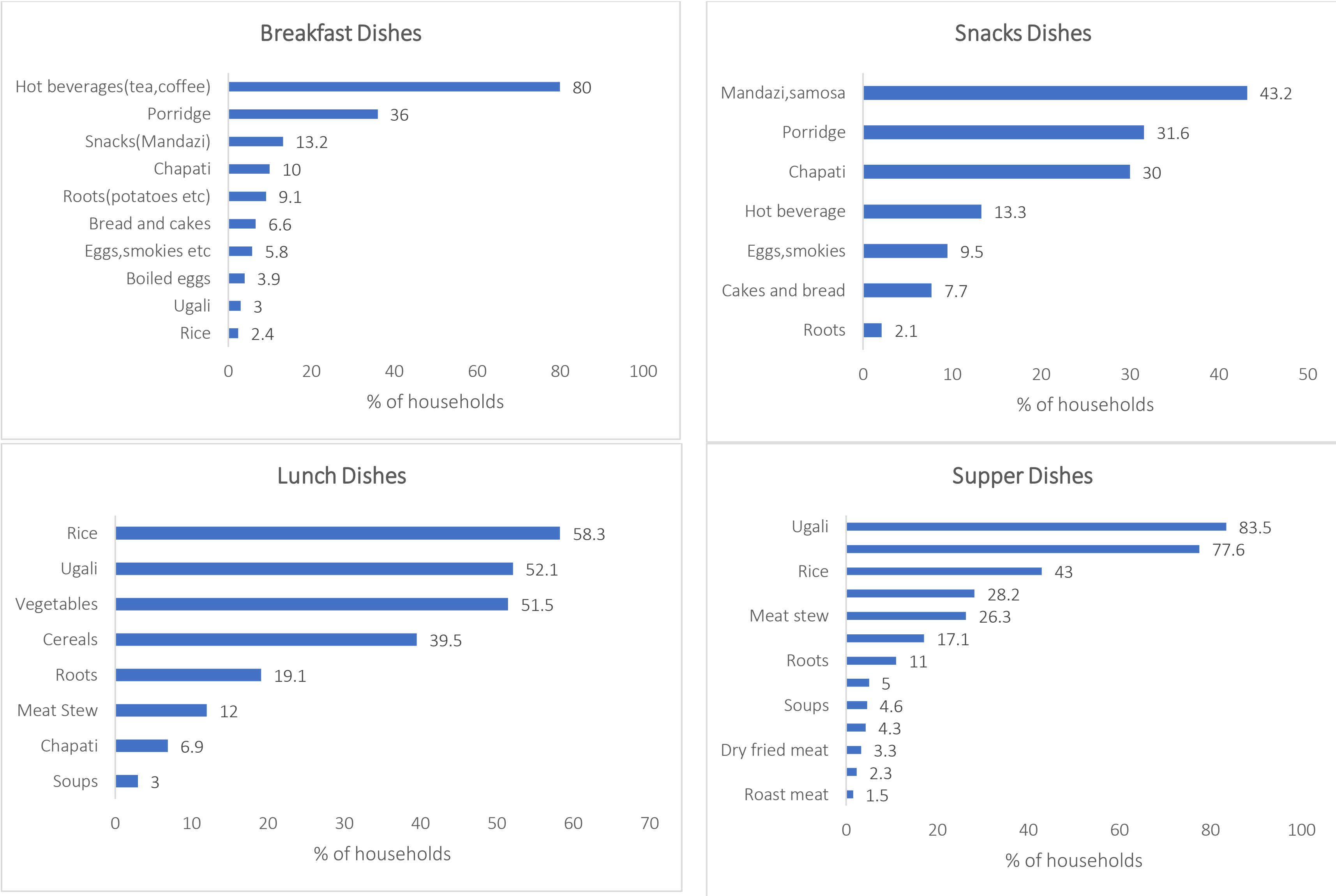
3.3.3 Cooking Practices for Typical Cuisines in Kenya

Kenyan households commonly prepare three main meals: breakfast, lunch, and supper, with supper being the most prevalent meal prepared by 98.8 percent of households, followed by breakfast (93 percent), and lunch (65.6 percent) (see Figure 3.10 and 3.11). A significant 28 percent of households prepare supper but not lunch. Snacks, such as Mandazi, Samosa, and Mahamri, are typically prepared by only 2.3 percent of households, despite being common breakfast items, suggesting they might be purchased rather than prepared at home. Breakfast usually comprises hot beverages or porridge, with over 93 percent of households consuming it. Lunch menus are dominated by rice, Ugali, and vegetables, with each prepared by over 50% of households. However, supper sees a shift, with Ugali and vegetables taking precedence over rice. Snacks mainly consist of Mandazi and samosa, but also include porridge, chapati, and hot beverages. These findings are largely in line with cooking diaries conducted in Kenya e.g., eCook (Leary et al., 2019) and EED Advisory (2023).



3.10 Typical Household Meals in Kenya

Figure: 3.11 Typical Household Meals in Kenya: Breakfast, Lunch, Supper, Snacks



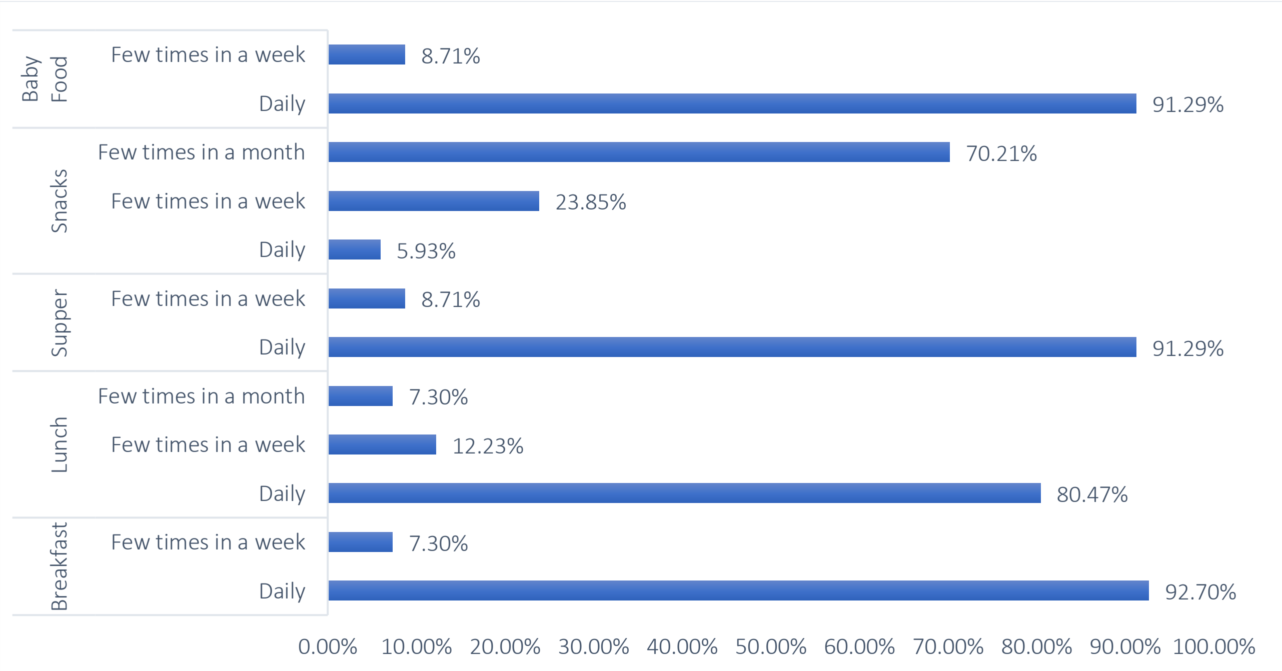
The research examines the complex factors affecting household choices of dishes and cooking techniques in Kenya, categorizing the data by income, gender, and meal times. Taste preferences, ingrained from childhood and influenced by culture, economics, and social factors, play a key role (Foskett, Rippington, Paskins, & Thorpe, 2017). The survey shows that there are minimal gender differences in how meals are prepared but a correlation with wealth, particularly for lunch. Popular dishes vary by mealtime and socio-economic class: for example, wealthier households are more likely to include a broader variety of dishes like meat stews, roots, and cereals. Female-headed households dominate in snack and chapati preparation as wealth increases. The study also acknowledges the influence of local settings and culture, as indigenous plants and animals often form the base of meals. Overall, choices in food and cooking methods are deeply embedded in a matrix of cultural, economic, and social factors and evolve over time.

3.3.4 Frequency of Meals Preparation

We examine the frequency of households' meals preparation and the different cooking techniques used by households in preparation of most popular dishes. Among the households that prepare breakfast, lunch, supper, and baby foods, a majority prepare daily. However, it is worth noting that relatively fewer households prepare lunch on daily basis relative to breakfast, supper, and baby food. Specifically, over 10 percent fewer households prepare lunch daily relative to breakfast, supper, and baby food. This further, reinforces the relative importance of breakfast and supper in Kenyan households as already highlighted in Figure 3.12.

It is also notable that households that typically prepare snacks such as Mandazi, Samosa, Mahamri among others, mostly prepare them a few times in a month (70.21 percent of the households. However, a significant proportion prepare snacks a few times a week (23.85 percent). This further reinforces the earlier curiosity of where households source their snacks daily as only 5.93 percent of households typically prepare their snacks on daily basis yet snacks are a significant part of household breakfast.

Figure 3.12 Frequency of households' meals preparation



3.3.5 Cooking Techniques used to Prepare Typical Dishes

Household were asked to describe how they prepare typical meals. Most households reported using more than one technique in preparing their typical dishes. As a result, the proportion reported in the table refers to the proportion of households who reported using the respective techniques. As shown in Table 4.2 below, boiling and frying emerge as the cooking techniques that are dominantly used in preparing majority of the typical dishes in Kenyan households. Baking is the least used technique in preparing typical foods in Kenyan households. It should be noted that baking is dominantly used to prepare snacks in Kenyan households. However, as shown in Figure 4.4 households typically prepare snacks a few times in a month and others a few days in a week. Baking is thus not highly prevalent among Kenyan households.

Table 3.3 maps out common Kenyan dishes, their cooking techniques as reported by households during the survey, and the electric cooking appliances that are compatible with these techniques. The table helps to show the extent to which electric cooking appliances are compatible with Kenyan dishes and meals.

Table 3.3 Common Kenyan dishes, their cooking techniques, and compatible eCooking appliances

TYPICAL DISHES	MEAL FEATURED IN	PREVALENCE ACROSS WEALTH CLASSES	FREQUENCY OF PREPARATION	COOKING TECHNIQUES (HOUSEHOLD PROPORTION %)	COMPATIBLE ELECTRIC COOKING APPLIANCES
PORRIDGE ***(Uji wa Muhogo, Uji wa Mchele, Oats)***	Breakfast	Poor to lower middle class	Daily (36 percent of households)	Boiling (98 percent)	EPC Induction Cooker Electric Kettle *(to pre-boil water)*
HOT BEVERAGES ***(Tea, coffee, hot chocolate)***	Breakfast, Snacks	All wealth classes	Daily (80 percent of households)	Boiling (99.7 percent)	Electric Kettle *(to pre-boil water)* Induction Cookers Electric solid plate/coil hob
SNACKS ***(Mandazi, samosa, mahamri)***	Breakfast, Snacks	Upper middle and wealthy	A few times a month (70 percent) A few times a week (24 percent)	Deep Frying (63 percent) Shallow frying (7.2 percent) Baking (24 percent)	Air Fryer Microwave Ovens Electric oven
CAKES AND BREADS	Breakfast, Snacks	Upper middle class to wealthy	Few times a month	Baking (63 percent) Frying (36 percent) Roasting (4.8 percent)	Electric oven Microwave Oven
EGGS	Breakfast, Snacks	Upper middle class and wealthy	Daily	Boiling (90 percent) Shallow Frying (29 percent)	Induction Cookers Electric solid plate/coil hob
SAUSAGES/BACON	Breakfast	Upper middle class and wealthy	Daily	Shallow Frying (94 percent) Deep frying (11 percent)	Air Fryer Induction Cookers Electric solid plate/coil hob Electric oven
CHAPATI ***(Chapati, roti)***	Breakfast, Lunch, Supper	All wealth classes	Varies	Shallow Frying (71 percent) Baking (25 percent) Roasting (9 percent)	Induction Cookers Electric solid plate/coil hob Electric Oven

ROOTS ***(Potato, Cassava, Yams, Arrow roots etc.)***	Breakfast, Supper	Upper middle class and wealthy	Varies	Boiling (97 percent) Shallow frying (38 percent) Deep frying (5.6 percent) Steaming (4.4 percent) Stir frying (4.9 percent)	EPC Rice Cooker Electric Kettle *(to pre-boil water)*
RICE ***(Plain rice, Pilau, Mseto wa Maharagwe, Fried rice)***	Lunch, Supper	All wealth classes	Daily (Lunch, 58 percent of households)	Boiling (91 percent) Sautéing/stir frying (39 percent)	Rice Cooker EPC Induction Cookers Electric solid plate/coil hob Electric kettle *(to pre-boil water)*
CEREALS ***(beans, maize, githeri, peas, ndengu, etc.)***	Lunch, Supper	All wealth classes	Daily (Lunch, 40 percent of households)	Boiling (95 percent) Sautéing/stir frying (63 percent)	EPC Rice Cooker
UGALI	Lunch, Supper	All wealth classes	Daily (Lunch 52 percent, Supper 84 percent)	Boiling (88 percent) Simmering (12 percent)	Electric Kettle *(to pre-boil water)* EPC Induction Cookers Electric solid plate/coil hob
VEGETABLES ***(Sukuma wiki, spinach, cabbage, Kienyeji, etc)***	Lunch, Supper	All, but more in upper classes	Daily (Lunch 52 percent, Supper 78 percent)	Stir Frying (82 percent) Boiling (38 percent) Steaming (25 percent)	Induction Cookers Electric solid plate/coil hob EPC
MEAT STEW ***(Beef, goat, mutton, Camel, Chicken, trotters)***	Lunch, Supper	Lower middle to wealthy	Daily (Lunch 19 percent, Supper varies)	Sautéing/stir frying (96 percent) Boiling (72 percent) Simmering (79 percent) Deep frying (14 percent) Roasting (6.5 percent)	EPC Induction Cookers Electric solid plate/coil hob

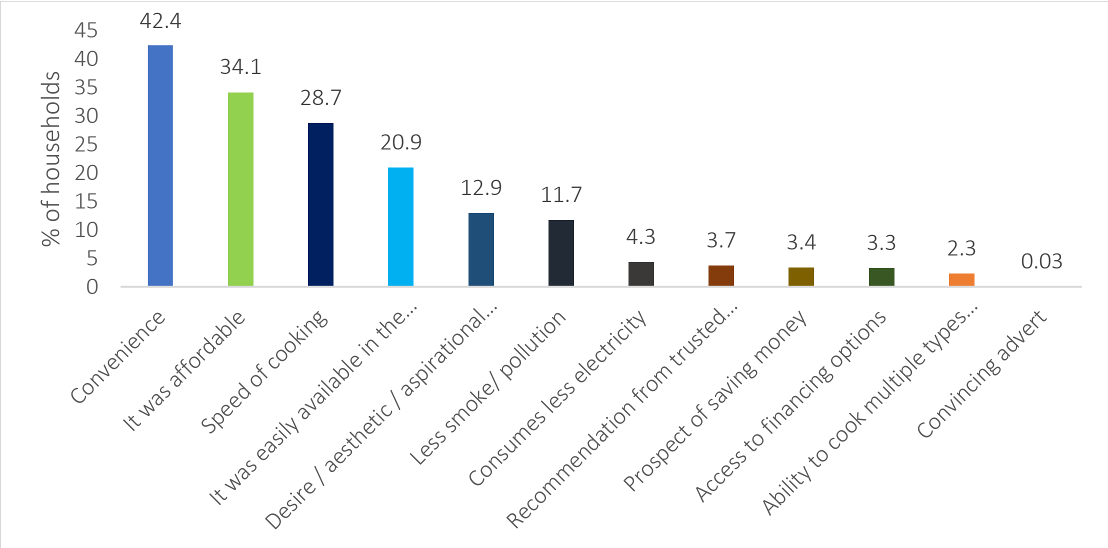
SOUPS ***(Chicken soup, bone soup, pumpkin soup)***	N/A	Lower middle to wealthy	Varies	Boiling (93 percent), Sautéing/stir frying (40 percent) Deep frying (6.6 percent) Simmering (3 percent)	EPC Rice Cooker Electric Kettles *(to pre-boil water)*
DEEP FRIED MEAT ***(Beef, goat, mutton, Camel, Chicken, trotters)***	Supper	Lower Middle to Wealthy	Varies	Deep Frying (63 percent) Boiling (28 percent) Sautéing/stir frying (46 percent) Roasting (4 percent)	Air Fryer Electric oven
ROAST MEAT ***(Beef, goat, mutton, Camel, Chicken, trotters)***	Supper	Upper Middle to Wealthy	Varies	Sautéing/stir frying (74 percent) Roasting (44 percent) Boiling (29 percent) Deep frying (21 percent) Baking (6 percent)	Air Fryer Electric oven EPC
SHALLOW FRIED MEAT ***(Beef, goat, mutton, Camel, Chicken, trotters)***	Supper	Lower Middle to Wealthy	Varies	Shallow Frying (94 percent) Boiling (38 percent) Roasting (1.4 percent)	Induction Cookers Electric solid plate/coil hob Electric oven

Note: The Compatible Electric Cooking Appliance list is not exhaustive, and different models of electric appliances may offer additional functionalities.

3.3.6 Appliance choice

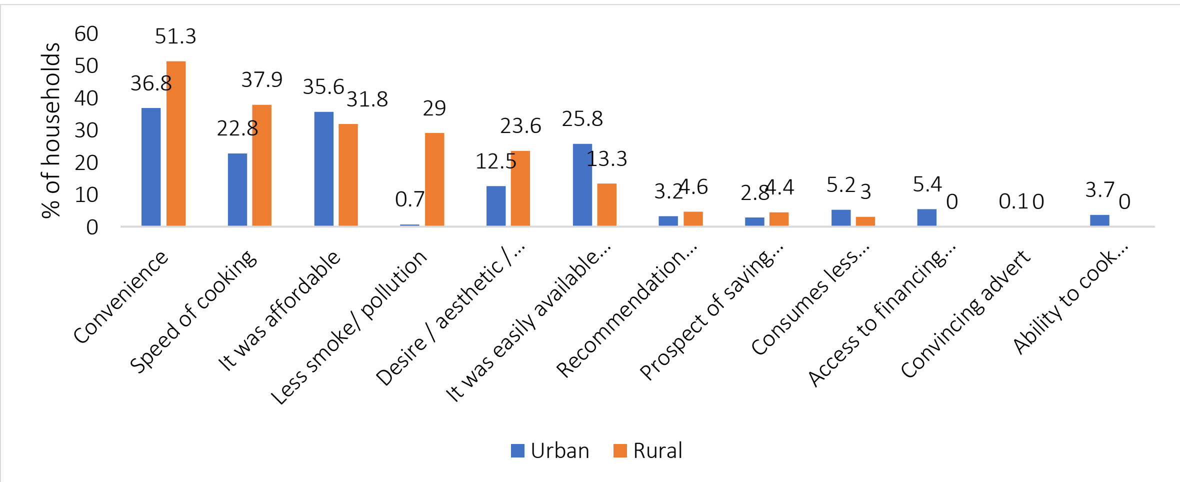
From the survey results, the factors behind the household decision to acquire electric cooking appliances included (42.4 percent), followed by affordability (34.1 percent), speed of cooking (28.7 percent), availability in the market (20.9 percent), desire/aesthetic/aspirational appeal (12.9 percent), and less smoke produced during cooking (11.7 percent), among others (see Figure 3.13).

Figure 3.13 Primary consideration for appliance choice



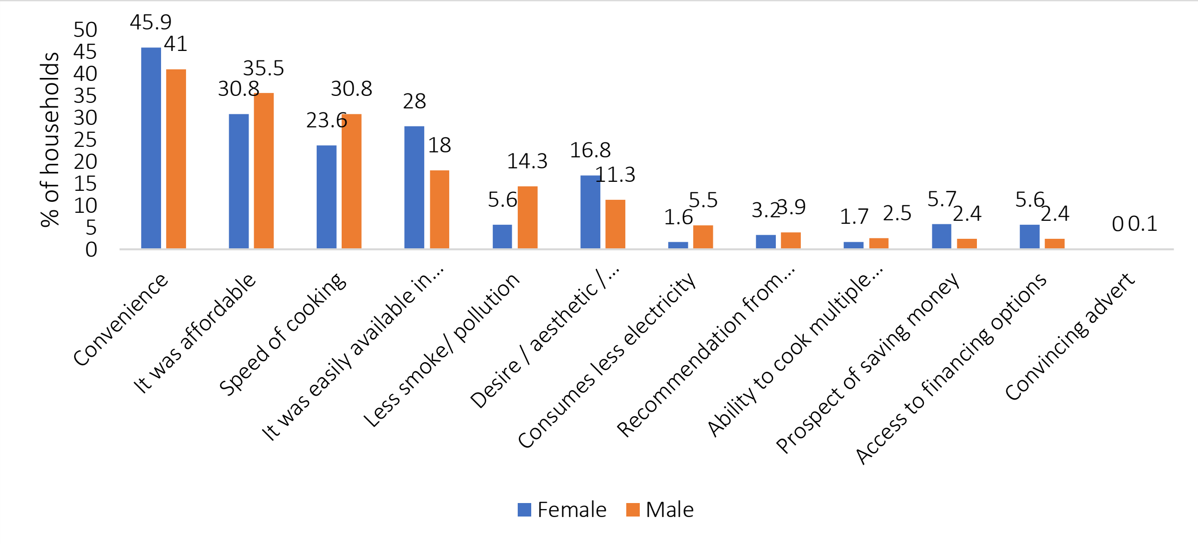
As depicted in Figure 3.14, from all the factors influencing households' decision to purchase electric cooking appliances, rural households seemed to rely more on recommendations from trusted parties such as friends and SACCOs. Again, urban households were more inclined to purchase an electric cooking appliance due to their affordability, availability, less electricity consumption, access to appliance financing options and versatility in food preparation compared to households in rural areas. Rural households were mainly influenced by the convenience of the appliance(s), lower pollution, aesthetic appeal, faster cooking times and lower electricity consumption compared to urban households.

Figure 33.14 Primary consideration for appliance choice: a comparison between urban and rural households



Female-headed households prioritized factors like aesthetic appeal, convenience, appliance availability, potential for cost savings, and financing options for electric cooking appliances more than male-headed households. In contrast, male-headed households were more swayed by affordability, cooking speed, versatility in food preparation, reduced pollution, and recommendations from trusted sources, as depicted in Figure 3.15.

Figure 3.15 Primary consideration for appliance choice: a comparison between male-headed and female-headed households



3.3.7 Willingness to Pay for eCooking Appliances

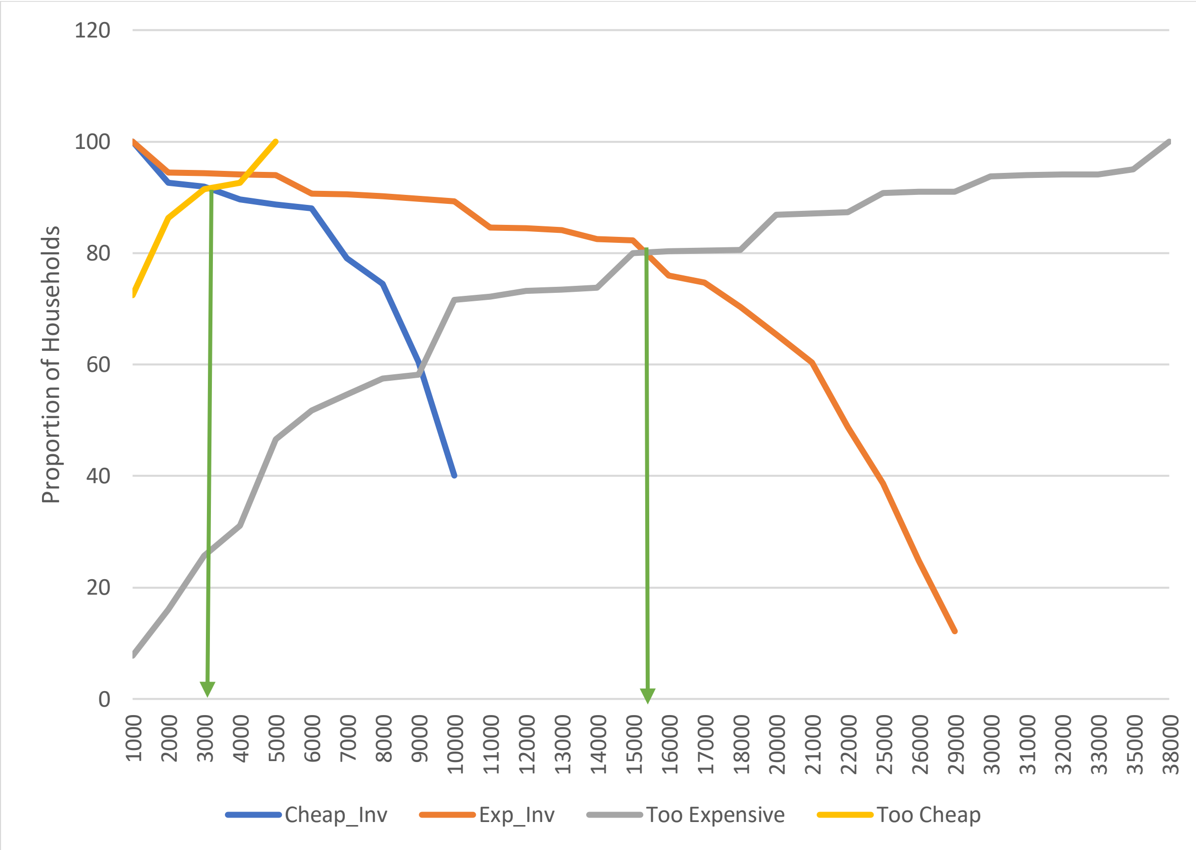
Apart from wealth, the other important economic determinant of ownership of eCooking appliances is the price. To examine the importance of price on ownership of an eCooking appliance, this study used the van Westendorp (1976) approach to gauge households' willingness to pay for an eCooking appliance. Households were given a description of a hypothetical eCooking appliance that would potentially reduce their current monthly expenditure on cooking fuel and prepare all the foods they are currently consuming. Households were asked to provide five different price points for the hypothetical eCooking appliance:

- the price they would willingly pay
- a price they would consider expensive but would still pay
- a price they would consider cheap but they would not question the appliance's quality
- a price they would consider so expensive that they would not make a purchase.
- a price they would consider so cheap that they would question the appliance's quality.

The van Westendorp price sensitivity meter was subsequently employed to analyze the responses of households. Its purpose was to establish the price range within which households would be open to paying for the hypothetical eCooking appliance. The minimum price at which households are willing to pay aligns with the point where the graphs for the inverse of "cheap" and "too cheap" intersect. Similarly, the maximum price corresponds to the intersection of the graphs for inverse of "expensive" and "too expensive." Illustrated in Figure 3.16 below is the determined price range for the hypothetical eCooking appliance. It was found that households would consider a price range spanning from Ksh.

3,000 to Ksh. 15,500 as acceptable for an electric appliance that not only reduce their current monthly cooking fuel expenses but also handles all the foods that they currently prepare.

Figure 3.16 Households' willingness to pay for an eCooking appliance: price range



The van Westendorp price sensitivity meter was subsequently employed to analyze the responses of households. Its purpose was to establish the price range within which households would be open to paying for the hypothetical eCooking appliance. The minimum price at which households are willing to pay aligns with the point where the graphs for the inverse of "cheap" and "too cheap" intersect. Similarly, the maximum price corresponds to the intersection of the graphs for inverse of "expensive" and "too expensive." Illustrated in Figure 3.12 below is the determined price range for the hypothetical eCooking appliance. It was found that households would consider a price range spanning from KES. 3,000 to KES. 15,500 as acceptable for an electric appliance that not only reduce their current monthly cooking fuel expenses but also handles all the foods that they currently prepare.

Comparing the outcomes of the van Westendorp price sensitivity analysis with an evaluation of the pricing for energy-efficient eCooking appliances (such as Microwaves, Rice Cookers, and Electric Pressure Cookers) reveals that the average price range for these appliances might fall within the bracket that households would find acceptable. To illustrate, a basic microwave is priced at Ksh. 6,499, a rice cooker at Ksh. 2,999, and an Electric Pressure Cooker at Ksh. 5,663. This suggests that while price can play a significant role in determining the ownership of eCooking appliances, other equally influential factors impact their adoption. These factors encompass availability, electricity costs, personal preferences, the knowledge and beliefs of households currently reliant on polluting fuels, and more.

Furthermore, it's important to note that many energy-efficient appliances are task-specific and cannot handle all household's cooking needs, necessitating appliance stacking to meet all household's cooking needs. This in turn increases the appliance ownership cost. Lastly, it is worth highlighting that ownership does not necessarily equate to usage. As demonstrated in this study, while more than a quarter of households possess some form of electric appliance, only 3.9 percent use electricity as their primary cooking fuel.

In sum, adopting energy-efficient eCooking appliances represents a complex issue beyond mere pricing considerations. Factors like availability, electricity expenses, personal preferences, and cultural beliefs all play a significant role. This complexity necessitates a comprehensive strategy integrating various elements, including education, technological advancements, and policy frameworks. Initiatives like public awareness campaigns and educational endeavours can play a pivotal role in enlightening households about the advantages of eCooking. It is crucial to emphasize not only the cost-effectiveness but also the positive impacts on the environment, health, and drudgery. As this study shows, price ranges of these appliances align with what households deem acceptable, implying that other factors play a significant role that should not be overlooked.

Creating energy-efficient appliances capable of managing a wider array of cooking tasks would effectively overcome the constraints imposed by task-specific appliances. This approach would diminish the necessity for owning multiple appliances, potentially reducing the overall cost of adopting eCooking solutions.

By offering financial incentives like tax breaks or purchase subsidies, the acquisition of eCooking appliances could be incentivized. Such measures would effectively decrease the initial cost hurdle, rendering these appliances more appealing to households.

Expanding initiatives like the Pika na Power demonstrations, which focus on behavioural change, could be pivotal in transitioning households away from traditional, polluting fuels like firewood and towards cleaner alternatives like electricity.

3.4 Knowledge, Attitudes, and Beliefs in Different Market Segments

Social cultural beliefs and perceptions influence behaviour and adoption of new technologies and practices. In some households or communities, cooking using modern appliances is considered a foreign concept and, therefore, subject to varied perceptions and beliefs especially about the taste of food. Households do not automatically switch from traditional fuels to more modern sophisticated energy sources with improved disposable income, as besides cost, some households have issues with the taste of the food, holding the perception that food cooked using fuels such as charcoal and firewood has a better taste than that prepared using electric cooking appliances.

The household survey indicated that 74.6 percent of respondents perceived differences between food cooked on electric appliances and those cooked using traditional methods. No significant differences were found across electricity connection types, main fuel types (70-75%), gender, or regions (65-85 percent) (See Figure 3.4). However, 77.4 percent of wealthy households noticed a difference, while upper middle-income households showed the least concern for cooking method differences (72.8 percent).

Urban households in Cluster 8 (represented by Murang'a) had the highest proportion of individuals who perceived e-cooked and traditionally cooked foods to be different at 100 percent (See Figure 4.9). Other notable regions were Cluster 6 (represented by Elgeyo Marakwet) urban households at 86.8 percent and Cluster 2 (represented by Lamu) at 84.4 percent, which could be attributed to their cuisine 'Swahili dishes'. Notably, 27.2% of the lowest income group perceived taste differences, compared to 18%-22% in other income categories, except the upper middle. More men than women found taste differences by 1.7%. Kerosene users reported higher taste differences (26%) than other fuel users. Most firewood users associated traditional methods with smoke (1.8%), compared to LPG users (0.3%). Speed explained most regional differences in cooking methods (75%-86%), with the North Rift region having the highest percentage.

Table 3.4: *Public opinion on perceived differences between electric and traditional cooking methods based on taste, cost, speed of cooking, smell and cleanliness*

		Taste	Cost	Speed	Smell	Cleanliness
Region	Urban	39.3%	51.1%	34.7%	28.5%	6.8%
	Rural	60.7%	48.9%	65.3%	71.5%	93.2%
Gender of household head	Female	30.8%	31.5%	28.6%	13.0%	16.3%
	Male	69.2%	68.5%	71.4%	87.0%	83.7%
Wealth	Poor	20.5%	20.7%	18.3%	4.6%	5.5%
	Lower middle	21.1%	20.5%	21.1%	0.2%	17.8%
	Middle	20.0%	18.2%	19.9%	17.7%	27.4%
	Upper middle	17.7%	18.6%	19.2%	39.0%	13.1%
	Wealthy	22.0%	22.0%	21.5%	38.5%	36.2%
Electricity connectivity	Kenya Power	78.5%	85.2%	78.9%	60.5%	63.2%
	Private minigrid	2.2%	1.2%	3.0%	0.0%	4.7%
	SHS	13.0%	8.2%	12.5%	22.7%	24.8%
	Unconnected	5.9%	5.0%	5.3%	16.7%	3.1%

Household survey results align with focus group discussions from Bungoma, Kilifi, and Nairobi, where people had mixed opinions about food cooked with electric appliances. Some participants preferred the taste and aroma of food cooked with charcoal or firewood over LPG or electricity. For instance, rice cooked in a rice cooker was considered bland compared to charcoal or firewood-cooked rice. In Bungoma and Nairobi, some participants believed that Ugali cooked on a charcoal stove had better taste and colour than electric-cooked Ugali due to slower cooking. *"Electric cooking is fast and some foods like ugali may not be very tasty",* a participant explained. Focus group participants attributed taste differences to modern versus traditional pots seeping into the food while cooking, asserting that "*the ugali cooked with firewood and charcoal tastes better than that cooked with electricity*", and that "*there is a difference in colour of the ugali cooked with firewood and electricity*". They believed some foods, like scones, pizza, chips, and chicken, would retain their taste when cooked with other fuels. They also asserted that foods requiring steaming, such as beans and barbecued steak, were unsuitable for electric cooking.

Nationally, households attributed perceived differences between electric and traditional cooking methods to cooking speed (77.9 percent), taste (66.3 percent) and cost 24.5 percent (See Table 5.6). Only small percentages cared about smell (1.9 percent) and cleanliness (3.1%) as factors. Other reasons included ease of use, and multipurpose functionality of modern methods. More rural households that pointed out speed of cooking (65.3 percent), taste of the food (60.7 percent), smell of the food (71.5 percent) and cleanliness (93.2 percent) were the primary factors explaining differences between electric appliances and traditional cooking methods compared to the urban households. More male headed households (69.2 percent) also mentioned taste as the factor explaining the difference between food cooked using modern and traditional methods. This was the case for households connected to Kenya Power (78.5 percent) and also wealthy households (22 percent). When analysing perceptions related to eCooking appliances, an EED Advisory (2023) study found that the EPC and the air fryer were best rated in terms of speed of cooking, safety, satisfaction with cooking pots and heat regulation capability. The study revealed that households perceive LPG to be more reliable than electric cookers, even though they noted drawbacks such as the requirement for matchboxes or the lack of an indicator to determine cylinder capacity.

Some participants were hesitant to adopt electric cooking, fearing it would wear out pots faster than traditional 3-stone fireplaces due to concentrated versus distributed heat at the bottom of the pot. However, others attributed negative perceptions to a lack of awareness and exposure, as well as knowledge gaps in appropriate kitchenware for electric cooking. A focus group participant asserted that *"cooking with electricity damages cooking pots".*

However, some participants believe the negative perceptions and beliefs held against electric cooking are due to lack of awareness and exposure to electric cooking. "*It is lack of experience and exposure that makes others think that the food tastes different. It also depends also on the quality of sufuria one is using*". *"It is important to know also the type of cook ware that we can use with electricity e.g., we cannot use earthenware to cook on electricity".* Lack of knowledge on the appropriate kitchenware to use for electric cooking is also a gap.

3.5 Household stacking of cooking solutions

Stacking involves combining different energy sources and technologies to satisfy a household's energy needs. For instance, a household could use both electricity and gas appliances for tasks like cooking and heating. Previous research indicates that stacking is prevalent in Kenyan households (EED Advisory, 2023; Leary et al., 2019; Ministry of Energy and Petroleum, 2019b). In order to analyse stacking, we collected data on households' main cookstove, secondary cookstove, and tertiary cookstove. As shown in the Table 3.5, approximately two-thirds of households own at least two cookstoves. This practice is widespread across both urban and rural areas. Notably, there is an observable trend wherein the number of stoves increases with higher wealth quintiles. The highest wealth quintile exhibits the highest proportion of households owning three cookstoves, whereas the two lowest quintiles have slightly over half of their households owning only one cookstove. Consequently, it is reasonable to suggest that household wealth significantly influences the propensity for cookstove stacking.

Table 3.5 Household stacking of cookstoves across regions and wealth

Categories		Zero Cookstoves	One Cookstove	Two Cookstoves	Three Cookstoves

Region	National	0.07%	36.61%	42.64%	20.68%
	Urban	0.19%	36.05%	42.46%	21.29%
	Rural	0.00%	36.94%	42.74%	20.32%
Wealth Quintiles	Poor Quintile	0.00%	53.17%	33.34%	13.49%
	Lower Middle Quintile	0.00%	52.12%	33.58%	14.30%
	Middle Quintile	0.00%	36.06%	47.33%	16.61%
	Upper Middle-Class Quintile	0.35%	28.17%	52.38%	19.10%
	Wealthy	0.00%	16.51%	45.88%	37.61%

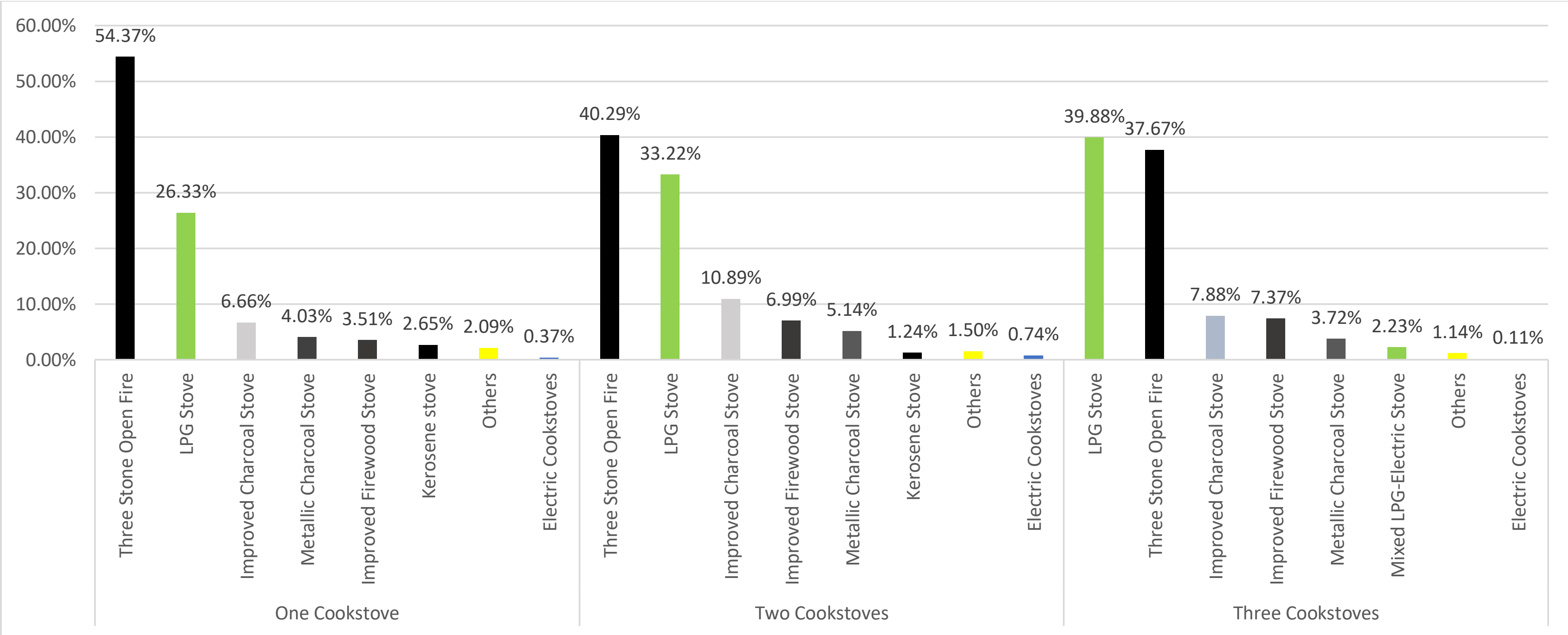
Assessing the ownership of cookstoves across various categories of household stacking strategies reveals that a typical household stack would comprise at least three-stone open fire, LPG stove, and improved charcoal stove. This observation underscores the importance of understanding the factors influencing households' preference for these cookstoves, which in turn could guide strategies for expediting the adoption of eCooking technologies.

Notably, the significance of LPG stoves becomes more pronounced as households' transition from using a single cookstove to a stack of three cookstoves, as illustrated in 3.17. Intriguingly, the LPG stove stands out as the most owned stove among households possessing a cookstove stack of three. Gaining insights into the underlying factors driving the prevalence of LPG cookstoves within households could offer valuable guidance for developing interventions aimed at accelerating the adoption of eCooking technologies.

The findings of this study underscore the need for a comprehensive strategy when transitioning to eCooking, encompassing cultural, economic, and market development considerations. For instance, when households were questioned about the difference between food prepared using eCooking technologies and traditional cooking technologies, 65 percent mentioned disparities in taste. Whether this distinction is perceived or real, it signifies that interventions like awareness campaigns or practical demonstrations could play a pivotal role in accelerating the adoption of eCooking technologies.

The prevalence of three-stone open fires (TSOF) can also be attributed to their low initial cost. This study highlights that households face either no costs or minimal expenses when establishing TSOF. However, the successful adoption of LPG stoves indicates the potential to motivate households to incorporate eCooking technologies into their stacking approaches. For instance, the mean average cost of buying the LPG cooking solution is Kshs. 4,337 yet this study indicates that the LPG stove is regarded as an aspirational cooking technology by 31.10 percent of households, the highest among all stoves, only followed by electric pressure cooker at 27 percent. It is plausible that emergence of LPG as an aspiration cookstove has been fostered by interventions such as subsidies, awareness campaigns, and tax exemptions, among other policies. Similar policies can be extended to promote the adoption of eCooking technologies.

Figure 3.17 Prevalence of different stoves across stacks



Closely intertwined with affordability is the ready availability of biomass fuels such as firewood and charcoal. Equally, this study shows that LPG is readily available to households. When questioned about potential shortages, 66 percent, 61 percent, and 89 percent reported that they rarely or have never experienced firewood, charcoal, and LPG shortage respectively. In addition, there exists a well-established distribution network for LPG that has been developed over time. This is not the case for eCooking technologies. For instance, this study shows that eCooking stoves are primarily concentrated in urban areas, which potentially exclude a substantial proportion of rural households.

Summary

In sum, this section provided insights into household ownership and usage patterns of eCooking appliances in Kenya. 25.2% of households reported owning an eCooking appliance. Appliances like electric kettles and water heaters are most common, particularly in grid-connected households. Rural households surprisingly reported higher ownership of eCooking appliances. Gender and wealth also play a significant role in eCooking adoption, with male-headed households being more likely to own eCooking appliances, and ownership skewed towards higher wealth quintiles, with some exceptions like the high prevalence of inefficient electric coil stoves among lower-income households.

The study also analyses appliance usage, cooking practices, and typical cuisines in Kenyan households. Most households use electric appliances mainly for boiling water (63.2%) and reheating food (12.7%). The study further explores typical meals in Kenyan households, finding that supper is the most frequently prepared meal, and fewer households prepare lunch regularly compared to breakfast and supper. Breakfast primarily consists of hot beverages and porridge, with the former being consumed by nearly twice as many households as the latter. Lunch and supper have similar constituent dishes Generally, household menus are narrow and include rice, ugali, vegetables, cereals, meat stews, and roots. Further, common meals vary by wealth and gender, with upper-class households showing a greater variety in dishes. Taste preferences are deeply influenced by a matrix of cultural, economic, and social factors.

Households expressed a willingness to pay between KES. 3,000 and KES. 15,500 for eCooking appliances. The decision to purchase eCooking appliances is influenced by a variety of factors including recommendations from friends and family, affordability, and cooking speed. Urban and rural households, as well as male and female-headed households, prioritize different factors when choosing to purchase these appliances.

Social cultural beliefs significantly shape the adoption of modern cooking appliances. Many view using these appliances as foreign and believe that food cooked traditionally tastes better. 74.6% of households believe there's a difference in taste between food cooked on electric appliances and those prepared using traditional methods. The major perceived differences between electric and traditional cooking are due to speed (77.9%), taste (66.3%), and cost (24.5%). Focus group participants deemed foods like chapati, pilau and ugali to be better tasting when cooked traditionally. The findings emphasize the importance of knowledge and cultural beliefs in the adoption of new technologies, and the role of behaviour change campaigns and consumer education on the benefits of electric cooking.

Stacking refers to the use of multiple energy sources and technologies in a household to meet their energy needs. A typical household "stack" includes at least a three-stone open fire, an LPG stove, and an improved charcoal stove. Around two-thirds of households use more than one type of stove, a practice common in both urban and rural areas. Further, wealthier households are more likely to own multiple stoves, with the wealthiest quintile showing the highest ownership of three stoves. Notably, as households transition from using a single stove to multiple stoves, LPG stoves become increasingly significant. Among households with three stoves, the LPG stove is the most commonly owned.

The findings highlight the need for targeted interventions, such as subsidy programs targeting lower-income and rural households to make eCooking appliances more affordable, and awareness campaigns to promote the benefits and proper usage of efficient eCooking appliances. Financing schemes, particularly for female-headed households, could be introduced to overcome upfront cost barriers. Finally, the market presence of energy-efficient appliances that fall within the households' willingness-to-pay range could be increased.

4 THE TRANSITION TO ECOOKING AS AN ALTERNATIVE COOKING SOLUTION

4.1 Profiling Households Access to Cooking Solutions: A Multi-Tier Framework Approach

The study assesses the status quo of households' access to cooking solutions using the MTF approach. The MTF defines households access to cooking solutions based on six technical and contextual attributes that consider users' cooking experience, environment, and the market and energy ecosystems. These attributes are: (i) exposure, (ii) efficiency, (iii) convenience, (iv) safety, (v) affordability, and (vi) fuel availability. Each attribute has six tiers, ranging from 0 to 5 to measure progress. Tier 0 is the lowest applicable tier, representing no access, and Tier 5 is the highest classification, representing full service. Each household is then assigned an aggregate tier classification corresponding to the lowest tier. The aggregate tier is then averaged over the population or subpopulations of interest. Based on the aggregate tier score, a household is classified as having access to cooking solutions as follows:

- Modern Energy Cooking Services (MECS) if it has a score of Tier 4 or higher across all six attributes.
- Improved Cooking Services (ICS) if it has at least a Tier 2 aggregate score across all six attributes. Households with MTF Tier 2 or Tier 3 are considered in Transition.
- Traditional Cooking Services (TCS) if it has a score of Tier 1.

Table 4.1 summarises the MTF classification approach used in this study.

Table 4.1 Profiling Household Access to Cooking Solutions: A Multi-Tier Framework

Attribute	*Measurement*
Exposure Tiers	This measures personal exposure to pollutants and depends on both stove emissions and ventilation. Exposure is ideally calculated based on emission testing information and tiers determined based on ISO/TR 19867-3 Voluntary Performance Targets for cookstoves based on laboratory testing (2018). Cookstove Tiers are assigned as follows: i. **Stove emission tier is 0** if households use traditional solid fuel stove as their primary stove. ii. **Stove emission tier is 5** if households use solar cooker, electric stove, piped natural gas stove, biogas stove, or LPG cooking gas stove as their primary cookstove. iii. **Stove emission tier will be between Tier 1-4** depending on the type of cookstove and fuel used and include most of the improved cookstoves. Determination of Tier 1-4 is normally based on lab testing results. However, this study did not incorporate lab tests for its tier categorization, but instead, relied on multiple sources to establish the Tier levels. Key among these sources were emission factors listed in the Clean Cooking Alliance's catalogue[15], which serves as a comprehensive repository of stove designs, fuel types, and testing data. Additionally, we sourced emission estimates for various fuels from peer-reviewed academic papers. The final exposure categories were established

[15] Clean Cooking Alliance. (n.d.). Clean Cooking Catalog. Retrieved January 6, 2023, from http://catalog.cleancookstoves.org/

	based on the ISO/TR 19867-3 guideline, which provides Voluntary Performance Targets for cookstoves.
Efficiency Tiers	Efficiency measures the combination of combustion and heat-transfer efficiency of the households' cooking technology. The tiers and the threshold for efficiency classification are guided by ISO/TR 19867-3 Voluntary Performance Targets for cookstoves based on laboratory testing (2018). As in the exposure tiers, this study used a combination of Clean Cooking Alliance repository of stove and fuel typology and literature review to determine efficiency measures. However, the tier allocation was based on ISO/TR 19867-3 Voluntary Performance Targets for cookstoves.
Convenience Tiers	Convenience measures the time a household spends collecting or purchasing fuel and preparing the fuel and their stove for cooking. Although the original MTF focuses on time to collect fuel, this study extends the attribute to include time for delivery to account for households whose cooking fuel is delivered to their residence. The convenience tier is computed as follows: $Conv_{Tier} = Time\ collect\ Fuel\ per\ Trip \times \frac{No\ of\ Time\ Fuel\ Collected\ in\ Month}{7}$ Convenience Tiers are computed as follows: i. **Tier 1:** Households that spend at least 7 hours per week collecting fuel and used more than 10 minutes the previous day preparing the cookstove and/or fuel for cooking. ii. **Tier 2:** Households that spend more than 7 hours per week collecting fuel and used more than 10 minutes the previous day preparing cookstove and/or fuel for cooking. iii. **Tier 3:** Households that spend between 1.5 hours and less than 3 hours per week collecting fuel and used less than 10 minutes the previous day preparing the cookstove and/or fuel for cooking. iv. **Tier 4:** Households that spend between 0.5 hours and less than 1.5 hours per week collecting fuel, and used less than 5 minutes the previous day preparing the cookstove and/or fuel for cooking. v. **Tier 5:** Households that spend between 0.5 hours per week collecting fuel and used less than 2 minutes the previous day preparing the cookstove and/or fuel for cooking.
Safety Tiers	Safety measures serious injuries from the primary stove over the last 12 months. The safety Tiers are assigned as follows: i. **Tier 0:** Death ii. **Tier 2:** Poisoning, Fire in house, Person burned. iii. **Tier 3:** Other problems only if they are very minor problems. iv. **Tier 5:** None
Affordability	Affordability measures the expenditure on fuels. A cooking solution is considered affordable if a household spends less than 5% of the household expenditure on their cooking fuel in a month. Affordability Tiers are assigned as follows: i. **Tier 2:** The household's monthly total expenditure on fuel is greater than or equal to 10 percent. ii. **Tier 3:** The household's monthly total expenditure is greater than 5 percent but less than 10 percent of household total expenditure. iii. **Tier 5:** The household's monthly total expenditure is less than 5 percent of households total expenditure.
Fuel Availability	Fuel availability measures the availability of primary fuel over the last 12 months. It captures the readiness of the fuel when needed by the user. Fuel availability Tiers are assigned based on households' response to the question:

'how often was the fuel unavailable in desired quantity?'. The Tiers are assigned as follows:

i. **Tier 2:** Often
ii. **Tier 3:** Sometimes
iii. **Tier 4:** Rarely
iv. **Tier 5:** Never

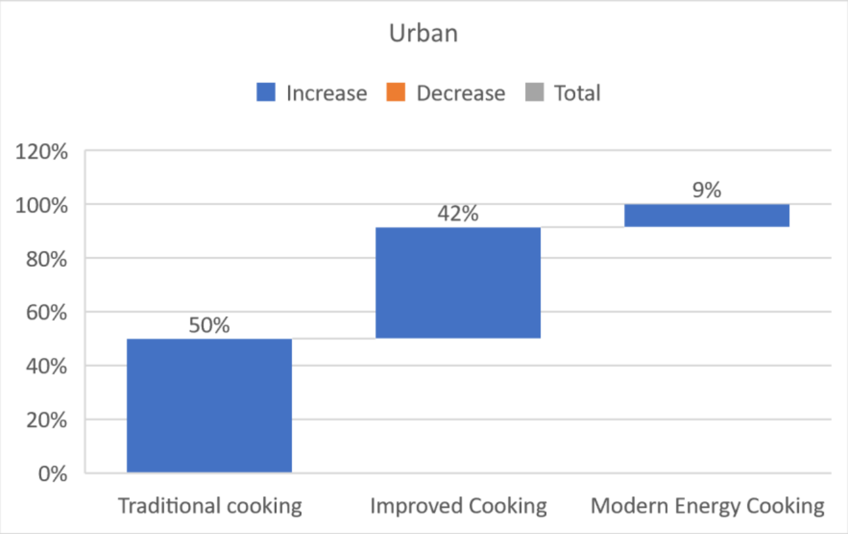
This study follows the MTF guideline and assigns households an aggregate tier classification that corresponds to the lowest tier of all six. Based on the aggregate tier score, a household is classified as having access to Modern Energy Cooking Services (MECS) if it has a score of Tier 4 or higher across all six attributes. A household is classified as having access to Improved Cooking Services (ICS) if it has at least a Tier 2 aggregate score across all six attributes. Households with MTF Tier 2 or Tier 3 are considered in Transition. Households with MTF Tier 1 are considered as having access to traditional cooking services (TCS). The distribution of households based on national, urban-rural segments, gender of household head, wealth quintile, and clusters is given below.

The Multi-Tier Framework (MTF) analysis for cooking reveals some insightful trends about cooking practices across different demographics and locations. TCS remain prevalent in both urban and rural areas, but they are especially dominant in rural areas with an 87 percent usage rate compared to 50 percent in urban areas (see Figure 4.1). Despite this, urban regions show a higher inclination towards adopting ICS and MECS, with 42 percent using ICS and 9 percent using MECS. In contrast, the adoption of these more advanced cooking solutions is notably lower in rural areas.

When broken down by wealth quintiles, the data presents some intriguing contradictions (see Figure 4.2). Contrary to what might be expected, TCS are less prevalent among the poorest and lower-middle-class households. Instead, it is the middle to wealthy class households that rely more heavily on TCS for cooking. However, it is worth noting that wealthy households also lead in the adoption of MECS. ICS, interestingly, find the most usage among poor households, followed by the lower middle, middle class, and upper-middle-class households. This nuanced picture suggests that both economic and cultural factors play a complex role in shaping cooking practices across different segments of the population.

The integrated MTF framework considering household access to electricity and access to cooking solutions demonstrates a substantial opportunity for transitioning to eCooking. More than 70 percent of households connected to the grid and using TCS possess a grid connection capable of supporting eCooking (see Figure 4.3). A comparable pattern is evident among households connected to the grid and using ICS. Although a large proportion of households use MECS with grid connections that can support eCooking, only a small fraction currently engages in eCooking, as indicated by the modest proportion of eCooking users. Consequently, this market segment presents a readily available target for expediting eCooking adoption, requiring minimal intervention costs.

Figure 4.1 Household Access to Cooking Solutions: Urban vs Rural households



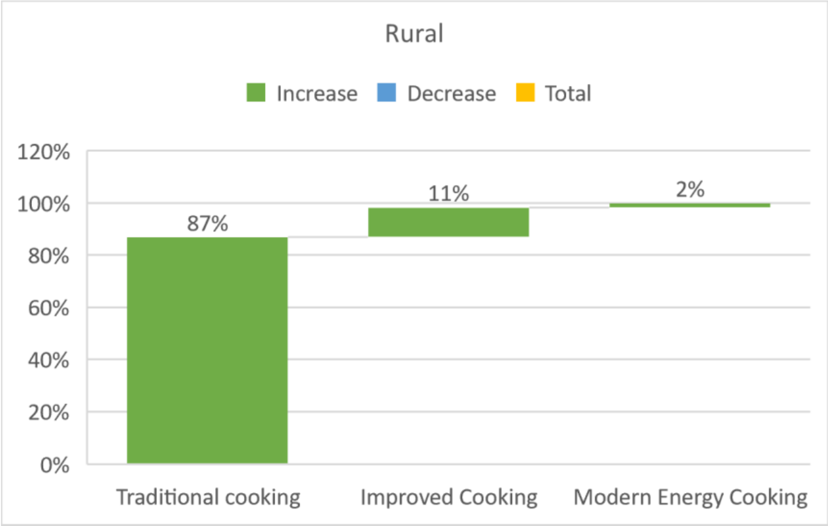
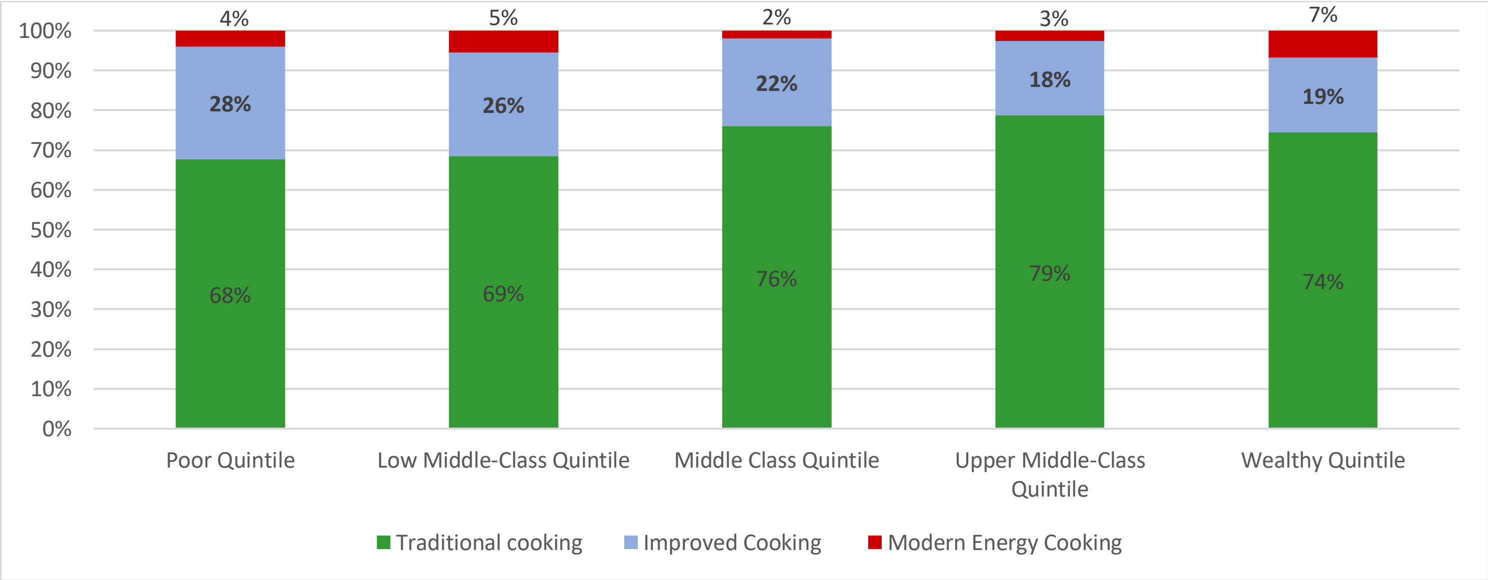


Figure 4.2 Household Access to Cooking Solutions by Wealth Quintiles



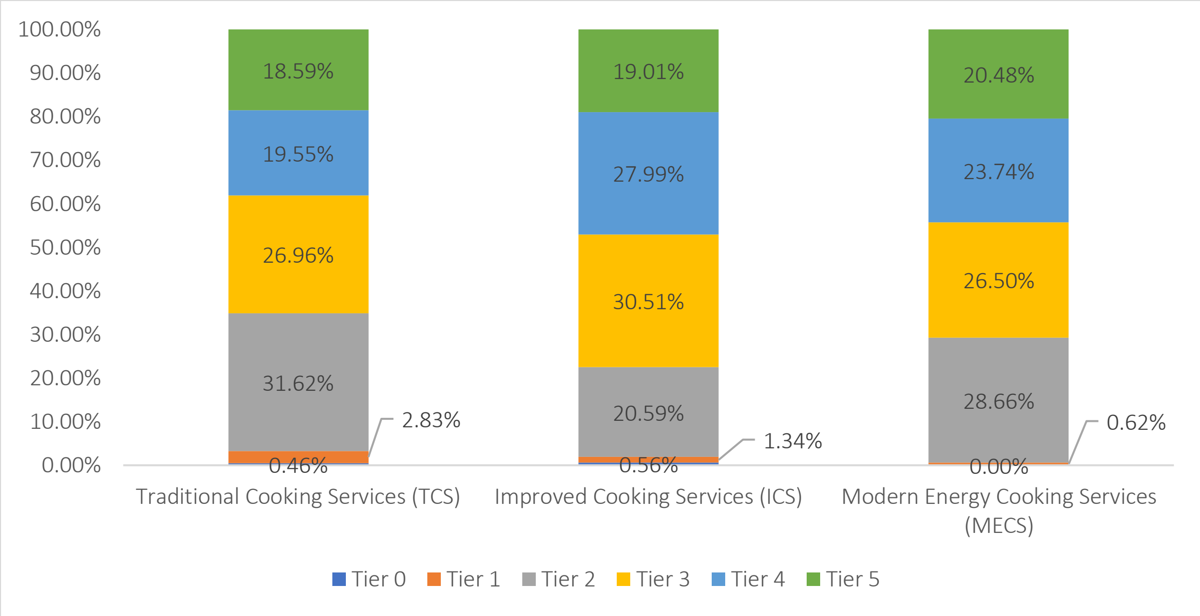


Figure 4.3 Mapping adoption of cooking services to electrification tiers

The findings from the Multi-Tier Framework (MTF) analysis have important implications for policy and practice when it comes to scaling modern cooking services. The fact that traditional cooking methods are less prevalent among the poorest households may suggest that economic constraints are not the sole barrier to adopting modern or improved methods. This opens up an avenue for targeted interventions that go beyond merely subsidizing the cost of modern cooking technology. Cultural preferences and education might play a significant role; hence, awareness campaigns or practical demonstrations could be particularly effective for this segment of the population.

Moreover, the urban-rural divide in the adoption of improved and modern cooking methods indicates the necessity of geographically tailored policies. For rural areas, where traditional cooking is overwhelmingly prevalent, initial efforts might focus on introducing improved cooking services as a transition to more modern methods. The higher adoption rates of modern cooking services among the wealthy also suggest that policy measures such as tax incentives or subsidies for modern cooking technology could find the most traction among upper-income brackets. However, considering that improved cooking methods are most popular among the poor, a focus on making these transitional technologies more efficient and sustainable could provide a more realistic short-term solution for lower-income households. Overall, the data points towards the need for a multi-pronged approach that considers both socio-economic and geographic factors for successfully scaling modern cooking services.4

4.2 The Relative Cost of eCooking in Kenya

The Kenyan eCooking appliance market is diverse and features fierce competition among new and established players, with a variety of products catering to different income levels and preferences. Consumers have numerous options to choose from, with brands ranging from expensive to more affordable alternatives. Table 4.2 summarises the typical retail prices for selected eCooking appliances in Kenya. The majority of appliances are priced between KES 3,000 and 15,000, aligning with the "willing to pay" analysis. Therefore, these appliances could be affordable for a broad range of households under the right conditions. As the market continues to evolve, it is expected that more innovative and cost-effective solutions will emerge, further promoting the adoption of eCooking appliances.

Table 4.2 Typical retail prices for selected eCooking appliances in Kenya. Source: Own data.

Cooking Appliance	Approximate Min Price[16]		Approximate Max Price	
	KES	USD	KES	USD
Mixed LPG/electric standalone cooker	22,995	177	204,995	1577
Microwave	6,499	50	222,600	1712
Air fryer	5,999	46	42,219	325
EPC	5,663	44	25,995	200
Induction/infrared cooker	4,469	34	162,300	1248
Rice Cooker	2,999	23	19,500	150
Electric Hotplate	945	7	11,850	91
Electric Kettle	759	6	7,995	62
Water heater	299	2.08	2,274	15.83

Earlier in 2023, Kenya Power proposed an increase in electricity tariffs and a lowering of the qualifying limit for the lifeline power subsidy, a move that would have meant significant additional costs for low-income households that are considering the shift to electric cooking. After public consultations, and advocacy by the eCooking Community of Practice, the Energy and Petroleum Regulation Authority's tariff review acknowledged that the proposed structure might discourage adoption of electric cooking, and in response, the regulator introduced an intermediate tariff band (Domestic Ordinary 1) to bridge the gap between lineline and regular domestic tariff (EPRA, 2023). However, this tariff was still higher than the retail tariffs that prevailed in most of the year 2022.

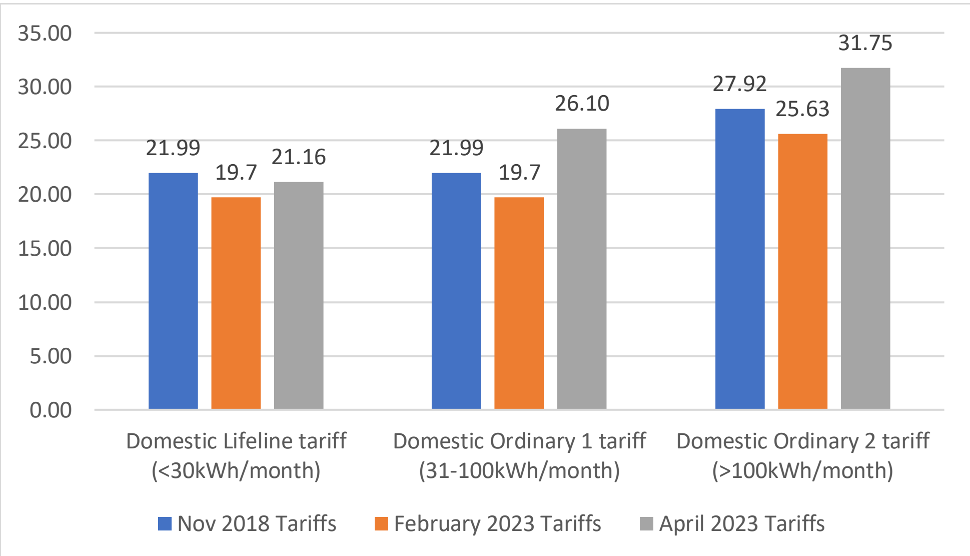


Figure 4.4 Domestic electricity tariffs in Kenya

[16] Most prices are sourced from online retailers such as Kilimall, Jumia, ZuriCart and Quest, and from websites of distributors such as Hotpoint.

We examined several studies that explored the relative cost of cooking with electricity, including two internal studies by Village Infrastructure Angels (VIA) and BURN Manufacturing. These studies were conducted under varying conditions and methodologies, thus the comparative analysis should be considered as indicative rather than conclusive. Using the 2023 electricity tariffs—both before and after April 2023 when the new tariff came into effect—we reanalysed potential household expenditures on eCooking in comparison to other fuel sources such as LPG, charcoal, and kerosene based on reported figures. To facilitate comparison, we adopted the upper limit in each case (e.g., 100% eCooking by ESMAP, cooking all meals by BURN. We also applied the Domestic Ordinary 1 tariff, given that in all cases, monthly consumption levels were above 30kWh but below 100kWh. Table 4.3 broadly summarises the findings in terms of electricity fuel consumption.

Table 4.3 Monthly electricity consumption for cooking across different studies in Kenya

Source	**Methodology**	**Appliances tested**	**Findings on Energy Consumption (mean monthly)**
ESMAP (2020)	Techno-economic numerical simulation	Electric pressure cooker, hot plate	• 57.6 kWh/month (100% eCooking), • 19.2 kWh/month (50% eCooking)[17]
EED Advisory (2023)	Univariate linear least square regression	Electric pressure cooker, hot plate, air fryer	• 29.82 - 59.65 kWh monthly[18]
Kenya eCookbook by Leary et al. (2019)	Comprehensive study using Cooking Diaries	Rice Cooker, Microwave, Electric Kettle, Electric Pressure Cooker, Electric Hot Plate	• 85 kWh/month
Burn Manufacturing (2023)	CCTs and KPTs among urban households in Kiambu and Nairobi	Burn induction cooker	• 69 - 75kWh/month (all meals) • 46.8kWh/month (1-2 meals)[19]
Village Infrastructure Angels (2022)	Fuel comparison	Normal and efficient electric cooking pots	• 54 – 75kWh/month[20]

We also estimated eCooking costs using data from the Kenya National eCooking Survey on household cooking habits, including meal preparation routines, the number of meals typically cooked in a day, their frequency, the composition of dishes per meal, specific dishes, cooking techniques employed, and other pertinent aspects of cooking. This approach generated an extensive dataset that effectively captured the diversity of household cooking behaviors. However, it is important to note that, due to the nature of data collection in surveys, the study was unable to directly measure household energy consumption. Additionally, cooking diaries are generally considered more precise in collecting actual usage data compared to surveys. Therefore, in the process of estimating eCooking costs, this study

[17] 1.92 kWh/day (100% eCooking), 0.64 kWh/day (50% eCooking)
[18] 3.68MJ to 0.41MJ per dish
[19] 2.3-2.5 kWh/day (all meals), 1.56 kWh/day (1-2 meals)
[20] 1.8 – 2.5kWh/day

employs a triangulation approach, combining data from eCooking diaries and survey responses to construct eCooking costs.

We found some inconsistent results across studies (see Figure 4.5). In the ESMAP study in particular, cooking with electricity appeared more cost-effective both before and after the tariff revision. However, other studies suggest that while the old tariff was beneficial for eCooking, the updated tariff makes eCooking more expensive than alternatives like LPG and firewood, except for charcoal as reported in the VIA study. In the BURN study, eCooking under the new tariff is more costly that using LPG. We found similar results in our own analysis of survey data. eCooking and LPG are cost comparative in the VIA study. These variations indicate that for households to switch to eCooking based on cost considerations, a tariff reduction in line with the pre-review level would be necessary to make eCooking more competitive, especially relative to LPG.

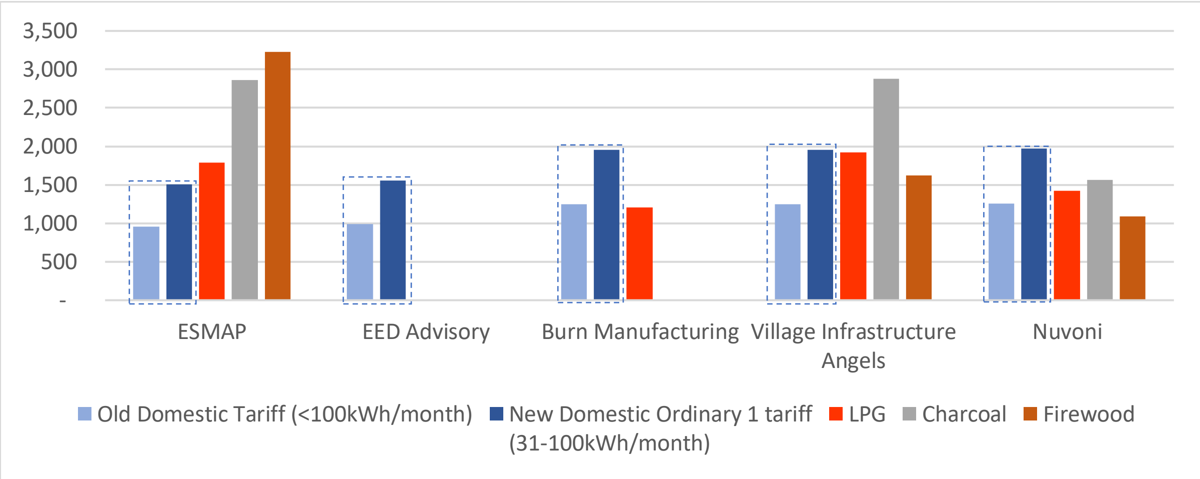


Figure 4.5 The cost of eCooking relative to other fuels across various studies

4.3 The eCooking Transition: An Optimistic Scenario

MECS programme modelling forecasts that if 40% of Kenya's grid-connected charcoal users, which equates to about 2.6 million people or 0.7 million households, transitioned to electric cooking, several significant impacts could be realized (Leary, 2022). Using the WHO's BAR-HAP tool, it is projected that this shift would avoid 1,203 Disability Adjusted Life Years (DALYs) per year and reduce CO2 equivalent emissions by 1.9 million tonnes annually. There would also be a decrease in unsustainable wood harvest by 0.4 million tonnes each year. In terms of societal benefits, it would save 191 million hours of women's time every year, translating to about 272 hours per household per year.

Our analysis of household electrification reveals that many Kenyan households, irrespective of wealth, gender, or fuel type, possess Tier 3+ electricity suitable for electric cooking. If we optimistically disregard barriers like wealth constraints (impacting appliance and electricity tariff affordability), household size (which dampens interest in eCooking due to small pot sizes or retail appliances unsuitable for larger families), gender biases (highlighting reduced adoption rates among female-led households due to various constraints), and regional disparities (with urban areas having better appliance availability and higher incomes), our findings indicate that 64.9% of Kenyan households are poised to immediately switch from traditional fuels to electric cooking, as illustrated in Figure 4.7.

Factoring in the existing 3.88% of households already using electricity for cooking, this rises to 68.7%. This potential transition population includes 31% of those currently using firewood, 25% using LPG, and 8% using charcoal, as shown in Table 4.4.

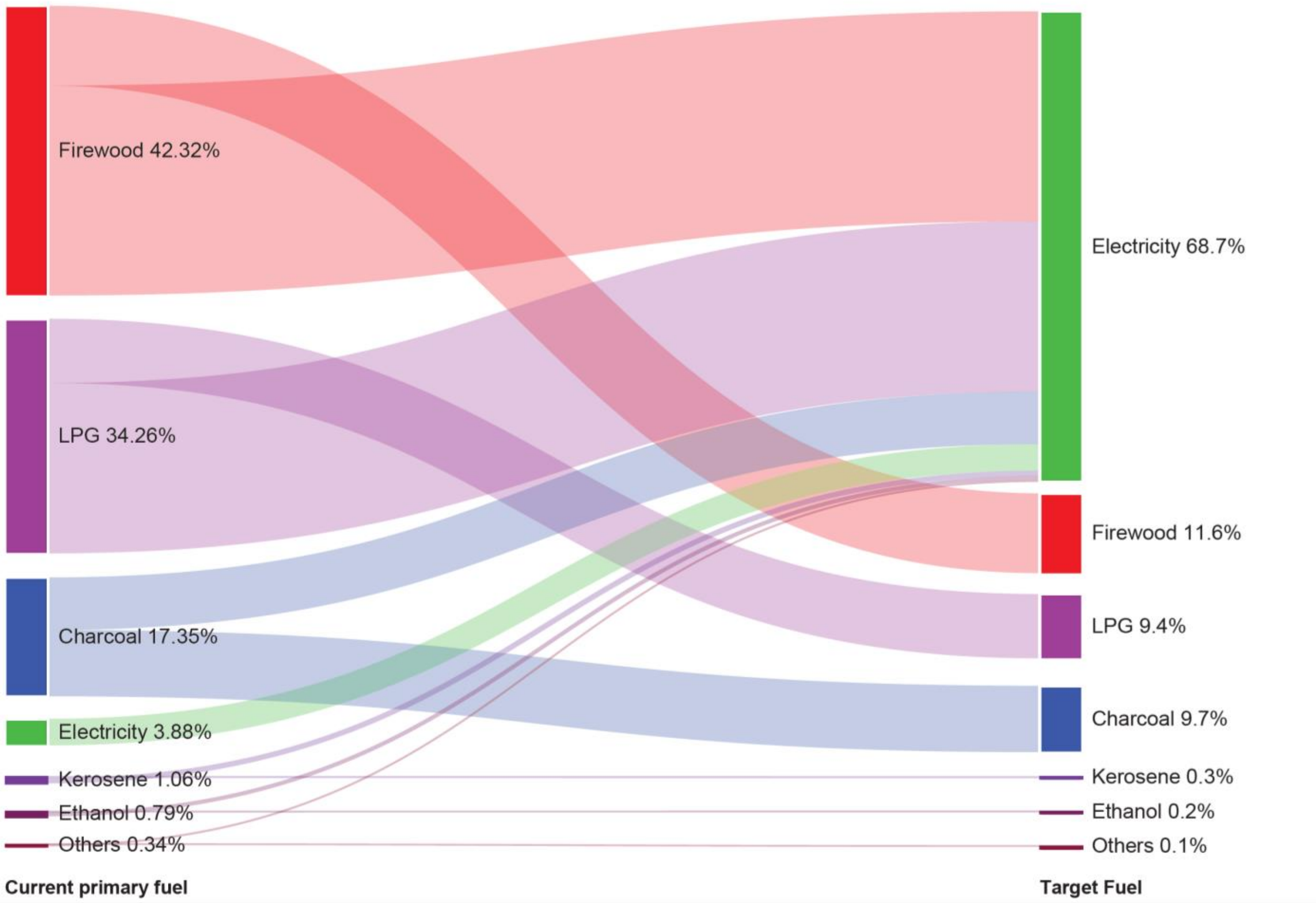


Figure 4.6 Transition to eCooking based on Tier 3+ Electricity Access

Table 4.4 Proportions of other fuel users with Tier 3+ electricity

Current fuel	Proportion with Tier 3+ electricity
Firewood	30.67%
LPG	24.88%
Charcoal	7.67%
Kerosene	0.77%
Ethanol	0.59%
Others	0.28%

The scenario in which 68.7% of Kenyan households can immediately switch to electric cooking is optimistic. While optimistic scenarios aim to inspire and set ambitious targets, it is important to recognize what needs to be done to make such a scenario feasible:

- Improve affordability of eCooking appliances and electricity tariffs: Many households might have access to Tier 3+ electricity but may not be able to afford the initial investment in electric cooking appliances or the ongoing electricity costs. Subsidies or financing options could help make the transition more affordable for these households.

- Upgrade the electricity generation, transmission and distribution infrastructure: The current electrical grid may not be equipped to handle a large increase in electricity demand that would occur with a mass transition to electric cooking. Investment in infrastructure improvements, including an increase in renewable energy capacity, would be essential.
- Awareness and Education: As we shall see below, many people are unfamiliar with the benefits of electric cooking or how to use electric cooking appliances efficiently. Further, cooking methods are deeply ingrained in the cultures of Kenya, and a shift to electric cooking could require behavioural adaptations. Awareness campaigns may help address these gaps.
- Policy Support: Legislative measures might be required to incentivize or even mandate the switch to electric cooking in certain sectors. Government policies across related ministries such as energy, health and environment, along with their respective strategies, action plans and targets would be streamlined towards such an ambitious goal. Government policies can support market development activities for scaling eCooking (e.g., through subsidies and tax incentives), support the upgrading electrification infrastructure, support R&D in the eCooking ecosystem, among other interventions.
- Supply Chain: A reliable supply chain for electric cooking appliances, as well as their parts for repair and maintenance, along with suitable financing mechanisms for all players involved, would need to be established. Encouraging local manufacturing and/or assembly of electric cooking appliances can create jobs and help tailor the products to local needs, making adoption easier. The rural-urban gap in appliance availability and support would also need to be addressed.
- Gender Constraints: Given that cooking is often a gendered activity, specific constraints faced by female-headed households, such as affordability or social norms, need to be addressed to enable their full participation in this transition.

In summary, while the optimistic scenario sets an inspiring target, realizing it will necessitate a coordinated, multi-pronged approach that tackles social, economic, and infrastructural challenges head-on.

5 THE ENABLING ENVIRONMENT FOR ECOOKING

5.1 The Supply Chain for eCooking Appliances

5.1.1 Importation of eCooking appliances

Electric cooking appliances are imported from various countries. Key source countries include China, India, Vietnam and Taiwan in Asia, France, The Netherlands, Germany, Turkey, Czech Republic, United Kingdom and Italy in Europe, United Arab Emirates and the United States (see Figure 5.1). Primary players in the importation process include manufacturers and suppliers that produce the appliances in the source countries; Kenyan companies or entrepreneurs that import and distribute them to retailers or directly to consumers such as Nagoya Holdings Ltd; freight forwarders and customs brokers who facilitate the shipping and clearance of the goods through customs at Kenya entry ports; and regulatory authorities, particularly the Kenya Bureau of Standards (KEBS) which ensures that the imported products meet local safety and quality standards, and the Kenya Revenue Authority (KRA) oversees the customs clearance and taxation process.

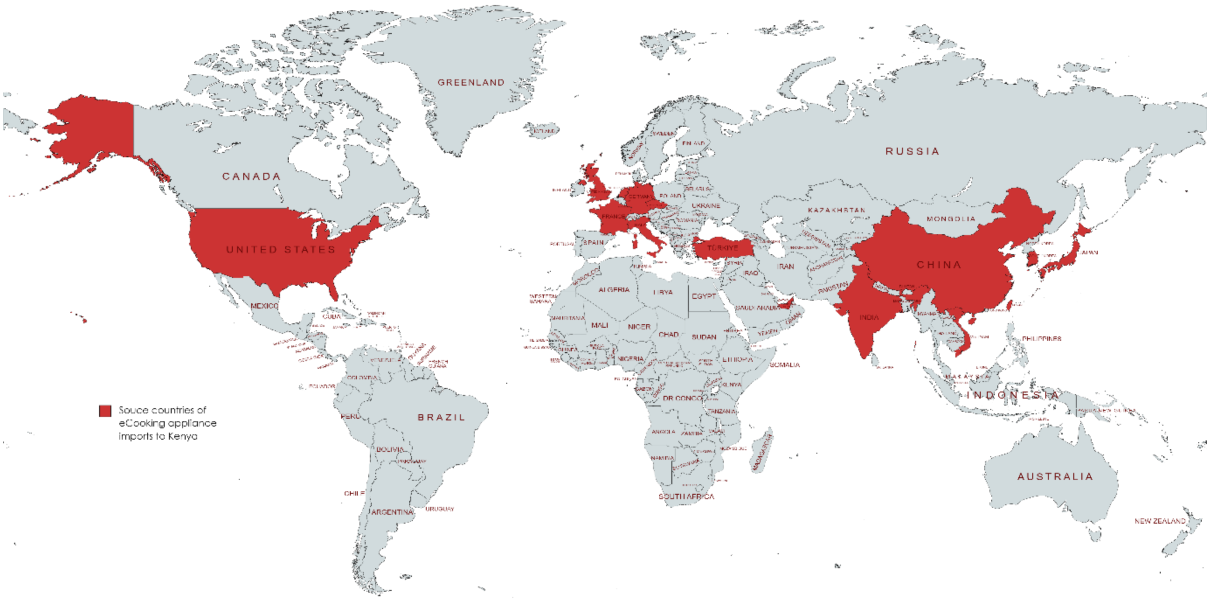


Figure 5.1 Source countries for electric cooking appliance imports into Kenya

The supply chain for electric appliances is complex and involves multiple stages, from raw material extraction to the end consumer. The process can vary depending on the specific appliance and the companies involved. A general outline of the supply chain for electric appliances before they arrive in Kenya, both from a local and international perspective, is as follows (illustrated in Figure 5.2):

- Component manufacturing: Electric cooking appliances require various raw materials such as metals, plastics, and electronic components. These materials are sourced from mines and oil fields worldwide. For instance, copper might come from Chile, while rare earth metals could be sourced from China or Australia. The raw materials are processed and transformed into components needed for the electric appliances. These components can include motors, circuit boards, wires, and various electronic components. Manufacturing facilities are located in various countries, including China, Taiwan, Japan, South Korea, and the United States, among others. Table 5.1 illustrates the differences between origin countries and primary manufacturing countries for different brands of eCooking appliances.

- Assembly, quality control and testing: Once the components are manufactured, they are sent to assembly facilities where the electric appliances are put together. Some appliances may have their assembly done in one country, while others may have parts assembled in multiple locations before being consolidated into a final product. China is a major hub for the assembly of appliances. After assembly, the electric appliances undergo rigorous testing and quality control checks to ensure they meet safety and performance standards. This step is crucial to guarantee the reliability and safety of the appliances.
- Packaging and Shipping: Once the appliances pass quality control, they are packaged and prepared for shipment. The shipping method depends on factors like the volume of the shipment and the importer's budget constraints, and these affect the retail price of the appliance. The most common delivery models for importing electric cooking appliances to Kenya include:
    - Full container load (FCL) shipping: Importers purchase a full container of appliances, which is more cost-effective for large-scale importers, who in Kenya, tend to be wholesale distributors.
    - Less than container load (LCL) shipping: Importers purchase smaller quantities of appliances, sharing container space with other importers. This model is suitable for small and medium-sized enterprises. However, as experienced by Bidhaa Sasa, it is challenging to find other SMEs in the sector that are interested in collaborating on such import arrangements.
    - Air freight: This is a faster but more expensive option, typically used for high-value or time-sensitive shipments. Airfreight is rarely used to ship eCooking appliances.
- Import and Customs Clearance: Upon arrival in Kenya, the appliances must pass through customs clearance. Import duties, taxes, and fees may be applied, depending on the type and value of the appliances. Importers or distributors are responsible for ensuring compliance with Kenya's import regulations and obtaining any necessary permits or certifications. To ensure the imported appliances meet local safety and quality standards, the importer must obtain a Certificate of Conformity (CoC) from KEBS or an authorized inspection agency in the source country. Customs duties, taxes, and any other applicable fees must be paid to the Kenya Revenue Authority (KRA) before the goods are released.
- Distribution and Warehousing: After clearing customs, the appliances are transported to distribution centres or warehouses in Kenya. Distributors and wholesalers manage the inventory, storage, and distribution of the appliances to retailers across the country.
- Retailers: Retailers purchase the electric appliances from distributors or wholesalers and sell them to the end consumer through the delivery models discussed in the previous section.

Lead times for importing electric cooking appliances can range from a few weeks to several months, depending on factors such as the source country, shipping method, and customs clearance. Costs arising from this supply chain include the price of the appliances, shipping and freight charges, insurance, customs duties, taxes, and any fees charged by regulatory authorities, freight forwarders, and customs brokers. These costs are often passed on to end consumers through the retail price of the appliance.

Table 5.1. eCooking appliances brands imported and their origin and primary manufacturing countries

Appliance Type	Brands available in Kenya	Origin Country	Primary Manufacturing Countries
Electric Pressure Cooker	Von	Kenya	China, Asia
	Nutricook	UAE	China
	Bosch	Germany	Europe, China, India
	MIKA, Ramtons, Rebune, Signatur, Tlac	Various	China
	Moulinex	France	Europe, China
	Sencor	Czech Republic	China, Asia
Air fryer	Philips	Netherlands	Europe, China, Asia
	Nutricook, Von	UAE/Asia	China
	Kenwood	UK	Europe, China
	MIKA, Nunix, Ramtons, Rebune, Tlac	Various	China
Rice cooker	Sayona, Armco, Marado, GC, Nunix, Signature, Ohms, Von	Various	China
	Kenwood	UK	Europe, China
	Panasonic	Japan	Japan, China
Mixed LPG/electric standalone cooker	Nunix, Eurochef, Ramtons, Von, Bruhm, Sayona, Haier, TLAC	Various	China
	Ariston	Italy	Italy, Asia
	Bosch	Germany	Europe, China, India
	Beko	Turkey	Turkey, Global
Electric solid plate/coil hob	Armco, Nunix, Rashnik, Sterling, Karnik	Various	China
	Silvercrest	Germany (Lidl)	China
	Sokany	Various	China
	Eurochef	Various	China
Microwave oven	LG	South Korea	South Korea, China, Vietnam
	Hisense, Haier	China	China
	Ramtons, Nunix, Ailyons	Various	China
	Bosch	Germany	Europe, China, India
	Von	Kenya	China
	Panasonic	Japan	Japan, China, Asia
	Samsung	South Korea	South Korea, China, Vietnam, India
	Ariston	Italy	Italy, China
Electric kettle	Ailyons/Lyons, Rashnik, Scarlett, Itel, Nunix, Rebune, Ramtons, Sayona	Various	China
	Philips	Netherlands	Europe, China
	Von	Kenya	China
	Kenwood	UK	Europe, China
	Black & Decker	USA	USA, Mexico, China
	Panasonic	Japan	Japan, China
	Tefal	France	France, China
Water heater (immersible)	Generic brands	Various	China
	Tronic	Germany (Lidl)	China

Note: Brands may have several manufacturing sites, and the origin might differ from the manufacturing location

According to 2019 import data (Rousseau and Scott, 2022), four importers dominate the Kenyan eCooking appliance market, the largest being HotPoint Appliances, followed by Hypermart Limited, Ideal Appliances, Armco Kenya. Smaller importers include Samsutech, Crom Impex, Amedo Centres, Zedsons Limited, Newmatic Africa and Naivas Limited. Table 6.3 lists the brands of electric cooking devices imported into Kenya by the above-named enterprises, or available on popular ecommerce platforms such as Jumia, Kilimall, ZuriCart and Quest.

Over the second half of 2019, as further reported by Rousseau and Scott (2022) and Leary (2022), the import landscape for electric cooking appliances in Kenya showcased varied import volumes. Oven/cookers, which encompass both electric and electric/gas combinations, led the market in terms of sales volumes, with a remarkable 68,859 units imported. This dominance was also mirrored in their value, amassing a significant 8.4m USD over the six-month period, even though only 24 distinct models were identified online. Following suit, hotplates registered an import volume of 21,401 units, translating to a value of 110k USD. Rice cookers, boasting 384 unique models, had a sales volume of 14,780 units and contributed to imports valued at 148k USD. Kettles, despite their extensive variety of nearly 1,700 models, presented more modest figures with 18,465 units and a value just shy of 70k USD. Electric Pressure Cookers had a more subdued footprint, with 6,500 units imported and only 15 models available in the market.

Retailers, through key informant interviews, highlight some challenges in the international supply chain for eCooking appliances, among them, high upfront costs, fluctuating prices, rapidly changing appliance models, and the lack of customization for local cuisines and languages. These issues can create difficulties for both distributors and customers, as well as hinder the adoption of electric cooking appliances in Kenya.

- High upfront costs: importing electric cooking appliances from countries like China or India often benefits large importers who have the financial resources and bargaining power to negotiate better prices and order large volumes of appliances. This can create barriers for smaller, regional businesses that lack the resources and scale to compete effectively in the eCooking supply chain. Governments, financial institutions, and development organizations could provide targeted financing options for smaller businesses to help them overcome these upfront costs. An example of such an intervention is the MECS Supply Chain Challenge Fund which is working with SCODE and Nyalore Impact to develop innovative mechanisms to lower supply chain costs for eCooking appliances.
- Fluctuating prices: The frequent changes in the pricing of appliances, particularly those imported from China, can cause friction between distributors and customers, as well as affect the distributors' ability to plan orders and manage inventory. Price fluctuations are also caused by foreign exchange variations. To address this issue, shorter turnaround times and more transparent pricing mechanisms may be needed to minimize price fluctuations and improve customer satisfaction. The industry could also benefit from hedging against forex fluctuations.
- Low import volumes: Retailers such as HotPoint and supermarkets report that energy-efficient appliances such as EPCs and Air fryers are still slow-moving products in retail stores, thus, they have usually been imported in low quantities. As demand at the retail level has begun to rise, it has been difficult for retailers to convince importers to order larger consignments of the

appliances. As one entrepreneur observed, importers would rather fill their containers with television sets than EPCs.

- Rapidly changing appliance models: As electric cooking appliance models change frequently, distributors may face challenges in marketing and selling the latest versions to customers who have placed orders based on previous models. Increased communication between manufacturers and distributors, then distributors and their customers could help manage expectations and ensure smoother transitions between model updates.
- Lack of customization for local cuisines and languages: Many electric cooking appliances are designed with foreign cuisines in mind and may feature instructions in foreign languages, making it difficult for Kenyan customers to adapt and use the products effectively. Localization of appliance features, including pre-set cooking programs for local dishes and instructions in local languages, can enhance user adaptability and encourage the adoption of electric cooking appliances.
- Poor quality imports: The Chinese market, which is the preferred source of eCooking appliances for many Kenyan retailers and distributors, is flooded with low-quality products, making it challenging to find and verify the best quality items. With market information asymmetry, limited resources and time, the process of sourcing and testing for high-quality products in such a market is difficult. SCODE experienced this problem when they first imported a DC EPC, it had a different power rating compared to the label on the product, lacked safety features and had poor quality workmanship.
- Limited capacity of EPCs: Most EPCs available in the international market have a capacity of 6 litres, which may not be sufficient for larger families in Kenya. Although some 8-liter and even 60-litre EPCs and pots are now available, they are not broadly accessible in the open market.

Addressing these challenges will require collaboration between manufacturers, distributors, and policymakers to create a more conducive environment for the adoption of electric cooking appliances in Kenya. This may involve investments in local manufacturing, improved supply chain management, and targeted interventions to support customer needs and preferences.

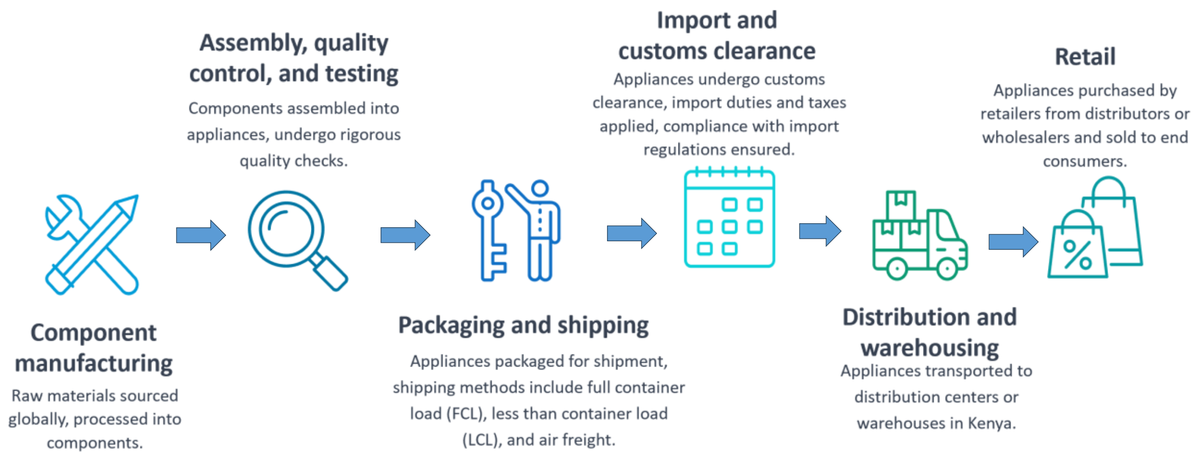


Figure 5.2. Stages in the supply chain for imported electric cooking appliances

5.1.2 Local Manufacturing of eCooking Appliances

Manufacturing of e-cooking appliances in Kenya is still nascent, but recent developments have shown that there is potential to scale up local manufacturing. Key among them are developments within

BURN Manufacturing who are already manufacturing tens of thousands of improved biomass stoves at their factory in Ruiru, Kiambu County, and are gearing up to start local assembly of eCooking devices. PowerPay are doing local assembly of smart eCooking appliances, i.e., modifying conventional appliances with a smart widget to enable data recording, transmission and remote lockout for PayGo. VIA and SCODE are assembling solar eCooking systems in Kenya, and Biolite are developing an interoperable DC EPC for offgrid solar systems. These local manufacturers are using the Original Equipment Manufacturer (OEM) manufacturing model (otherwise referred to as contract manufacturing) whereby the local entities collaborate with overseas manufacturers, predominantly in China[21], to produce branded electric cooking appliances, which allows them to establish a presence in the market with their own brand name while leveraging the OEM's production capabilities, economies of scale, and established supply chains. OEM manufacturing refers to a business model where a company produces parts or products that are used in the assembly or production of another company's final product (Bhattacharjee, 2021).

For countries like Kenya which have nascent manufacturing sectors for high technology industries, OEM manufacturing offers access to advanced technology and expertise which may not yet be available locally, cost efficiencies associated with large-scale production, which can lead to lower prices for the end consumers, faster market entry for enterprises looking to introduce new electric cooking appliances to the market without having to invest heavily in manufacturing infrastructure, and customisation of appliances to local needs and preferences (Abade, 2011). Despite these advantages, it is essential for Kenya to strike a balance between leveraging OEM partnerships and fostering the development of local manufacturing capabilities to ensure long-term economic growth and sustainability.

Fabricating electric coils in informal settings

Informal settlements often exhibit a high degree of resourcefulness when it comes to meeting basic needs. Local artisans make or adapt frugal electric coils hobs and heaters using salvaged materials from discarded appliances or electronics, like old stoves, heaters, or even transformers. Salvaged wire is wound into a coil shape, mounted on a non-conductive and heat-resistant base like a piece of ceramic or certain types of stones or bricks. Connectors are attached to both ends of the coil, which are then connected to a power source. Sometimes, a rudimentary switch is added to turn the coil on or off. The coil should be tested to ensure it heats up correctly and doesn't present immediate dangers. In the spirit of improvisation, residents of informal settlements might use locally available tools and materials to enhance the functionality and safety of their homemade coils. This could include adding a protective cage around the coil or crafting makeshift knobs to adjust the heat level.

The potential for assembly and local manufacture of electric cooking appliances in Kenya can be assessed across various aspects, such as capabilities and skills, access to raw materials, infrastructure, policy framework, and logistics.

[21] China dominates OEM manufacturing, given that there were 86 industrial parks for small kitchen electrical equipment as of mid-June 2022. The small home appliances industry is thriving in Lianjiang, a city in Guangdong, counting more than 1,100 small appliance manufacturers. The manufacturers include 220 rice cooker manufacturers, 90 electric kettle manufacturers, and manufacturers of other accessories. Midea, Haier, and Gree take a significant portion of Chinese home appliances' market value in 2021 (Sukwanto, 2022).

- Capabilities and skills: Kenya's growing manufacturing sector includes capabilities in metal fabrication, electronics, and assembly, which provide a foundation for the local production of electric appliances. Kenya is already doing local assembly of electrical appliances, with enterprises such as BURN Manufacturing delving into assembly of EPCs and induction cookers, and Productive Solar Solutions assembling DC solar systems for Village Infrastructure Angels. Electric coil cookers are being fabricated in the informal sector. Further, some components of solar PV are being locally manufactured for nearly a decade or more (see Bhamidipati et al., 2021 for a detailed analysis of Kenya's PV sector). KenGen—which is looking to construct a manufacturing plant at its Tana Power Station in Murang'a County—is gearing up to start production of solar panels[22]. However, sector stakeholders in key informant interviews indicated that there is a shortage of skilled engineers and technicians required for the entire manufacturing chain. To address this gap, investment in education, technical training, and capacity building programs will be essential.
- Access to raw materials: Kenya has access to some necessary raw materials, such as metals and plastics, for manufacturing appliances. However, establishing or strengthening local supply chains and securing access to other critical components (e.g., electronic components, batteries) are crucial for supporting local manufacturing[23]. Partnerships with neighbouring countries and international suppliers could help enhance the availability of raw materials.
- Infrastructure: Adequate infrastructure, such as electricity supply, transportation networks, and manufacturing facilities, is vital for local manufacturing. While Kenya has made significant progress in improving its infrastructure, particularly reliability of electricity and transportation, further investments and improvements may be necessary to support the growth of the appliance manufacturing industry.
- Policy framework: Supportive government policies can stimulate the growth of the electric appliance manufacturing sector. Initiatives such as tax incentives, investment promotion, and the development of industrial parks can encourage local manufacturing. BURN Manufacturing, which started its business in an industrial park in Ruiru, Kiambu County and has since moved to larger premises to support its growth, has benefited from this particular enabler. Additionally, policies such as the proposed eCooking Strategy, the Kenya National Electrification Strategy that promote renewable energy and energy-efficient appliances can drive demand for locally manufactured electric appliances.
- Logistics: Efficient logistics are essential for the smooth operation of the electric appliance manufacturing industry. Kenya's strategic location in East Africa provides opportunities for exporting to neighbouring countries and beyond. Developing efficient logistics networks, including transportation and warehousing facilities, can help Kenyan manufacturers tap into regional and international markets.

In conclusion, there is promising potential for the assembly and local manufacture of electric appliances in Kenya, given the existing manufacturing capabilities, access to raw materials, and strategic location. However, to fully realize this potential, targeted investments in infrastructure,

[22] Kamau, M. (2022). KenGen ramps up plans to build solar panel production plant. Retrieved June 4, 2023, from The Standard website: https://www.standardmedia.co.ke/business/news/article/2001433588/kengen-ramps-up-plans-to-build-solar-panel-production-plant

[23] Manufacturing Africa. (2022). *Manufacturing Africa: Consumer electronics manufacturing in Kenya*. Retrieved from https://manufacturingafrica.org/download/manufacturing-africa-consumer-electronics-manufacturing-in-kenya-sector-overview00/

human capital, policy framework, and logistics will be necessary. By addressing these aspects, Kenya could develop a competitive electric appliance manufacturing sector, contributing to economic growth, job creation, and improved living standards.

5.1.3 Local delivery models

Two key informants from the retail sector argued that until recently, electric cooking appliances were targeted at urban dwellers who are connected to the national grid, have higher disposable incomes, are considered more savvy, and thus, amenable to using such electric appliances. The target market has now begun to expand as more rural households are connected to the national grid. Further, there are significant developments in mini grid and microgrids in Western, Central and Coastal Kenya, and frontier regions in Northern Kenya, and SHSs have diffused very rapidly in rural Kenya. These developments have created a new segment of potential users of electric cooking appliances. As a consequence, retailers and distributors have started to build business models around this target market.

eCooking appliances in Kenya are distributed through a variety of delivery models described below.

- **Physical retail outlets:** eCooking appliances in Kenya are typically distributed through brick-and-mortar outlets, such as large chain supermarkets like Naivas, Quickmart, and Carrefour, which offer competitive prices, discounts, and a wide range of brands. Standalone wholesale and retail shops also sell appliances in the Central Business District (CBD) of towns and cities. Luthuli Avenue, Nyamakima Trade Centre and River Road and their environs in the Nairobi CBD are popular one-stop centres for electronics, with shops increasingly stocking branded, self-branded and unbranded appliances such as air fryers, EPCs, microwaves, and electric kettles[24]. According to household survey findings as shown in Figure 5.1, 38.41 percent of households purchased electric cooking appliances from supermarkets, followed by wholesale/retail shops (22.56 percent), small retail stores, and specialist shops (8.54%). Focus group participants indicated that supermarkets are generally more trusted as vendors of genuine appliances than shops in the CBD, as they offer warranties from the brands they sell. To access the most diverse range of products and best prices, participants stated that they visit retail outlets in cities and larger towns.
- **Authorized Dealers and Distributors:** Many electric appliance brands have authorized dealers and distributors in Kenya. These dealers and distributors may have their own physical stores or operate online, and they sell appliances directly to customers or to smaller retailers. Key players in Kenya include Hotpoint Appliances Ltd, SayonaPPs Electronics, and Anisuma Traders. Authorized dealers procure appliances directly from manufacturers or authorized distributors. They then engage in various marketing activities, such as advertising, branding, and promotional campaigns, to create awareness and attract customers. They may also participate in trade shows, exhibitions, or other events to showcase the appliances in new markets. Authorized dealers are typically responsible for providing after-sales support to customers, which includes handling customer inquiries, addressing complaints, processing returns or exchanges, and providing technical assistance or repairs for appliances under

[24] SERC (2021). Appliance quality in Kenya. https://serc.strathmore.edu/electric-appliance-quality-in-kenya/

warranty. These outlets are located in urban areas, particularly Nairobi, Mombasa, Kisumu, Nakuru, Eldoret and Thika.

- **Online shops and marketplaces:** There are several e-commerce outlets and platforms in Kenya that sell appliances online, thus provide a convenient way for consumers to browse, compare, and purchase a wide range of electric appliances from the comfort of their homes, and then have them delivered to their doorstep. These include Jumia Kenya which is the most popular online marketplace, Kilimall, Masoko, and HotPoint Appliances, which has an online shop to augment sales in its physical outlets. Social media also offer platforms for internet sales. In the household survey, in 11.67% of households indicated that they purchased their appliance from social media. Promotional and tutorial videos using social media platforms including among others Facebook, WhatsApp, TikTok and Instagram attracts customers to purchase e-cooking appliances. 11.3 percent of households indicated that online platforms were their main point of purchase for their electric cooking appliances, revealing the growing importance of e-commerce in this space.
  Selling appliances via the internet in Kenya presents both opportunities and challenges. According to the Communications Authority of Kenya, internet penetration is Kenya is quite high at 93.9 per cent in 2022 due to investments in fibre optic connectivity and cellular phone penetration[25]. With the increasing adoption of digital technologies, including smartphones and internet usage, and payment systems such as M-Pesa and debit cards, more Kenyan consumers are becoming comfortable with online shopping. Selling appliances online offers opportunities to reach customers in remote areas where physical retail stores may not be available. Online marketplaces also allow for a diverse range of appliances to be offered to customers, including both global and local brands as evident in Jumia and Kilimall. To facilitate further uptake of ecommerce for eCooking appliances, various challenges need to be addressed, among them, further investment in e-commerce infrastructure in Kenya, especially logistics to support order fulfilment, shipping, and customer service. Participants of FGDs highlighted concerns about the security of online transactions, data privacy, and trustworthiness of online sellers.
- **Door-to-Door Sales:** Some companies and entrepreneurs in Kenya use a door-to-door sales approach to distribute appliances. Sales representatives visit customers at their homes or businesses, showcase the appliances, and take orders for delivery. BURN Manufacturing and Jikoni Magic (also known as Kisambara Ventures Ltd) pioneered this approach for eCooking appliances with great success so far, and this model enables them to create a more intimate and customized sales experience, as the sales representative or agent can tailor their pitch to the specific needs and preferences of each customer. Door-to-door sales provide an opportunity for product demonstration, which is necessary for appliances such as the EPC, air fryer or induction cooker which may be new to customers. This approach has enabled these companies to build relationships with customers, creating loyalty and referrals. Door-to-door sales are however labour intensive, time consuming, and have a limited reach, as sales representatives can only cover a certain number of households or businesses within a given timeframe.

[25] Etyang (2022). Internet penetration rises by 62.5 per cent, Oguna says. The Star Newspaper. https://www.the-star.co.ke/news/2022-06-30-internet-penetration-rises-by-625-per-cent-oguna-says/

Figure 5.3 Point of purchase for most recent e-appliance

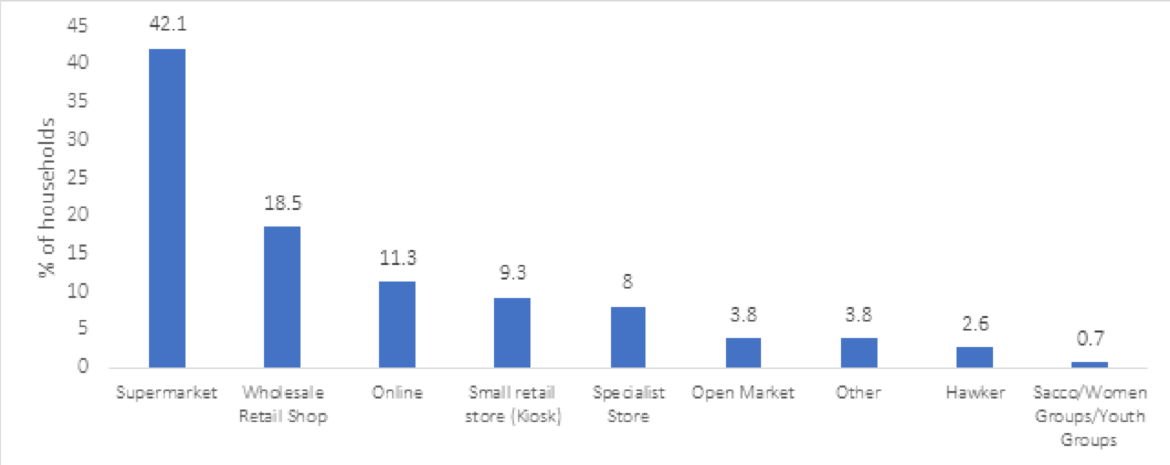
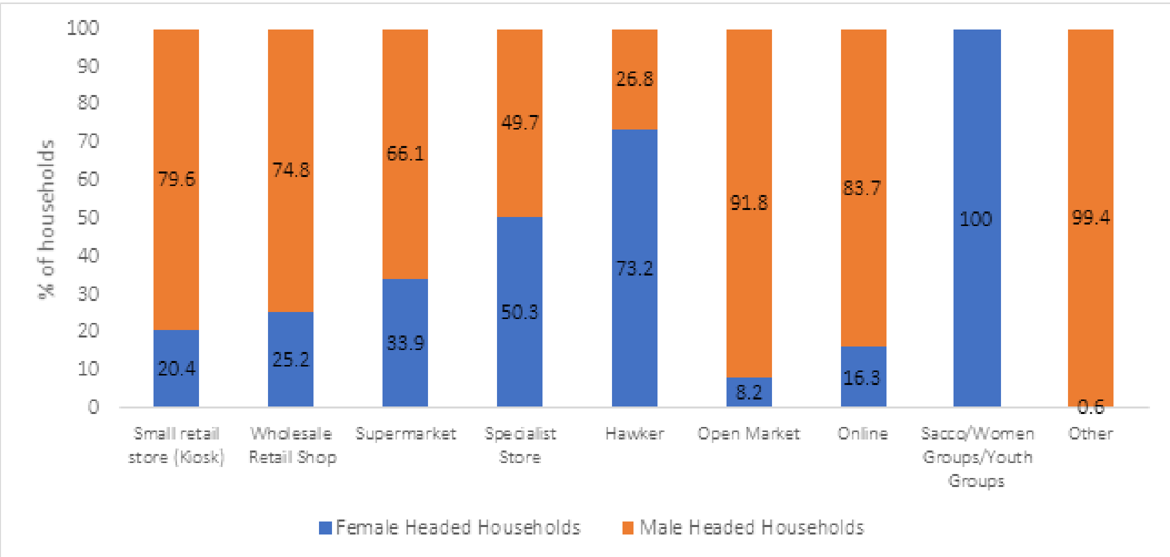


Figure 5.4 Point of purchase for the most recent electric appliance in female and male-headed households.



There are several pilot initiatives that are adapting and developing new product designs and delivery models in Kenya, among them, Bidhaa Sasa, SunCulture, SNV, Perebere Energy, Caritas Kitui, Biolite and Fosera. Minigrids developers such as PowerHive and Renewvia have piloted EPCs within their minigrids. Models under piloting include:

- **Agency model and regional hubs:** Enterprises identify and develop relationships with pre-existing small retail shops in desired locations to carry their product. They also opt to establish new agents who are then branded after the company. Enterprises such as Bidhaa Sasa and SCODE have created regional 'hubs' in rural market centres, where each hub acts as a centre of operations in that region. BURN Manufacturing's agency model focusses on woman-to-woman marketing, where female 'super customers' are identified as brand champions or product ambassadors to sell stoves – on commission – in the communities. This approach lowers the cost of distribution of appliances in rural areas particularly, while establishing a brand presence in those areas (Byrne et al., 2020).

- **Distribution through self-help groups and revolving funds (Chamas):** A pioneer in Kenya in this regard is Bidhaa Sasa whose market is currently in Western Kenya. In their women-to-women distribution model , customers who would like to purchase the product have to find five others equally interested in it. They then buy the products as a group (usually self-help groups locally known as *chamas*) and a common instalment plan is agreed, with the group acting as a payment guarantor. The group members are then trained together on how to use the appliance and they would support each other after that (Ochoa, 2020). For Bidhaa Sasa, the women often became repeat customers for additional product offerings within the company. Therefore, the group model serves three purposes: access to credit, education and marketing. However, the company must invest significant effort to develop strategic but personal relationships with the *chama*s (Byrne et al., 2020). Interestingly, the household survey indicates that only female-headed households purchased their appliances from women groups and chamas. Groups or chamas are also a key channel in creating awareness on e-Cooking, especially in rural areas (8.1%) compared to urban (7.6%).

In order to increase direct sales of electric cooking appliances, retailers in Kenya use a variety of marketing methods to promote electric cooking appliances to customers. Traditional advertising methods such as print ads in newspapers, billboards, and posters have been used to create awareness. Retailers also advertise on radio and TV channels to reach a wider audience. Beyond these traditional media, new marketing channels are increasingly being adopted. An unconventional way of creating awareness for appliances through the media is using reality series such as *Shamba ShapeUp* which reaches upwards of 12 million people across Kenya[26], and its use provoked an influx of customer orders to retailers. Other examples include online advertising through social media such as Facebook and Instagram, and ads on websites which have gained popularity in Kenya as internet penetration continues to grow. Most retailers operate active Facebook, Instagram and YouTube channels to engage their customers by answering questions, doing product demonstrations and advertising new product releases. Of particular interest is the use of social media influencers to market eCooking appliances in Kenya. A case in point is SayonaPPs' collaboration with 'Kabi WaJesus', a popular social media personality who promoted the SayonaPPs Air Fryer/Pressure Cooker to his 950,000 Instagram followers, and this yielded an overwhelming response that depleted SayonaPPs's inventory. This demonstrates the untapped potential of social media to generate buzz and create positive brand exposure for electric cooking appliances, as social media users in Kenya tend to be savvy and aspirational.

Of the 92.6 percent of the population that knew about e-cooking in the household survey, friends and family and adverts on television, newspapers, radio and billboards were the major communication channel from which respondents obtained most of the information on new cooking appliances (56.5 percent and 32.5 percent respectively). Other main channels included social media (16 percent), own experience (14.8 percent), formal education (11.7 percent) and group or chama (7.7 percent).

[26] Chilambe, P. A., Gichinga, P., & Girvetz, E. H. (2022). *Shamba Shape Up: Using digital channels to deliver bundled agriculture, climate, and financial information services*. Retrieved from https://cgspace.cgiar.org/handle/10568/126423

Across gender, cluster, income level segments and main cooking fuel, family and friends dominated as the main source of information with percentages ranging from (37.3%-65.9%) followed by media advertisements dominated with percentages ranging from (23.7%-39.5%). Some information channels were omitted for main fuel users and main electricity since they yielded 0 or very insignificant proportions.

Similarly, mainstream media (adverts on TV, newspapers, billboards and radio) were the main the easiest way to inform the masses about eCooking across various regions. Cluster 7 (represented by Nairobi) dwellers rely most on mainstream media (44.2 percent) compared to social media at 31, implying that people in town have more access to the Internet or smartphones compared to other clusters. In addition to demonstrations through mainstream media like TV, radio and billboards, leveraging social media apps (short or long videos, postings, chats) would appeal more to urban dwellers.

Other effective marketing channels include product demonstrations at malls, supermarkets, or other public places, road shows, and participation in trade shows and exhibitions. These methods allow potential customers to see and experience the appliances first-hand. In-store promotions, such as special offers, discounts, and bundled deals have also been effective at enticing customers to purchase electric appliances. One retailer emphasised that word-of-mouth marketing and referrals are powerful marketing tools in Kenya, and retailers achieve this by providing excellent after-sales service and support, including warranties, customer helplines, and product servicing to enhance customer satisfaction.

To augment these commercial marketing initiatives, the African Centre for Technology Studies (ACTS) in partnership with the MECS programme, county governments, the Clean Cooking Association of Kenya, the Kenya Power and Lighting Company, Gamos East Africa, and appliance retailers have launched regional eCooking hubs in Nakuru, Kitui, Makueni and Kisumu by to create awareness and stimulate demand for e-cooking (Bolo, Atela, Randa, Osogo, & Akala, 2022). Beyond marketing, the hubs are expected to become centres of excellence to promote the eCooking agenda at the local level by for instance, testing context-relevant business models and financing mechanisms, and promoting county-level policy processes that are favourable to eCooking scaling.

In conclusion, the electric cooking appliance market in Kenya has experienced significant growth and diversification in recent years. Retailers and distributors have adapted their business models to cater to the emerging market segments, offering a variety of electric cooking appliances through an array of distribution channels such as physical retail outlets, authorized dealers and distributors, online shops, door-to-door sales, agency models, and revolving funds (Chamas). Marketing efforts have evolved to include both traditional advertising methods and innovative approaches, such as social media campaigns, influencer marketing, and reality TV shows. These strategies have successfully increased awareness and demand for electric cooking appliances. Furthermore, regional eCooking hubs, established through collaborative efforts between various stakeholders, are expected to promote the eCooking agenda and foster the development of context-relevant business models, financing mechanisms, and favourable local policies. To fully capitalize on this potential, continued investment in e-commerce infrastructure, logistics, and customer service is needed.

5.2 Financing electric cooking

In general, the two key components of clean cooking financing address demand-side and supply-side challenges associated with providing sustainable cooking options for households (Shupler, Mangeni, et al., 2021). Demand-side or consumer financing refers to a range of financial products and services designed to make it easier for end-users (households or individuals) to afford and adopt electric cooking solutions. Consumer costs related to clean cooking in general comprise life-cycle costs, i.e., the cost of acquiring the cooking appliance or stove, the operating costs which include purchasing the related fuel such as electricity, maintenance and repair expenses, as well as the costs of any replacement parts or accessories, and end-of-life costs which involve disposal or recycling of the electric cooking appliance once it has reached the end of its useful life (Gill-Wiehl, Ray, & Kammen, 2021; MECS & Energy4Impact, 2021). Supply-side financing for clean cooking focuses on providing financial support and resources to businesses, manufacturers, and distributors involved in the production, promotion, and distribution of clean cooking solutions (Puzzolo et al., 2019). The goal is to strengthen and expand the clean cooking market, making these solutions more accessible and affordable for consumers.

5.2.1 Consumer financing mechanisms

The upfront costs of electric cooking appliances are a bottleneck in the efforts to transition to electric cooking as one of the clean cooking pathways. To address the affordability constraints related to the upfront costs of electric cooking appliances and costs of appliance ownership, innovative consumer financing models are being introduced into the market. Models include cash and carry, asset financing loans, PayGo, layaway savings, chamas and microfinance.

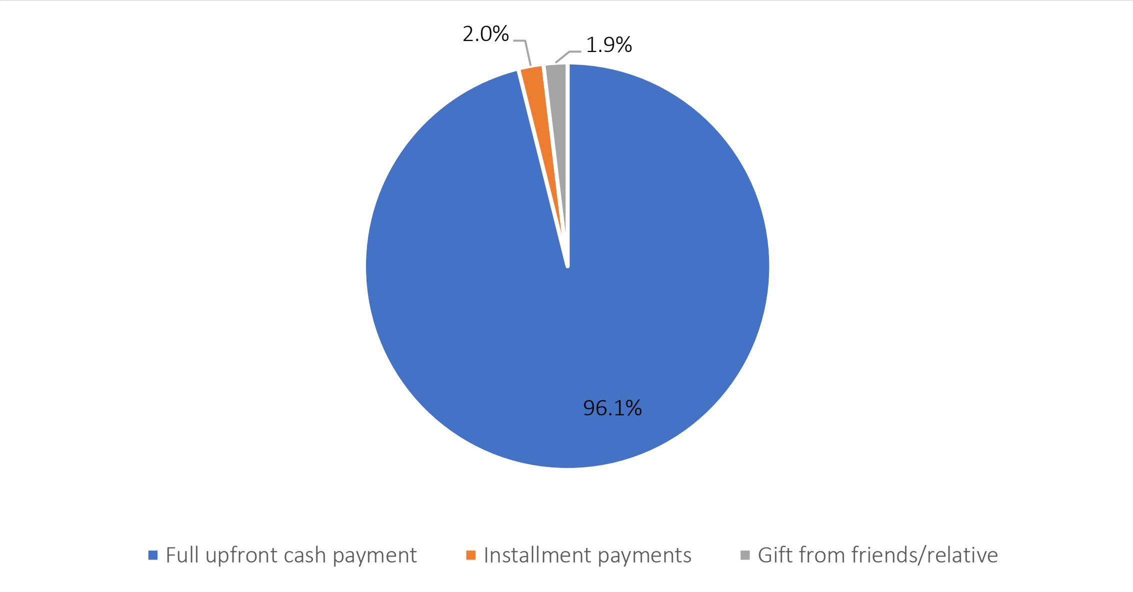
- ***Cash and carry model:*** In Kenya, upfront cash payments are by far the most common method for purchasing electric appliances. Many households save up, particularly for aspirational appliances such as the mixed electric/LPG standalone cooker, and EPC or air fryer, by setting aside a portion of their income specifically for this purpose, typically for 1 – 6 months. They may also use their available cash reserves or leverage existing savings to make a one-time payment for the appliance. Our survey data shows that, 96.1 percent of the households report that they paid full upfront cash when purchasing their electric appliances, as illustrated in Figure 5.5. The is little variation in the preference for cash across income levels as shown in Figure 5.6.

Table 5.2 Consumer financing models for electric cooking appliances in Kenya

Consumer financing mechanism	Description
Cash and Carry Model:	Upfront cash payments are the most common method for purchasing electric appliances. Many households save up or use existing cash reserves to make one-time payments. Preferred payment method across income levels.
Asset Financing Loans	Kenya's microfinance sector offers formal and informal institutions for loans. Savings and Credit Cooperatives (SACCOs) provide savings and borrowing options. Limited adoption of loans for household electric appliances. Rural households more reliant on microfinance institutions and commercial banks.
PayGo Models	Pay-as-you-go models allow consumers to pay for appliances in installments. Initial deposit followed by regular payments until full cost is covered.

	Mobile money payments, like M-Pesa, support these models. Successful for entities like Powerhive, BURN Manufacturing, and Bidhaa Sasa.
Layaway Savings	Customers make a deposit and regular instalments over a fixed period. Once full payment is made, the customer owns the appliance. Offered by supermarkets like Naivas and Carrefour.ere Limited adoption, preferred by middle-class households.
Chamas/ROSCA (Self-Help Groups)	Social networks like chamas and merry-go-rounds facilitate appliance ownership. Group liability eliminates the need for individual credit checks. Members finance each other and support acquiring appliances. Dominant source of borrowing for both rural and urban households.
Gifts	Some households receive electric appliances as gifts from friends and family. Particularly common among poor households. Financing structures and business models can be tailored to address financial constraints of these households.

Figure 5.5 Payment method used when acquiring the electric cooking appliance.



- ***Asset financing loans***: According to Hsu et al., (2014), Kenya's microfinance sector is well developed, which includes various formal and informal institutions. In addition, Feather and Meme, (2019) point out that Kenya boasts a solid and well-established savings and credit culture particularly through groups called Savings and Credit Cooperatives (SACCOs), where members can save and borrow money, with members co-guaranteeing each other, and buy goods ranging from household equipment to land and property. Companies like Aspira, FlexPay and LipaLater now offer digitally-enabled asset financing for eCooking appliances through partnerships with major retailers like Hotpoint Appliances. Further, several appliance distributors have established partnerships with banks for asset financing loans for appliances, e.g. Hotpoint Appliances with Kenya Commercial Bank or Nyalore Impact with Equity Bank.
  The solid digital payment infrastructure in the country, where 80 per cent of the adult population uses these digital payment systems supports all these varieties of financial instruments and institutions (Klapper and Hess, 2019). It is surprising therefore that only 5.8 percent of the households acknowledged having borrowed funds to purchase household

electric appliances (see Figure 5.7). 16 percent of the households indicate to have secured the loan to purchase a big household item from microfinance institutions. More rural households however secured the loans from these institutions compared to urban households (18.9 percent and 8 percent) respectively (Figure 55.8). Although the gap is small, it shows how important microfinance institutions are in rural areas and how they enable households access cleaner sources of energy and energy saving household appliances (Atahau, Sakti, Huruta, & Kim, 2021). Access to loans from commercial banks is evenly distributed across all households despite their income levels as shown in Figure 5.10. It is worth noting that a bigger proportion of urban households secured their loans from commercial banks (32.6 percent) compared to rural households (9.9 percent). Although a higher proportion of male-headed households (17.1 percent) indicate that they obtained loans for the purchase of a large electric appliance from commercial banks, a higher proportion of female-headed households (19.7 percent) reveal to have obtained the loans from savings and credit cooperative societies (SACCOs) compared to male-headed households (14.9 percent) indicating a narrowing credit access gap between male and female-headed households. Promoting financial inclusion for women through access to banking and credit facilities will help them save and get loans for energy appliances and equipment. This might be done through introducing financial assistance measures, such as subsidies or loans aimed exclusively towards women, can be a direct way of making energy services and appliances more accessible to them.

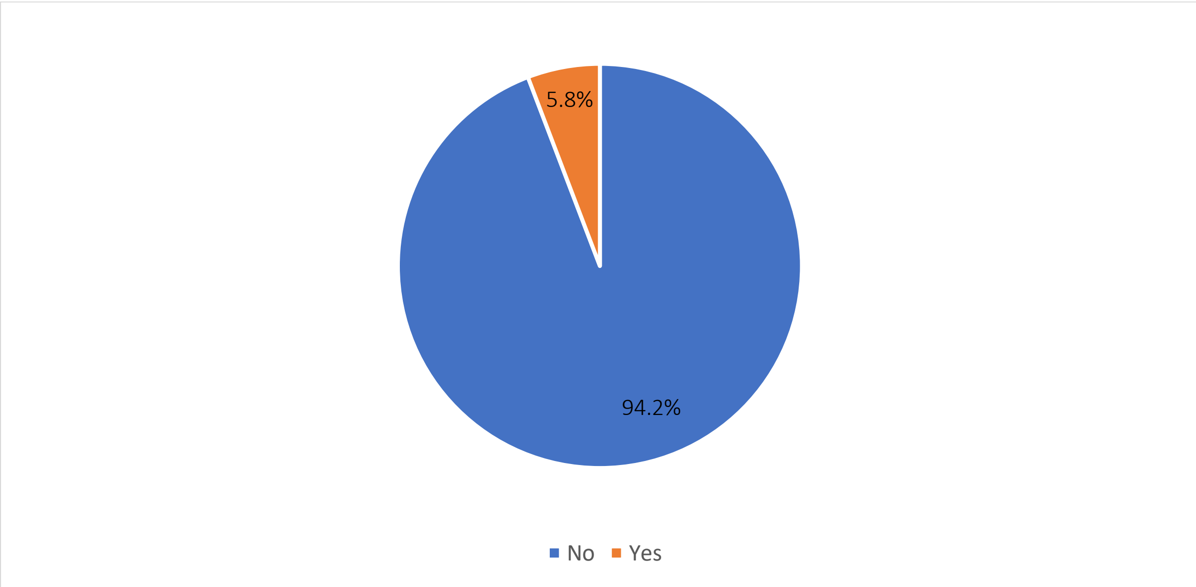


Figure 5.6 Have you taken a loan to finance a big household item?

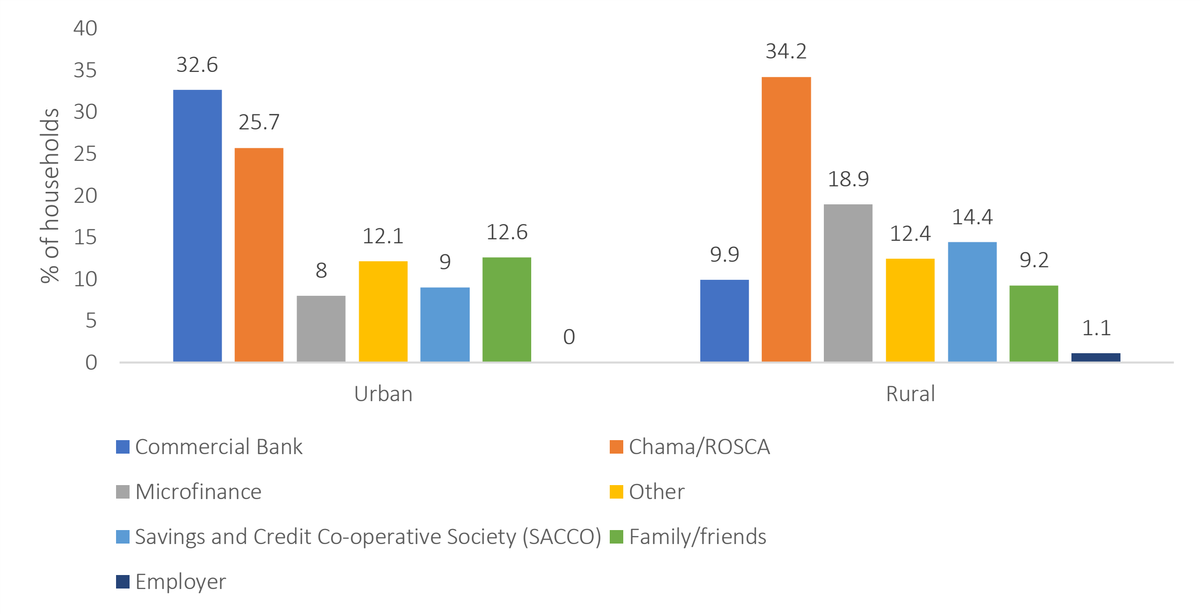


Figure 5.7 What institution provided the loan/instalment plan-Urban/Rural

- **PayGo models:** Pay-as-you-go models are becoming increasingly popular in Kenya as a means of financing the purchase of cooking appliances and their respective fuels (MECS & Energy4Impact, 2021; Shupler, O'Keefe, et al., 2021). These models allow consumers to pay for their appliances in instalments, or for fuels on demand, making it easier for low-income earners to afford them. For appliance purchase, consumers typically make an initial deposit on the appliance, followed by regular weekly or monthly payments until the full cost is covered. The success of pay-as-you-go models in Kenya has been aided by the widespread use of mobile money payments e.g., through M-Pesa, which allow consumers to make payments using their mobile phones. This has made it easier for low-income earners who may not have access to traditional banking services to make payments and afford cooking appliances. The PayGo model has been successful for entities like BURN Manufacturing, PowerPay, and SunCulture, SunKing. SayonaPPs and Village Infrastructure Angels intend to pilot this model for eCooking appliances. To be able to sustain such a model, the enterprise has to determine who will absorb the risk of potential non-payment, and this has been a challenge for some, for instance in a pilot conducted by SNV in Kakuma where high defaulting rates were reported. This is also because it is very expensive to keep track and follow up customers to adhere to the payment plan, and when all fails, to repossess the appliance. Such an approach is also technology-intensive; the company needs robust IT systems that can reliably maintain such records and send out SMS alerts. Companies tend to mitigate this risk by imposing a markup of the appliance price to cater for the time value of money and default risk. Pay-as-you-cook (PAYC) models use PayGo and smart meters to facilitate on demand micropayments and enable providers to lock or unlock appliances based on payment status, ensuring that customers are only able to use the service if they have made the necessary payments.

- **On-bill financing:** On-bill financing (OBF) is an innovative consumer financing mechanism that allows consumers to finance energy-efficient improvements, including the purchase of electric cooking appliances, through a charge on their utility bill. With OBF, a utility or third-party lender provides the upfront capital needed for a customer to purchase energy-efficient appliances or make energy-related home improvements. The customer then repays this amount as a separate item on their regular utility bill over a specified period (Evens, 2015; MECS, & Energy4Impact, 2021). This financing model can make it more accessible for a broader range of customers, including those who might not qualify for traditional financing options. As consumers switch to more efficient appliances, they often experience a reduction in energy consumption, which can partially or fully offset the monthly repayment amount. On-bill financing has been trialled by Powerhive in their minigrids.

OBF and PayGo share similarities, yet they are distinct. PayGo requires payments to be made directly to the device retailer, and may sometimes integrate a lockout mechanism on the device. OBF channels payments through the utility.

- **Layaway savings:** Retailers alternatively offer the '*Lipa pole pole*' option, formerly known as hire purchase, and sometimes referred to as 'Layaway savings' (MECS & Energy4Impact, 2021), require customers to complete payments before carrying the appliance. Such agreements, customers make a small deposit to reserve the appliance, followed by regular instalments over a fixed period typically ranging from 3 to 24 months until the full cost of the appliance is covered. Once the final instalment is paid, the customer will own the appliance outright. Although customers can opt to pay their instalments in cash at the outlet, *Lipa pole pole* is often supported by mobile payment systems. Supermarkets such as Naivas and Carrefour offer this payment option for big ticket electric appliances, including cooking appliances. The benefits of this model for customers are that the price is similar to cash and carry, and that there are no financing costs such as interest fees and commissions. However, should the customer want to opt out of the transaction, they incur a cancellation fee. In our survey, only 1.26% of Kenyan households reported to have used instalment payments, and middle class households have the highest preference for this payment model (4.84 percent), as shown in while as shown in Figure 5.13.

- **Chamas/ROSCA (Self-help groups):** Social networks in communities and groups, known as chamas and merry-go-rounds, are being utilized to facilitate appliance ownership. This approach has been adopted by different enterprises to sell appliances, particularly the EPC, among them Bidhaa Sasa and SCODE. The model employs group liability to sell products, thereby eliminating the need for individual client credit checks. The group's capacity to guarantee members de-risks the sale of appliances. Members can finance each other and offer support in acquiring electric cooking appliances. Selling appliances to groups, rather than individual customers, is more sustainable, particularly for distributors in rural areas where acquiring individual clients and selling single appliances can be costly (Ochoa, 2020). The household survey reveals that a large number of asset financing loans came from Chama/ROSCA at 32 percent as shown in Figure 5.13. Chama/ROSCA was the dominant source of borrowing for rural households (34.2 percent). Additionally, it emerged as the second most dominant source of borrowing for urban households at (25.7 percent), revealing how dominant such financial institutions are in both the rural and urban areas.

  In Kenya, women face several challenges in accessing credit compared to men and that is why Self-Help Groups have stepped in to enable women to overcome these challenges. Women in Self-Help Groups, especially in rural areas are very strong entities for female empowerment, and this may explain why female-headed households point out Chama/ROSCA as their biggest source of loans to purchase electric appliances.

Gifts are an important channel for households to acquire eCooking appliances. The survey findings show that 10.1 percent of households reported receiving electric appliances as gifts from friends and family (Figure 5.5). A large portion of poor households (19.8 percent) received electric cooking appliances as gifts from friends and family, which may point to the difficulties they face in obtaining such appliances. To address this, financing structures and business models discussed above could further be tailored to address the financial constraints and irregular cash flows of these households. Awareness campaigns should also be conducted to educate households on where and how to access these financing options.

5.2.2 Supply-side financing mechanisms

Supply side financing helps to address the financial and operational challenges faced by businesses in the sector, including those who supply cooking appliances and fuels. These mechanisms can help enterprises overcome market barriers and reduce risks of market entry and scale up, particularly for clean cooking technologies (Clean Cooking Alliance, 2018). Supply side costs include research and development costs associated with designing, testing, and refining electric cooking appliances, capital costs related to production such as manufacturing and quality control, costs of distribution and logistics, and marketing, promotion and consumer support costs (Puzzolo et al., 2019). For electric cooking, supply side costs include the costs incurred by energy service companies such as utilities, minigrid developers and SHS companies to extend electricity access. It is also often the case that these energy service companies have excess capacity in their systems and are looking to invest in demand stimulation programmes such as eCooking.

Table 5.3 Supply side financing mechanisms

Supply-side financing models	Description
Grants	• These are funding mechanisms provided by development partners for research, development, and market expansion. • Grants support pilot projects and risky ventures with potential for significant impact. • Grants are disbursed through competitive processes or partnerships with local organizations. • Examples include MECS, EnDev, and Efficiency for Access Coalition.
Equity and Impact Investments:	• These are investments made by private investors, venture capitalists, and development finance institutions. • They provide patient capital for scaling operations and expanding reach. • Active investors in clean cooking enterprises include Acumen, Engie, Circle Gas, and FMO.
Results-Based Financing (RBF):	• RBFs link fund disbursement to predefined performance outcomes. • They lower market entry barriers and incentivizes clean cooking adoption. • Usage data from pay-as-you-go (PAYGO) or Pay-as-You-Cook (PAYC) models can inform impact metrics. • Examples include EnDev RBF, NEFCO, Kenya Higher Tier Cookstoves Market Acceleration project, and ABPP.

Smart-Meter-Enabled Carbon Financing	• Smart meters monitor energy consumption and calculates carbon emissions reductions. Carbon credits generated can then be sold to offset carbon emissions. • KOKO Networks and BURN Manufacturing have implemented this model. • There is untapped potential for accessing global carbon finance and promoting energy-efficient appliances.
Utility-Led Financing	• This mechanism allows consumers to spread appliance costs over time through monthly instalments. • Options include On-bill financing, on-bill repayment, and co-marketing/data-sharing. • It may involve partnership between utility companies and third-party financiers. • Viability in Kenya needs stakeholder engagement and potential donor support.

Supply-side financing methods have been tested or are under consideration for the Kenyan market include equity investments, grants, concessional loans, subsidy programmes using results-based financing mechanisms, carbon credits, and financial incentives, as discussed below.

- **Grants:** Grants are typical funding mechanisms run by development partners such as MECS under grant funding from UK Aid, GIZ which implements EnDev and the Green Climate Fund grants among others, Modern Cooking Facility for Africa by NEFCO—the Nordic Green Bank to support research, development, market expansion, and scaling up production for electric cooking in Kenya, Efficiency for Access Coalition which financed (R&D) projects on highly efficient appliances in collaboration with MECS, among others. MECS operates a challenge fund which provides early-stage research funding to stimulate innovations in modern energy cooking technology and systems and services, and the fund is centred on various key themes: supply chain, outreach and minigrid. MECS has run as a series of competitions, each with their own focus and objectives that have funded entities such as Burn Manufacturing, Jikoni Magic, PereBere Energy, the Oloika minigrid, etc[27]. ENGIE Africa offered grants to facilitate the testing efficiency and viability of Electric Cooking Solutions in sub-Saharan Africa[28].
  Grant funding is ideal to support pilot projects that test and refine electric cooking interventions before scaling them up. BURN Manufacturing, for example, received a $500,000 seed grant from the Clean Cooking Alliance in 2013 to start its operations, along with support from General Electric, the Overseas Private Investment Corporation (OPIC)[29],[30]. Grants are also suitable for highly risky projects that may not guarantee immediate returns but have the potential for significant impact. Grants provide flexibility to identify and resolve challenges and barriers, increasing the chances of success in larger-scale projects. Grant funding is often disbursed through competitive processes or

[27] The Electric Cooking Outreach (ECO) challenge fund. https://mecs.org.uk/challenge-fund/past-funds/mecs-eco-challenge-fund/

[28] Clean Cooking Alliance (2019). Call for Electric Cooking Solutions for Sub-Saharan Africa https://cleancooking.org/funding-opps/call-for-electric-cooking-solutions-for-sub-saharan-africa/

[29] Clean Cooking Alliance (2014). BURN Announces Opening of New Factory in Kenya. https://cleancooking.org/news/03-26-2014-burn-announces-opening-of-new-factory-in-kenya/

[30] Rotich (2023). Clean Stove Manufacturer Burn Opens New Factory In Kiambu. https://www.capitalfm.co.ke/business/2023/02/clean-stove-manufacturer-burn-opens-new-factory-in-kiambu/

partnerships with local organizations and businesses. Some grants require matching contributions from beneficiaries, and refunds if the beneficiary fails to meet the agreed milestones (MECS & Energy4Impact, 2022). They can be used to finance subsidies, most commonly through results-based financing programmes (see below).

- **Equity and impact investments:** Investments made by private investors, impact investors, venture capitalists, development finance institutions and foundations in clean cooking enterprises. These investments provide businesses at the early growth stage with the necessary capital to scale their operations, expand their reach, and increase the availability of clean cooking solutions. Business at this stage face significant hurdles e.g., on technology scale up, expansion of the distribution network, consumer credit processes of human resource recruitment. Investors such as venture capitalists often expect that, upon resolving these hurdles, the business is likely to yield significant commercial return. Impact investors such as foundations tend to offer more patient equity (MECS & Energy4Impact, 2022).

  There has been an uptick in corporate financing for clean cooking from investors such as Acumen, Engie, Circle Gas, FMO, and Shell Foundation. According to (Sharma & Slawek, 2021), BURN Manufacturing has received over USD 4 million in funding from investors such as Acumen, General Electric, United States Overseas Private Investment Corporation (OPIC, now the DFC), Spark+ and the Energy and Environment Partnership programme (EEP). This capital market is quite opaque, as often transactions are kept confidential.
- **Result based financing:** Results-based financing (RBF) is a financing mechanism that links the disbursement of funds to the achievement of predefined and measurable performance outcomes or results. RBFs are a popular mechanism in off-grid energy and clean cooking sectors, e.g., the EnDev RBF on Solar PV Hybrid Mini-Grids, the EnDev Pico PV RBF, the Kenya Higher Tier Cookstoves Market Acceleration project funded by DFID through the EnDev Programme (which has supported 20 companies), the Africa Biogas Partnership Programme (ABPP) and Kenya Off-Grid Solar Access Project (KOSAP). In these programmes, the objective is to lower market entry barriers associated with clean cooking. Beneficiary organisations pre-finance activities to lower market barriers, and incentives are paid upon verification that the end-user indeed purchased the cookstove (Byrne et al., 2021).

  The EnDev/CLASP EPC RBF programme, launched in 2020, was the first to focus on electric cooking in a developing country, specifically Kenya. With a $226,000 budget, it aimed to promote electric pressure cookers (EPCs). The selection of EPC models was initially based on quality standards and safety testing but was later relaxed. Six companies received grants covering 30-50% of EPC retail prices through a reverse-auction scheme. The goal was to sell 5,300 EPCs by October 2020, but the COVID-19 pandemic caused delays and adjustments to the program. EPCs sold ranged in price from $70 to $120, targeting urban and peri-urban customers with slightly higher incomes. Although sales targets were not met within the timeline, the original target is expected to be achieved through ongoing sales. New RBF schemes that include electric cooking include NEFCO's Modern Cooking Facility for Africa[31].

Several lessons can be drawn from the EnDev/CLASP EPC RBF and others implemented in the clean cooking sector. First, existing results-based financing (RBF) facilities have focused on transitioning customers from Tier 0-1 to Tier 2-3 cookstoves, but funders may need to shift their focus to incentivise access to Tier 4-5 clean technologies (Sharma & Slawek, 2021). RBF schemes can be used to bring together actors from the electricity access and clean cooking sectors, enabling mini-grid developers and cookstove manufacturers to explore new opportunities (Stritzke et al., 2021). High barriers to participation in previous RBF schemes can be addressed by incorporating ex-ante support for supply chain development and inventory, working capital facilities alongside the RBF (Byrne et al, 2021). For example, KOSAP Round 2 provided upfront incentives of up to 30% ex-ante to support market entry. It is also important to have flexibility in the incentive structure and the programme in general e.g., from uniform to tiered incentives, considering market realities such as currency devaluation, or the impact of COVID-19.

Further, 100% subsidies to households (free distribution) do not work as they result in low adoption rates and reselling of products, otherwise known as subsidy leakages (World Bank, 2020). A significant obstacle in Results-Based Financing (RBF) is the monitoring and verification process, which involves keeping track of stove usage. By promoting the growth of pay-as-you-go (PAYGO) or Pay-as-You-Cook (PAYC) solutions within the clean cooking industry, it may be possible to obtain usage data that is crucial for assessing impact metrics and making impact-related payments (MECS & Energy4Impact, 2021). The promotion of electric cooking should consider the context of energy tariff settings, as it influences consumer perception of costs. Integrating national energy policy consultations and cooperation with utilities to develop targeted tariffs and finance options could increase the impact of RBF programs (Stritzke et al., 2021). Finally, beyond the number of appliances or stoves sold, RBF schemes should also incorporate outcome-based incentive approach, e.g., gender inclusion, fuel usage[32], health and climate impacts, and integrate carbon finance (Sharma & Slawek, 2021).

- **Smart-meter-enabled carbon financing.** This financing model involves using smart meters to monitor energy consumption and calculate carbon emissions reductions resulting from the use of energy-efficient appliances. The carbon credits generated from these emissions reductions can then be sold to companies or governments seeking to offset their own carbon emissions. Smart-meter-enabled carbon financing could provide a pathway for low-income households to access energy-efficient electric cooking appliances. By reducing the upfront cost of purchasing these appliances, carbon financing could help to overcome the financial barriers that prevent many households from investing in energy-efficient cooking technologies.

[31] MCFA programme. (2022). The Modern Cooking Facility for Africa receives strong interest for its first funding round. Retrieved March 4, 2023, from Modern cooking website: https://www.moderncooking.africa/2022/07/06/the-modern-cooking-facility-for-africa-receives-strong-interest-for-its-first-funding-round/

[32] This is particularly relevant for eCooking, as its easier to monitor consumpton with smart meters and demand growth is the key outcome for utilities

In Kenya, preliminary successes in pilot projects in smart metering, PayGo financing and generation of carbon credits from cookstoves show that carbon financing in the sector has enormous potential. MGas has piloted low-cost smart meters for LPG canisters, using PayGo to enable low-income customers pay for as much gas as they can afford on demand. KOKO Networks, which is in the bio-ethanol space, is already selling carbon credits to companies so that they can subsidise the cost of their cookers and fuel for customers. BURN Manufacturing, which already sells smart EPCs, has a $25 million strategic partnership with impact investor Carbon Neutral Royalty to finance cookstove manufacturing and distribution in Africa in return for a share of carbon credits generated from the cookstoves.[33] ATEC, which is a new entrant in Kenya, has already tested PayGo smart induction stoves in Bangladesh and Cambodia that simultaneously generate digitised carbon credits for sale to global net zero partners, and benefits are partly used to subsidise customers' monthly instalments[34]. PowerPay uses and sells smart-metered PayGo technology—whose IoT capabilities are currently being extended. PowerPay's system can be leveraged to monitor and verify carbon savings, potentially unlocking additional funding or credits from carbon finance initiatives[35]. Gold Standard recently endorsed a new methodology which simplifies the validation of carbon finance data by utilizing smart meter data (MECS & ClimateCare, 2022), similar to that used by ATEC.

In the policy sphere, there is political will to support developments around carbon credit financing, as evidenced by President William Ruto remarks at the launch of the Africa Carbon Markets Initiative at COP 27, where he described carbon credits as Kenya's "next significant export"[36]. Although most carbon offset programmes have so far focused on land-based efforts around forestry and conservation, carbon projects in clean cookstoves and green energy investments in geothermal energy, solar energy generation and hydroelectricity are expanding[37], and thus, there is an opportunity design innovative projects around eCooking. Nevertheless, major obstacles still exist in accessing carbon financing for scaling eCooking, as Stritzke et al. (2021) argue. The complex and bureaucratic application process can deter smaller businesses from participating. There is

[33] Carbon Neutral Royalty. (2022). Carbon Neutral Royalty announces strategic partnership with BURN Manufacturing. Retrieved April 4, 2023, from https://www.newswire.ca/news-releases/carbon-neutral-royalty-announces-strategic-partnership-with-burn-manufacturing-821732205.html

[34] White, Z., & Qureshi, B. (2022, October 7). Introducing ATEC: Pay-as-you-go electric cooking for low-income customers in Bangladesh. Retrieved April 4, 2023, from Mobile for Development website: https://www.gsma.com/mobilefordevelopment/blog/introducing-atec-pay-as-you-go-electric-cooking-for-low-income-customers-in-bangladesh/

[35] GSMA (2023). IoT and Essential Utility Services: Kenya market case study. Retrieved from https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2023/04/IoT-and-Essential-Utility-Services-Kenya-market-case-study.pdf?utm_source=website&utm_medium=resourcepage&utm_campaign=IoTEUSKenya

[36] Kotut-Sang, J., & Somorin, O. (2023, February 7). Could carbon credits be Kenya's next leading export product? Retrieved June 4, 2023, from Business Daily website: https://www.businessdailyafrica.com/bd/opinion-analysis/columnists/could-carbon-credits-be-kenya-s-next-leading-export-product--4115202

[37] Mutemi, J., Kimanzi, E., Arrumm, M., Tharani, A., & Ndumba-Banja, C. (2023). Kenya: What the carbon - series 1: a snapshot of the recent developments in Kenya's carbon space. Retrieved April 7, 2023, from Bowmans Law Insights website: https://bowmanslaw.com/insights/impact-investment/kenya-what-the-carbon-series-1-a-snapshot-of-the-recent-developments-in-kenyas-carbon-space/

a lack of institutional linkages between clean cooking firms and carbon market stakeholders, as well as challenges in estimating actual usage and carbon emission reduction. Additionally, the need to scale projects in order to secure carbon financing creates a paradox, as this financing could help scale the sector and allow more actors to benefit from it.

- **Utility-led financing:** Utility-based financing is an umbrella term for a range of financial and business services that utilities and mini grids can offer or facilitate, with the goal of increasing customer access to consumer finance for electric appliances (Waldron & Hacker 2022). In general, this model allows consumers to spread out the cost of purchasing electric appliances over time, typically through monthly instalments added to their utility bills, instead of paying for the appliances upfront in a lump sum. Utility-based financing for electric appliances is often offered by utility companies or third-party financiers in partnership with utility companies.
  Utility-led financing for electric cooking appliances can take different forms, including on-bill financing (OBF) whereby the appliances are pre-financed by the utility, on-bill repayment (OBR) where appliances are financed by third parties, and co-marketing and data-sharing where appliances are financed by a third party but the utility provides support such as data for customer credit scoring or marketing support (MECS & Energy4Impact, 2021). Utility led financing is an attractive option to stimulate demand for electricity and eCooking appliances, particularly in Kenya where prepaid electricity metres are prevalent, and majority of connected households pay their electricity bills via mobile money. PowerHive has tested OBF. Kenya Power is conducting a utility-driven financing pilot in collaboration with PowerPay as part of the eCooking capacity building and market development programme in Kenya. While this initiative is not an OBF approach, it does encompass data sharing and collaboration on awareness campaigns.
  According to key informants, OBF may be difficult for Kenya Power to implement given its current financial health: the company in recent years has been under financial pressure due to various factors such as high debt levels, a decline in revenue collection, and a rise in operating expenses. These pressures also complicate its ability to access funding from capital markets. Thus, an OBR scheme could be tested with donor support. An OBR and data sharing/co-marketing schemes may be more viable, but such schemes need intensive stakeholder engagement with parties such as e-cooking manufacturers and distributors, financial institutions, technical and safety standard organisations, energy auditors and specialist consultants to design a feasible option (MECS & Energy4Impact, 2021). A data-sharing and co-marketing pilot for electric appliances between Umeme and EnerGrow is underway in Uganda.

In conclusion, the high upfront costs of electric cooking appliances have posed a significant challenge for households in Kenya. However, innovative consumer financing models are being introduced to address this issue and make appliance ownership more accessible. Each model offers a unique approach to breaking down the upfront cost barrier and enabling households to invest in clean cooking technologies. The widespread use of mobile money payments has facilitated the adoption of these financing models, particularly for low-income earners who may not have access to traditional banking services.

Supply side financing mechanisms include utility-led financing, and smart-meter-enabled carbon financing. As Kenya explores the potential of these models, it is essential to invest in robust monitoring and verification mechanisms, as well as the infrastructure necessary for the widespread adoption of technologies like smart meters. Collaboration between stakeholders such as manufacturers, distributors, financial institutions, and policy-makers is key to successfully designing and implementing these innovative financing models, ultimately making electric cooking appliances more accessible to households in Kenya.

5.3 After Sale Services, Repair and Maintenance

After-sales services for electric cooking appliances in Kenya cover a range of services, including installation, repair and maintenance, warranty support, spare parts provisioning, customer support and disposal at the end of life. Some major retailers and manufacturers also offer additional services, such as extended warranties, product training, and recycling programs for used appliances. These services are provided by authorized service centres such as Hotpoint Appliances, Carlcare Service, Ideal Appliances and Samsutech Service Centre which offer repair and warranty support for a range of brands besides their own. Some appliance retailers/distributors such as LG, Ramtons, Armco, Philips, SCODE, Burn Manufacturing and VIA which operate their own customer support and service centres. Some distributors lack service facilities, and according to one retailer, distributors are "*reluctant [because] they also are subject to the warranty that they are provided by the manufacturer. So, you bring in another intermediary on top of another intermediary and the manufacturer is far away in China or in Europe. So they want to reduce the risk of them not getting the warranty honoured*". Independent repair shops such as Nairobi Repair and Kijani Testing Ltd offering after sale support for manufacturers who do not have a presence in Kenya, with a focus on warranty and out-of-warranty repairs for appliances. Genuinely branded eCooking appliances in Kenya normally have warranties of between 1 and 2 years.

Figure 5.8 Proportion of households who repaired appliances

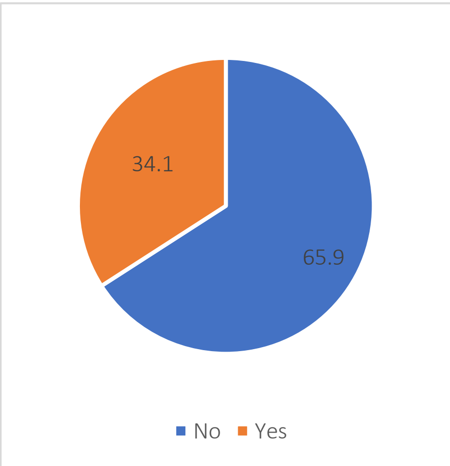
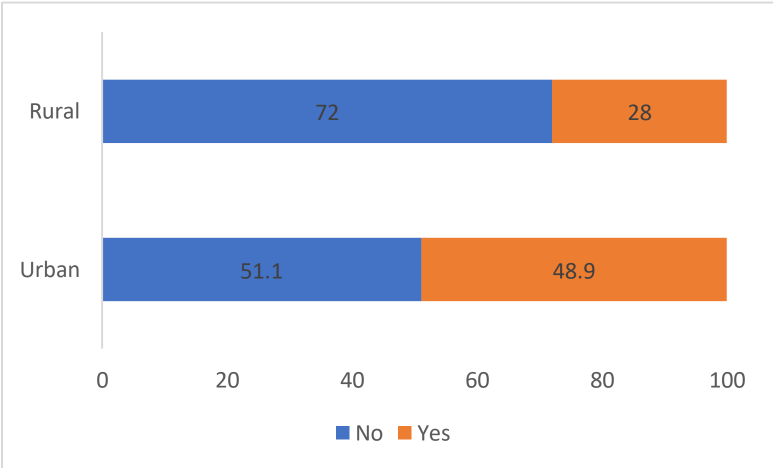


Figure 5.9 Proportion of households who repaired appliances – Urban/Rural



From our survey data, 34.1 percent of households reveal that they had taken their eCooking appliances for repair while 65.9 percent had never. While after-sales services are more readily available in urban centers like Nairobi, Mombasa, and Kisumu, the reach has been expanding to rural and semi-urban areas due to increased electrification and the growth of the electric appliance market. Results further reveal that 48.9 percent of the urban households used repair services while 28 percent of households from the rural areas used repair services as shown in Figure 55.4. Nevertheless, the retailers we interviewed explained that challenges of geographical reach persist, among them relatively low demand for eCooking appliances in some parts of rural Kenya and poor infrastructure in some parts of Kenya, which makes it difficult and costly for service providers to invest in service centers in those areas. For instance, upon customer complaint, SCODE and Bidhaa Sasa have to use a courier to retrieve the faulty appliance, then they verify the issue, notify the supplier likely located in Nairobi, and send it for repair or replacement. Once fixed, the appliance is returned to the customer, and the cycle repeats if needed. Bidhaa Sasa further argued that *"this is not a good system because there is no incentive for the wholesaler to be fixing a few EPCs per month".* Further, wholesalers, who are not engineers or manufacturers, might offer after-sales service, but it is usually subpar due to the absence of direct relationships with end-users. The turnaround time is also unnecessarily long, as *"it takes two weeks to fix something that they should be fixing in ten minutes".* These enterprises are seeking a solution that streamlines this process, reduces turnaround time, and improves customer satisfaction.

Further, there is limited awareness about warranties among customers, of lack of access to service centers or repair shops. especially in rural and remote areas. Of all the households that acknowledged to have taken their electric cooking appliances for repair at some point, only 11.7 percent of them were poor households. This low compared the lower middle income and the middle-income households. Highest number of the households that reported to have sought electric cooking appliances repair and maintenance services were wealthy households (39.6 percent). This could be attributed to their awareness of the repair and maintenance services and their ability to pay for the repair broken appliances.

Human resources such as skilled technicians and engineers and spare parts form the backbone of after-sales services for appliances in Kenya. The country has a growing pool of trained professionals. Nevertheless, there is a need for continuous skill development and training to keep up with the latest technological advancements and evolving customer needs. Access to quality spare parts, particularly for imported appliances, routinely delay repair and maintenance services. Genuine spare parts are also expensive. For instance, the cost to replace the float valve and its silicone cap for electric pressure cookers is as high as KES 790 in one of the authorised service centres. It has been argued that some producers price repairs prohibitively in the hopes that customers would instead buy brand-new models[38].

Customers who are unwilling or incapable of paying for services at such centres opts to go into the informal industry for more affordable services, where a robust repair ecosystem has developed, complete with skilled self-taught technicians and apprentices and counterfeit, recycled or fabricated spare parts. Our data shows that 28.1 percent of households used the services of an untrained technician in the informal sector, while 56.8 percent of households used the services of a trained or

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[38] Wambugu, A. (2021). Electric appliance quality in Kenya. Retrieved June 4, 2023, from Modern Energy Cooking Services website: https://mecs.org.uk/blog/electric-appliance-quality-in-kenya/

specialised local technician, and only 29.4 percent went to the product service centre. While many low-income households vouch for the reliability of informal repair shops, there have been instances of poorly done repair work that has caused further appliance malfunction or worse, injuries. A few urban and rural dwellers self-repair broken appliances as shown in figure 6.14 below.

Figure 5.10 Source of *support for eCooking appliance repair*

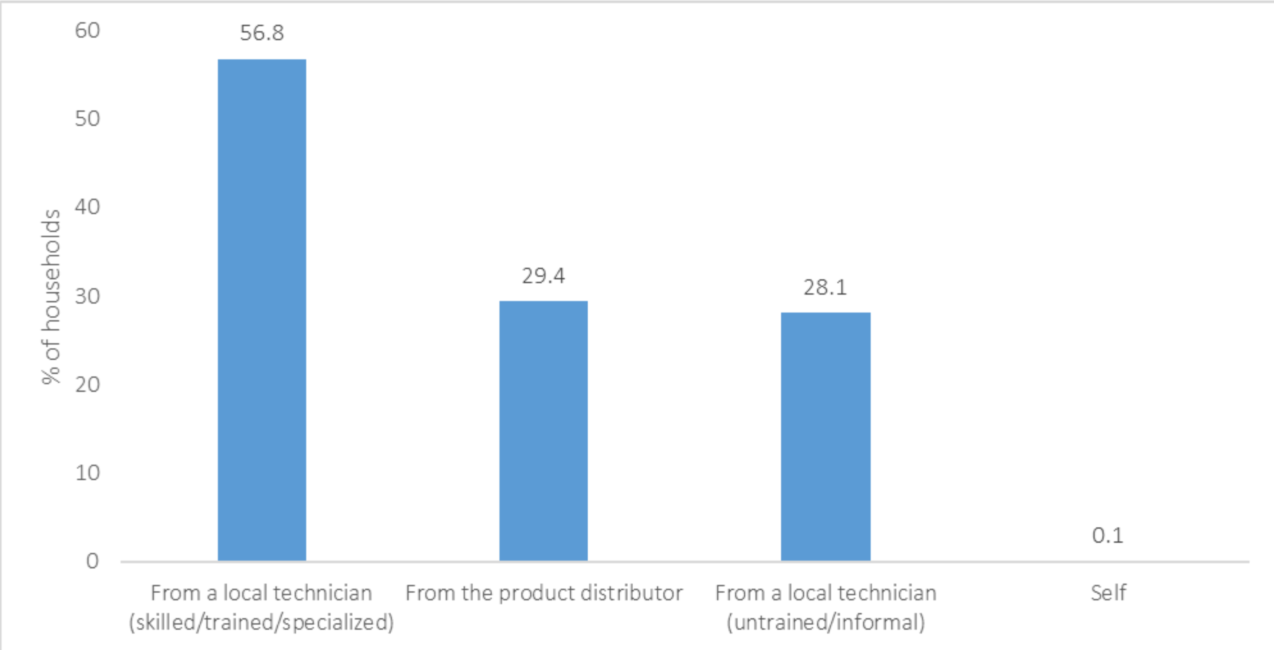
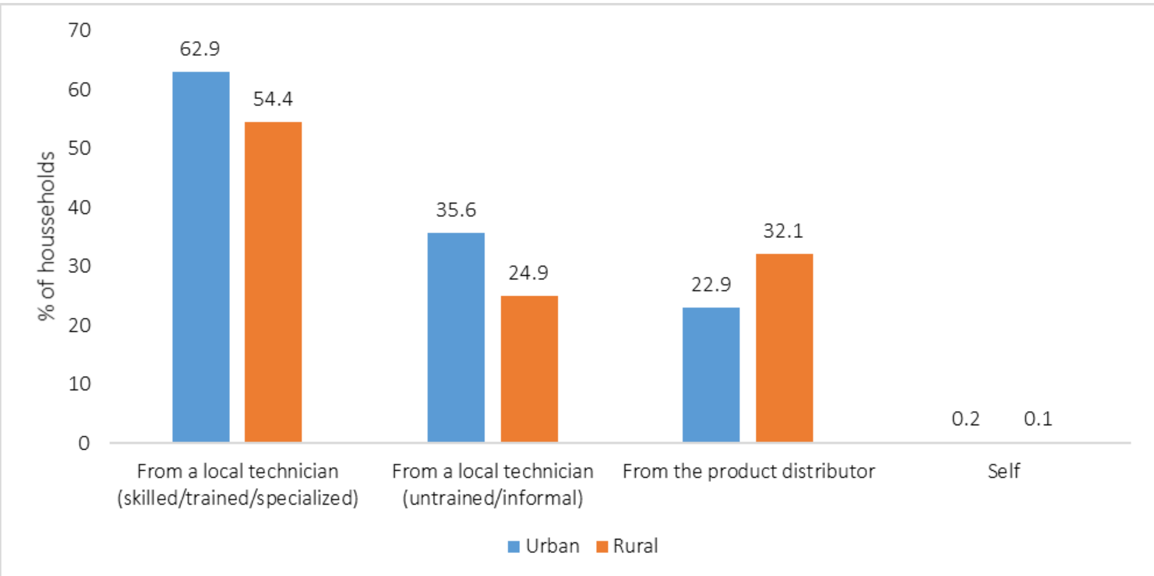


Figure 5.11 Source of *support for eCooking appliance repair* (urban/rural)



After sales service providers in Kenya have begun to leverage digital platforms and mobile technology to improve service delivery, customer support, and communication, making it easier for customers to access after-sales services. Some companies offer digital warranties as opposed of manual ones, this addressing loss of printed warranty cards which effectively void most product warranties. Some companies use email to share newsletters with new product information, maintenance best practices and even new recipes with their customers. Many companies have managed social media pages and chat features on their websites through which customers can interact with customer case staff. SayonaAPPs offer video calls with technicians to troubleshoot their products, which in many cases can circumvent the lenghtly channels needed to get the device back to the warehouse in Nairobi for repair.

To improve after-sales services for appliances in Kenya, the following mechanisms can be considered:

- Expanding service centres: Increase the number of authorized service centres in rural and semi-urban areas to cater to the growing demand for eCooking appliances, making it easier for customers to access repair and maintenance services.
- Enhancing technician training: Invest in continuous skill development and training programs for technicians to ensure they are up-to-date with the latest technological advancements and evolving customer needs.
- Streamlining warranty claims: Simplify the warranty claim process by reducing the number of intermediaries involved and improving collaboration between manufacturers, retailers, and service providers. This could lead to faster turnaround times and better customer satisfaction.
- Raising awareness about warranties: Conduct awareness campaigns to educate customers about the importance of warranties and their rights in terms of after-sales services, particularly in rural and remote areas.
- Encouraging the use of genuine spare parts: Collaborate with manufacturers to ensure the availability of quality spare parts at reasonable prices, reducing the reliance on counterfeit or substandard components.
- Regulating the informal repair sector: Develop guidelines and standards for informal repair shops, ensuring that they meet minimum quality requirements to protect customer interests and appliance safety.
- Leveraging digital platforms: Embrace digital platforms and mobile technology for service delivery, customer support, and communication. This can include digital warranties, email newsletters, social media pages, and chat features on company websites to facilitate better customer interactions and support.

In conclusion, the after-sales service landscape for electric cooking appliances in Kenya is multifaceted, with authorized service centres, independent repair shops, and appliance retailers providing various services. The growing demand for these services in rural areas highlights the importance of expanding access and raising awareness about warranties. Continuous skill development and training for technicians are essential to keep pace with technological advancements and customer needs. Gaps in the system could benefit from stronger collaboration between manufacturers, importers, retailers, and service providers.

5.4 Energy Service Companies and Uptake of eCooking

Energy service companies (ESCOs) such as utilities, mini-grid developers, and SHS companies play a crucial role in the marketing, selling, and supporting eCooking appliances in Kenya.

5.4.1 Utilities

Kenya's energy sector consists of various utilities and regulatory bodies that work together to ensure the provision, distribution, and regulation of energy resources within the country. Kenya Power (KPLC) is the primary electricity distribution company in the country, responsible for distributing and retailing electricity to customers. Kenya Power is currently the only customer-facing utility in the system, and therefore, it is better positioned to market, sell and promote eCooking appliances. In this regard, Kenya Power continues to leverage its infrastructure and customer base to promote, sell, and support eCooking initiatives. The company has run various awareness raising programmes to highlight the benefits of eCooking. Key among them is the "Pika na Power" (Cook with Power) programme[39] aimed at promoting electric cooking in the country by encouraging the adoption of energy-efficient electric cooking appliances among its customers. This initiative is linked to the 'Mke Nyumbani' television show first broadcasted in the 1990s. Pika na Power's main objective is to create awareness about the benefits of electric cooking, showcase the efficiency and cost-effectiveness of modern energy-efficient electric cooking appliances, and demonstrate their compatibility with common Kenyan dishes such as ugali, rice, stews, deep-fried foods, and baked foods. To achieve this, Kenya Power conducts live electric cooking demonstrations at its flagship model kitchen and studio at Electricity House in Nairobi's Central Business District, and is looking to launch demonstration centres in major towns and cities in Kenya. Through this programme, Kenya Power collaborates with electric cooking appliance manufacturers and retailers to promote and sell their products. Kenya Power is also collaborating with the Ministry of Energy and development partners to raise awareness about the environmental and health benefits of eCooking appliances, emphasizing their alignment with national development goals.

However, many opportunities to further leverage Kenya Power's resources in promoting eCooking still exist. As discussed in Section 5.2, Kenya Power could further promote eCooking by providing financing options, such as utility-led financing, pay-as-you-go schemes, or bundling eCooking appliances with new electricity connections to make them more affordable for consumers. Kenya Power could develop targeted marketing campaigns utilizing its customer database to send personalized marketing communications, such as emails and SMS promoting eCooking appliances.

Apart from Kenya Power, other utilities in the electricity sector work in tandem to ensure the growth, development, and sustainability of the sector, with a focus on increasing access to electricity, promoting renewable energy sources, and maintaining affordability for consumers. Kenya Electricity Generating Company (KenGen) is the largest power producer in Kenya, generating over 70% of the country's electricity from various sources such as hydro, geothermal, wind, and thermal power plants. Kenya Electricity Transmission Company (KETRACO) is responsible for the planning, design, construction, and maintenance of high-voltage transmission lines and associated substations. Rural

[39] Pika Na Power | Facebook. (n.d.). Retrieved March 8, 2023, from https://www.facebook.com/PikaNaPower/

Electrification and Renewable Energy Corporation (REREC) is mandated to promote rural electrification and the development and use of renewable energy sources, such as solar, wind, and biomass The corporation has implemented public minigrids to improve energy access in remote regions. Geothermal Development Company (GDC) is a state-owned company focused on the exploration, development, and promotion of geothermal resources. Finally, Energy and Petroleum Regulatory Authority (EPRA) is the regulatory body mandated with ensuring fair and transparent regulation, protecting consumer interests, and promoting the development of the sector in a sustainable manner.

These utilities can support the scaling of electric cooking in the following ways:

- *Strengthening and expanding the grid:* Kenya Power and KETRACO can collaborate to improve the electricity grid infrastructure, ensuring it can handle the increased demand from electric cooking appliances. This may involve upgrading transmission lines, substations, and distribution networks to minimize power outages and ensure a stable and reliable electricity supply. As a focus group participant argued, "*I would love to go 100% on electric cooking. However, there is always that disappointment, there is always that doubt of 'hii stima itaenda' (there's going to be a black-out). And there are days it is out a full day".* Further, this may involve deploying smart grid technologies to improve grid management and reliability.
- *Promoting renewable energy:* KenGen and REREC can work together to increase the share of renewable energy in the national grid, ensuring that electric cooking is powered by clean and sustainable sources. This could include continuing to invest in solar, wind, and geothermal power plants, as well as encouraging the use of decentralized renewable energy systems for households and communities.
- *Expanding rural electrification:* REREC and Kenya Power can collaborate to expand electricity access in rural areas, where a significant portion of the population still relies on traditional biomass-based cooking methods. This could involve extending the grid or implementing off-grid solutions, such as SHSs or mini-grids, that can power electric cooking appliances.
- *Providing affordable electricity:* EPRA and Kenya Power can work to ensure that electricity tariffs remain affordable for the majority of Kenyan households, which will encourage consumers to switch from traditional biomass-based cooking methods to electric cooking appliances. Strategies for creating a sustainable tariff regime for electric cooking include maintaining affordable lifeline tariffs, e.g., through cross-subsidization[40], implementing time-of-use tariffs to incentivise customers to cook with electricity during off-peak hours[41], and with technological upgrades in the system, dynamic pricing which would encourage consumers to use electric cooking appliances when there is surplus generation, helping to balance the grid and optimize energy usage. EPRA could also pilot dedicated eCooking tariffs with smart-metered eCooking appliances.

[40] There is still debate about the ethics of crosss-subsidization within a tariff regime. According to Mburamatare, Gboney, & Hakizimana (Mburamatare, Gboney, & Hakizimana, 2022), cross subsidization between customers which violate the equity or non-discrimination principle of a good tariff which discourages use by the overcharged and promotes overconsumption by the subsidized.

[41] The new tariff structure which takes effect from 1 April 2023 has introduced the time of use for all categories apart from domestic category. EPRA. (2023, March 24). Retail electricity tariff review for the 2022/23-2025/26 4th Tariff Control Period (TCP) effective 1st April 2023. Retrieved June 4, 2023, from Energy and Petroleum Regulatory Authority website: https://www.epra.go.ke/retail-electricity-tariff-review-for-the-2022-23-2025-26-4th-tariff-control-period-tcp-effective-1st-april-2023/

- *Developing and implementing supportive policies:* EPRA can create regulations and policies that encourage the adoption of electric cooking appliances, such as setting energy efficiency standards, offering incentives for manufacturers and consumers, creating an eCooking tariff, and promoting research and development in electric cooking technologies.
- *Raising awareness and education:* All the utilities can engage in public awareness campaigns, educating consumers about the benefits of electric cooking, including improved health, safety, and environmental outcomes. They can also provide information on how to choose energy-efficient appliances and use them effectively to minimize energy consumption.

It is worth mentioning that, with the leadership of Kenya Power, all these utilities cooperate to develop the Least Cost Power Development Plan (LCPDP), a strategic planning tool used by Kenya to identify the most cost-effective mix of power generation and transmission projects to meet the country's growing energy demand (Government of Kenya, 2021). The LCPDP now includes demand forecasts on eCooking, although conservatively.

5.4.2 Minigrids developers

Electric cooking in mini-grids is emerging as a promising solution to address the energy needs for cooking in Kenya, particularly in remote and off-grid communities . ECooking is a way to utilise excess capacity in minigrids in Kenya, particularly those designed by PowerHive, Renewvia, RVE.SOL (Rural Village Energy Solutions), and some small hydros. For instance, Powerhive, which first began by distributing hotplates to their customers and has sold 773 branded electric pressure cookers, has found that the EPC contributes up to 60% of energy sales in minigrid sites with EPC customers. Thus, electric cooking in minigrids can result in higher household electricity consumption, thereby increasing the demand for the electricity generated by the minigrid, also as shown in an eCooking pilot in Tanzania[42]. Further, offering electric cooking solutions as part of the minigrid's energy services can attract new customers, who may be more inclined to connect to the minigrid due to the added convenience and benefits of electric cooking. This can result in higher connection rates and customer satisfaction.

However, challenges remain in maintaining system reliability and operation in mini-grid systems due to sudden demand peaks, higher operations and maintenance costs, and the difficulties associated with maintaining reliability. A minigrid developer explained that as when "*try to increase the number of appliances like the EPCs to these customers, our sites tend to go down".* Despite these challenges, Couture & Jacobs (2019) argue that there is no inherent technical barrier to electric cooking within mini-grid systems. Mini-grids are scalable and can be upgraded to accommodate additional loads. The same developer argued that site downtime *"informed the decision from the management to increase the generational capacity, which has been happing recently".* Another minigrid developer argued that the use of electric pressure cookers may help shift a significant portion of the cooking load to daylight hours, reducing pressure on the system. Further, during the design phase, mini-grids can be sized to account for increased loads over time due to additional household uses and connections. There is also

[42] Schreiber, K., Waceke, M., Blair, H., Grant, S., & Ireri, S. (2020). Electric Pressure Cooking: Accelerating Microgrid E-Cooking Through Business and Delivery Model Innovations. PowerGen Renewable Energy, CLASP, Efficiency for Access Coalition. https://www.clasp.ngo/research/all/electric-pressure-cooking-accelerating-microgrid-e-cooking-through-business-and-delivery-model-innovations/

need to invest in substantial energy storage to accommodate large cooking loads from appliances with wattages between 120W - 3000W, which are often concentrated during early morning and evening hours. Storage represents a significant cost factor for mini-grid systems (Leach & Oduro, 2016). However, energy storage costs are expected to decline in the coming years due to improved efficiencies, increased investment, research and development, and economies of scale for batteries. (Lazard, 2018; RMI, 2018; BNEF, 2018).

Tariffs in most mini-grids is already significantly higher than on grid tariffs, thus purchasing appliances and cooking with electricity in such settings might be unaffordable for low-income households, hindering widespread adoption (Bahaj et al., 2019). One developer explained that low-income customers typically do not use the EPC frequently on the minigrid due to the cost of use. Further, ensuring consistent and reliable power supply from mini-grids is essential for the successful adoption of electric cooking. Power outages or rationing can discourage households from relying on electric cooking appliances.

In general, minigrid developers can support the scale-up of electric cooking in through several strategies and initiatives that promote the adoption and integration of electric cooking appliances within the communities they serve. These strategies include:

- *Demand assessment and planning:* Minigrid developers should conduct thorough demand assessments and projections to understand the energy requirements for electric cooking in their target communities. This information can be used to design and size minigrid systems that can adequately support the increased energy demand from electric cooking appliances. Their systems could also be optimised to handle the variable and peak loads from electric cooking appliances. This may involve optimizing the generation, storage, and distribution components of the minigrid to ensure that they can efficiently support electric cooking without compromising its reliability and stability. An successful example of this is the scaling of the Renewvia Energy solar minigrid in the Kalobeyei settlement in Turkana County which, apart from increasing the capacity to connect 3000 households, facilitated more optimal uptake of EPCs[43].
- *Consumer education and awareness:* Minigrid developers should engage in community outreach programs to educate consumers about the benefits of electric cooking, such as improved efficiency, reduced indoor air pollution, and cost savings. Demonstrations and workshops can be organized to showcase the use of electric cooking appliances and provide hands-on training to potential users. For example, PowerHive has engaged in local awareness campaigns, conducting cooking demonstrations, and providing training on the proper use and maintenance of electric appliances can help drive adoption.
- *Appliance financing and distribution:* Minigrid developers could collaborate with manufacturers, retailers, and financial institutions to offer affordable financing options and distribution channels for electric cooking appliances. This can include microloans, pay-as-you-go schemes under on-bill financing and on-bill repayment schemes, and bulk purchase discounts to make electric cooking appliances more accessible to low-income households.
- *Technical support and training:* Minigrid developers should provide technical support and training to local technicians and service providers to ensure that they have the necessary skills

[43] SNV. (2023). Piloting Electric Pressure Cookers in Kalobeyei (PEPCI-K). Retrieved June 4, 2023, from https://snv.org/project/piloting-electric-pressure-cookers-kalobeyei-pepci-k

to install, maintain, and repair electric cooking appliances. This can help create a local ecosystem of skilled technicians that can provide reliable after-sales services to customers.

- *Product bundling and cross-selling:* Minigrid developers can bundle electric cooking appliances with other energy products and services, such as SHSs, lighting, and mobile charging, to create attractive packages for consumers. Cross-selling can help increase customer adoption and utilization of electric cooking appliances while also promoting the overall uptake of clean energy solutions (Shuma et al., 2022).
- *Monitoring and evaluation:* Continuously monitor and evaluate the performance of electric cooking appliances connected to the minigrid to identify opportunities for system optimization and improvement. Feedback from users can help inform future project designs and system upgrades.

By implementing these strategies, minigrid developers can play a crucial role in supporting the scale-up of electric cooking in their target communities, contributing to improved energy access, better health outcomes, and reduced environmental impacts.

5.4.3 SHSs companies

SHSs are off-grid solutions designed to provide electricity to homes and communities that are not connected to a centralized power grid. These systems harness solar energy through photovoltaic (PV) panels and store it in batteries for later use. In Kenya, solar electric cooking is still in at a nascent stage. Among our key informants, opinions vary on the role of SHSs in facilitating electric cooking. Some argue that SHSs may not have the capacity to generate and store enough electricity appliances such as microwaves, electric kettles and induction cookers. Further, the capacity of SHS batteries might not be sufficient to store the enough energy required for electric cooking at night or for extended periods, along with lighting, entertainment and other concurrent household energy uses. Finally, most electric cooking appliances are designed to work with AC power, while SHSs generate DC power. Owens (2021) in a study of the outputs of M-Kopa, a DC-powered, off-grid SHS (SHS) found that the power requirements of existing e-cooking devices exceed the capacity of M-KOPA's SHS to enable non-daylight cooking hours, noting that the cost to provide this level of power supply would be prohibitive for customers.

Proponents of eCooking in SHS contend that these systems could, with minimal upgrades, support EPCs as the most energy efficient appliance. For instance, an inverter can be used to convert DC to AC power. Alternatively, DC cooking appliances can be used in SHSs. While these appliances are scarce in the Kenyan market, signs of scaling these appliances can be seen through the efforts of stakeholders like Village Infrastructure Angels (VIA), which is presently piloting DC appliances in Nairobi. SCODE has also tested 24V, 400W DC EPCs in villages near Nakuru town, and found that these appliances take longer to cook, unless the size of the power cable is increased (Maina, Wamalwa, Kisiangani, Kamau, & Kamau, 2021). This would however make the system unnecessarily bulky. Utilizing DC appliances is considered to be more efficient than converting power to alternating current (AC), as it eliminates the need for an inverter, thus reducing overall system costs.

Village Infrastructure Angels (VIA), Biolite and SunCulture have also designed more powerful SHSs that can support higher powered eCooking and other household activities and productive uses. SunCulture is piloting solar pressure cookers on a solar energy system dubbed ClimateSmartTM that is connected to a Lithium-Ion Battery. The enterprise is further exploring how to add innovative features such as remote cooker activation and predictive maintenance[44]. BioLite's SHSs typically include a solar panel, a central control unit with an integrated battery, and energy-efficient lighting. The SHSs are designed to provide lighting, device charging, and power for small appliances, and had been deployed along with Angaza's Pay-As-You-Go technology. The company has developed a hybrid AC/DC Electric Pressure Cooker with residential and productive use applications. VIA's modular solar system features solar panels, a Lithium iron phosphate battery and a control unit which can be used to power DC home appliances such as a solar washing machine and solar EPC. VIA also emphasise the value of insulated pots in saving energy during solar e-cooking. Athel Technologies have designed a solar DC induction cooker dubbed ecoMpishi, and it is already commercially available on the Kenyan market at a retail price of $500-800, which in their estimation, translates to about 2 to 4 years of typical current urban fuel expenditures on charcoal or LPG (Liquid Petroleum Gas) gas. Athel Technologies has also designed an all in one cooker assembled with two induction cooker, an electric barbeque grill area and two gas burners. The cooker has an inbuild back up batteries and come with solar panels. PURAMS (Productive Use in Rural African Markets using Standalone Solar), a project implemented by SERC is working on optimizing the eWant DC EPC by MECS by enhancing its safety features and smoothening its load curve when power is drawn from the battery[45].

VIA

The ecoMpishi, Image credit to Athel Technology

battery-supported eCooking, SCODE

Figure 5.12. Solar eCooking examples

In all of these systems, the cost of batteries is a main concern. In their pilot, SCODE tested the option of connecting two locally available, and more affordable 100Ah lead acid batteries in series to get 24V 100AH battery bank that took 5 hours to charge. In their own evaluation, VIA found that such a set-up is not ideal, not portable, and has a limited lifespan. Lithium-ion batteries—which have seen dramatic cost reductions in the last 10 years—offer a compact and durable alternative. The government has now zero-rated VAT on solar and lithium and ion batteries, which may increase their availability in the Kenyan market. Further, as eMobility diffuses in Kenya, the availability and cost of lithium-ion batteries is expected to become more favourable. It is worth noting that despite concerns about

[44] MECS. (2019). Powering energy efficient solar powered pressure cooker with ClimateSmartTM Internet-of-Things technology in Kenya. Retrieved February 11, 2023, from Modern Energy Cooking Services website: https://mecs.org.uk/challenge-fund/past-funds/leia/sunculture/

[45] Long-Term Joint Research and Innovation Partnership on Renewable Energy. (2023, March 27). PURAMS - Solar-powered DC electric pressure cooker: A sustainable and cost-effective solution. Retrieved March 8, 2023, from LEAP-RE website: https://www.leap-re.eu/2023/03/27/purams-solar-powered-dc-electric-pressure-cooker-a-sustainable-and-cost-effective-solution/

battery costs, expenditure models have shown that battery-supported electric cooking can be cost competitive with current expenditures on cooking fuels (Leary, Leach, Batchelor, Scott, & Brown, 2021). Direct drive solar eCooking devices also offer very low-cost eCooking solutions to rural households, as VIA have also demonstrated in their pilot. Lithium-ion battery costs have seen dramatic reductions in the last 10 years, and the eMobility and off-grid lighting sector are key drivers of availability and further cost reductions.

Thus, to power more energy-intensive appliances, SHS can be set up with larger photovoltaic panels, a more powerful inverter, and a larger battery storage system. A key informant argued as follows: *"In the more rural, peri-urban areas, you can easily fit one or 2 or 3 kilowatt of solar on the roof of anybody's house. Or at least 500 watts as we typically do, and people can cook with it. They can run a washing machine they can heat water, they can run their lights, they can run their entire life in the system"*. However, higher capacity SHSs have high upfront costs, and this could be financially challenging for many households. "*If you have the money for a massive SHS, you are the rich of the village*", a key informant argued. This underlines the need for innovative financing mechanisms to overcome affordability barriers. The benefit of procuring such systems despite their higher upfront costs is that at the end of the payment period, a customer will own the SHS and, effectively, have access to almost zero-cost source of energy for cooking for as much as 20 years. However, there is a need to periodically replace battery banks or inverters, typically every 3 to 7 years, based on customer behaviour and overall usage patterns. Battery and inverter replacements account for approximately 30% of the total SHS (SHS) cost, making it a significant expense for households looking to extend the lifespan of their SHS and maintain electric cooking capabilities. In this context, Couture & Jacobs (2019) recommend that PayGo or similar financing systems remain accessible to those customers to facilitate battery and inverter replacements. For example, if replacements can be financed through a PayGo plan akin to the original contract, households can continue to access clean electric cooking at an affordable cost.

At the macro scale, the key to making solar electric cooking cost-competitive relative to cooking with wood is dependent on four factors: ensuring long lifetimes for solar panels and batteries; importing and distributing batteries and solar panels at scale to keep overhead costs low; utilizing energy efficient eCooking appliances; and accounting for climate impact externalities in the existing cost of wood (Van Buskirk et al., 2021). The cost analysis indicates that integration of solar e-cooking with SHSs by increasing the size of the PV panel and the battery can be quite cost effective when compared to usual cooking cost (Batchelor et al., 2018).

Nevertheless, the SHS ecosystem in Kenya has been the global pioneer in developing PAYGO business models in the energy sector to facilitate affordability for lower income hosueholds offgrid. This is a customer base, running in the millions, are prime targets for upgrades to solar eCooking, as the requisite payment mechanism is already in place.

In sum, SHSs (SHS) companies can support the scale-up of electric cooking by implementing various strategies and initiatives:

- *Offering tailored SHSs:* SHS companies can design and offer SHSs specifically tailored for electric cooking. These systems should have the capacity to power energy-efficient electric cooking appliances like induction cooktops, electric pressure cookers, and slow cookers, in addition to other essential household loads.

- *Innovative financing options:* SHS companies can provide flexible financing options, such as pay-as-you-go schemes or micro-loans, to make electric cooking appliances more accessible and affordable for their customers[46]. By spreading the cost of appliances over time, households can more easily adopt electric cooking without facing significant upfront expenses.
- *Engaging in research and development:* SHS companies can collaborate with appliance manufacturers to develop energy-efficient electric cooking appliances that are compatible with their SHSs (Batchelor et al., 2018). This can include appliances with low power requirements, smart controls, and features that optimize energy consumption for off-grid households.
- *Education and awareness campaigns:* To encourage the adoption of electric cooking, SHS companies can engage in education and awareness campaigns that highlight the benefits of electric cooking, such as improved health, reduced air pollution, time savings, and convenience. These campaigns can be targeted at both existing SHS customers and potential new customers in off-grid communities.

5.5 Efficiency and Quality Assessment of eCooking Appliances

The ecosystem for efficiency and quality assessment for electric cooking appliances in Kenya is still at its infancy. The Kenya Bureau of Standards (KEBS) is mandated to develop standards, measurements, and conformity assessment regimes for locally made and imported goods. KEBS has safety and performance standards for improved biomass cookstoves, and more recently, eCooking appliances. Entities such as the Kenya Industrial Research and Development Institute (KIRDI) and the University of Nairobi have been testing biomass cookstoves. As the demand for electric cooking appliances gradually begins to grow, there are now efforts to develop capabilities around appliance testing and quality assurance for electric appliances.

5.5.1 Standards for eCooking appliances

Standards act as benchmarks that outline safety and performance measures. In Kenya, standards are developed through technical committees made up of a diverse group of stakeholders. KEBS has a specific technical committee dedicated to electric cooking appliances, i.e. KEBS/TC 90. This committee aligns its work with international standards, specifically, guidelines set forth by IEC TC 61 and IEC TC 59, the two international technical committees dedicated to electric cooking appliances. Safety standards in Kenya verify whether an electric cooking appliance provides an acceptable level of protection against electrical, mechanical, thermal, fire and radiation hazards. Table 6.6 identifies the safety standards for different eCooking appliances. Safety aspects covered by the standard include:

- Mechanical Design: Kenya prioritizes the stability and safety of electric cooking appliances. Standards are set to ensure appliances remain stationary during use, can withstand regular wear, and are resistant to both heat and fire. This guarantees both durability and user safety.
- Electrical Design: Kenya's electrical standards for eCooking appliances focus on user protection. They encompass classifications against electric shocks, safe temperature thresholds, measures against unintentional current flows, and the prevention of access to live

[46] Angaza. (2018). BioLite & Angaza Partner for PAYG SolarHome 620. Retrieved April 8, 2023, from Angaza website: https://www.angaza.com/2018/09/15/angaza-biolite/

components. Clearances between electrical parts further enhance safety by preventing short circuits.

- Environmental Design: Kenya's eCooking standards take the environment into account by ensuring appliances have adequate intrusion protection (IP rating) against solids and liquids. Additionally, appliances are designed to resist corrosion, reflecting a commitment to longevity in diverse climates.
- Marking and User Instructions: Kenya mandates that eCooking appliances come with concise operational guidelines, enabling users of all technological proficiencies to understand and safely operate their devices.

Table 5.4 Safety Standards for Electric Cooking Appliances in Kenya (KEBS, 2019)

Appliance type	**Safety standard reference**
Electric hot plates, Electric stoves, Induction cookers	KS IEC 60335-2-9:2019, Household and similar electrical appliances – Safety – Part 2-9: Particular requirements for grills, toasters and similar portable cooking appliances
Electric rice cookers, Electric slow cooker, Electric pressure cooker, Electric Multicooker	KS IEC 60335-2-15, Household and similar electrical appliances - Safety - Part 2-15: Particular requirements for appliances for heating liquids.
Electric cooking ranges	KS IEC 60335-2-6, Household and similar electrical appliances - Safety - Part 2-6: Particular requirements for stationary cooking ranges, hobs, ovens and similar appliances.

Performance standards assess the energy and cooking efficiency of electric cooking appliances. While many international standards outline key performance traits and their measurement methods, they typically do not provide specific performance benchmarks. Notably, these test methods replicate typical household cooking situations, even if they might not always mirror real-life household scenarios.

In Kenya, the standard for electric cooking appliances addresses several performance metrics (See Table 6.7 for a list of performance standards and their respective appliances). These include the heating-up time, which evaluates the appliance's energy efficiency and production capability; temperature control, which examines the appliance's responsiveness; sauté, gauging energy and time for typical food preparation; and energy efficiency, comparing energy consumed by the food to that used by the appliance. Additionally, measurements are taken for energy consumption during simmering, standby energy in induction appliances when hobs are off, heat distribution across cooking zones, and the appliance's dimensions and weight. There is a need to develop minimum performance requirements for eCooking appliances.

Table 5.5 Performance Standards for Electric Cooking Appliances in Kenya (KEBS, 2019)

Appliance type	**Performance Standard**
Electric hot plates, Electric stoves, Induction cookers, Electric rice cookers, Electric slow cooker, Electric pressure cooker, Electric Multicooker	IEC 61817:2000 + AMD 1:2004 CSV, Household portable appliances for cooking, grilling and similar use - Methods for measuring performance

Electric hobs	KS IEC 60350-2:2017, Household electric cooking appliances - Part 2: Hobs - Methods for measuring performance
Electric ranges	KS IEC 60350-1:2016, Household electric cooking appliances - Part 1: Ranges, ovens, steam ovens and grills - Methods for measuring performance

5.5.2 Testing and certification

There is still no national test method requirement for electric cooking appliances in Kenya. Thus, tests are done voluntarily, i.e., based on demand from retailers who want their products tested for product improvement or product development. Through the Global LEAP program, test methods have been developed for electric pressure cookers, considering factors such as durability, energy efficiency, service delivery, and price. This goes beyond the traditional focus on safety (Global Leap Awards, 2021). The test methods are developed by taking the closest existing test method by the International Electrotechnical Commission (IEC) and adding additional metrics specific to the local context, such as durability, usability, and cultural cooking habits. In addition, the testing methodology considers contextual factors in the performance of electric appliances in relation to grid (in)stability, and factors around weather (capacity to withstand the direct heat from the tropical sun when cooking outdoors or in hot rural kitchens). This protocol is being used by Kijani Testing Lab in Western Kenya and Strathmore Energy Research Centre. So far, there are still challenges regarding defining and contextualizing efficiency.

Kijani Testing Lab is a Kenyan startup based in Kisumu that focuses on providing field trials and market testing services to renewable energy, off-grid appliances. They have tested multiple appliances such as solar water pumps, incubators, and solar dryers, including EPCs, working with both local and international organizations. Strathmore Energy Research Centre (SERC) has an ISO recognized laboratory accredited to carry out tests on solar PV and improved cook stoves, and is now delving into eCooking appliance testing.

Testing data is shared with companies, allowing them to make improvements to their products, and some companies publish the findings. Kijani Testing Lab have found that most product developers take recommendations from testing organizations positively. Testing data is available on the Efficiency for Access website for anyone to access and analyse. The website contains detailed information on various appliances, including electric pressure cookers. According to Kijani, electric appliances in the Kenya market perform well in terms of emission safety, but challenges exist in performance under high voltage and compatibility with locally cooked foods. Key informants from CLASP further explained that, from a testing standpoint, the differences between cheaper and more expensive EPCs are mainly insulation, functionality, features, sophistication, sensing equipment, temperature controls, material, and size. However, it is difficult for consumers to distinguish between these differences without more consumer awareness and labelling.

Efficiency for Access is working with institutions like Kijani, SERC and University of Nairobi to develop the capacity for localized testing of electric cooking appliances. There is a focus on ensuring knowledge transfer and localization of testing to ensure continuous compliance with quality standards for imported appliances, and when applicable, locally manufactured appliances. There is a need for support and capacity building in these testing facilities, including KIRDI which is currently focused on

ICS testing. Further, there is a need to better resource the Kenyan Bureau of Standards (KEBS) to enable it to prioritize additional appliances and acquire equipment for standardization and labelling.

The process of creating standards and implementing labelling for appliances in Kenya is a long process that involves consultations and workshops. For example, the process for refrigerators took about a year and a half, and lessons can be drawn from that process to inform developments around eCooking. In 2017, CLASP developed a strategy through which the government and other actors can implement standards and labelling policies and programmes in Kenya which called for better coordination of institutions, policies and regulations on quality assurance for cooking appliances (CLASP, 2017). From this perspective, there is some progress given the existence of a technical working group consisting of practitioners from around the world to oversee the development of testing protocols. Currently, Kenya prioritizes products that pose a direct safety risk to the public, with appliances receiving lower priority unless they pose a safety risk. In this regard, there is a need to expand the scope of testing. There is need to also prioritise testing for DC appliances that are used in rural and off grid areas.

After testing, standardized labelling provides consumers with easily accessible and transparent information about appliance performance, energy efficiency, and safety. This enables consumers to make more informed choices when purchasing cooking appliances, leading to increased energy savings and improved safety. Standardized labelling can also incentivize importers to only import high quality, safe and more energy-efficient cooking appliances. As mentioned previously, SCODE has already experienced quality problems with a poorly labelled DC cooker that an overseas manufacturer sent to them, and there is need for better mechanisms for reporting and follow up by the Kenya Bureau of Standards. Only one kitchen appliance—refrigerators—has the Kenya Energy Label which is specific to Kenyan national standards issued by EPRA (See Figure 5.18). Other appliances may have labels from other jurisdictions, but there's no requirement for labels on these products. KEBS also has mandatory standardization marks for all manufactured products, whether local or imported, which are also applied to eCooking appliances (see Figure 6.16). KEBS can support in verifying testing reports before energy labelling is issued by EPRA.

An industry stakeholder mentioned that, in some cases, consumers may interpret products with labels as more expensive and thus shy away from purchasing them. This highlights the need for increased consumer awareness and education about the benefits of energy-efficient appliances and the role of labelling in making informed choices.

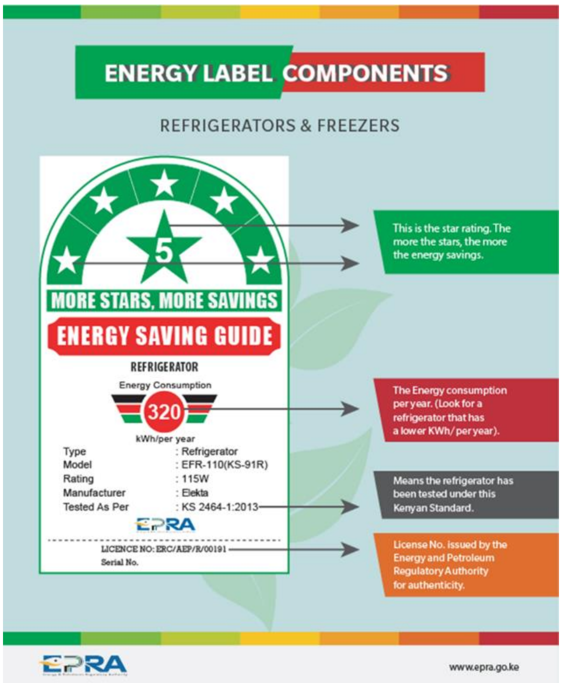
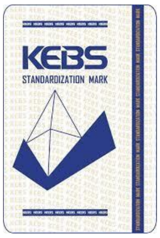


Figure 5.13 The Kenya Energy Label used on refrigerators. The m*ore stars* on the label, the *more energy efficient* an appliance is. Source: Energy Petroleum Regulatory Authority.



Standardization Mark
Mandatory for all locally manufactured products
This is a mandatory product certification scheme for locally manufactured products

Import Standardization Mark of Quality
Mandatory mark for all imported goods intended for sale in the local market. The mark has a Track and Trace software. Importers apply for this mark by submitting Copies of Certificate of Conformity, Import Declaration Form and Customs Entry to KEBS.

Diamond Mark of Quality
The Diamond Mark of Quality is a voluntary product certification scheme awarded to manufacturers (either based locally or abroad) that have demonstrated a high degree of excellence in product manufacturing and quality.

Figure 5.14 KEBS marks of quality[47]

One key recommendation is that before implementing any regulation, the Kenyan market needs to experience more market attraction and growth. This could be achieved by adopting voluntary standards. Creating a voluntary standard for eCooking equipment would provide a foundation for national-level market development programs, including reduced tariffs, subsidies, and affordable finance.

[47] KEBS Marks of Quality. Retrieved from https://www.kebs.org/index.php?option=com_content&view=article&id=32&Itemid=339

In sum, the following areas could benefit from capacity building to improve appliance testing and labelling in Kenya:

- Developing national test methods for electric cooking appliances in Kenya can help ensure a consistent quality standard for the market.
- Strengthening local testing facilities like KEBS testing lab, Kijani Testing Lab, Strathmore, and the University of Nairobi can help improve their capacity and expertise in testing electric cooking appliances. KIRDI, which already has capacity and a state-of-the-art testing facility for ICS, should be encouraged to delve into eCooking appliance testing.
- The capacity of Kenyan Bureau of Standards (KEBS) needs to be enhanced to enable it to prioritize additional appliances and acquire the necessary equipment for standardization and labelling. KEBS also needs to expand the portfolio of standards to include energy labelling, EPRA's star rating for energy efficiency could be extended to cover eCooking appliances.
- Fourth, increasing consumer awareness and education about the benefits of energy-efficient appliances and the role of labelling in making informed choices can help drive demand for higher-quality products and lead to market growth.

By addressing these areas, Kenya can improve its capacity for appliance testing and labelling, leading to a better-informed market and higher-quality electric cooking appliances for consumers.

6 THE POLICY ENVIRONMENT

6.1 Existing Policy and Regulatory Framework in eCooking

International policies and strategies play a critical role in driving electrification and clean cooking—the foundational sectors whose developments influence adoption of electric cooking at scale across sub-Saharan Africa. Key among them are the United Nations Sustainable Development Goals (SDGs), particularly SDG7 (Affordable and Clean Energy) which aims to ensure universal access to affordable, reliable, sustainable, and modern energy services by 2030 (United Nations, 2015). Promoting electric cooking to help facilitate the transition to modern energy services will have huge positive effects on the other SDGs, including SDG 3 (Good Health and Well-being), SDG 13 (Climate Action), SDG 5 (Gender Equality) and SDG 1 (No Poverty) (Atela et al., 2021).

Various global initiatives, which are aligned to these SDGs, have been established to support the transition from dirty fuels to modern energy cooking services. Sustainable Energy for All (SE4All) is a global initiative, launched by the United Nations, has a number of targets including universal access to affordable, reliable and modern energy services by 2030, and doubling the global rate of improvement in energy efficiency. Kenya's targets included reaching 100% of the population with both electricity and clean cooking solutions, while further improving the share of renewable energy sources up to 80%. Kenya also set an energy efficiency goal to reduce total energy intensity by 2.78% annually[48]. SE4All advances a clean cooking programme that undertakes strategic activities around electric and clean cooking, including research and development, technical and partnership support, and advocacy. So far, 75% of Kenyan households are electrified, and as of 2021, 81% of Kenya's energy is generated from renewable sources, and 20% of the population can access clean cooking. Efforts to promote electric cooking among electrified households could help move the needle towards achieving these targets.

Similarly, the Clean Cooking Alliance (CCA), formerly the Global Alliance for Clean Cookstoves, is a global partnership that aims to promote clean cooking solutions across the world, and its priority countries—Kenya being one of them—receive extensive in-country engagement. The CCA also supports national and regional alliances, such as the Clean Cooking Association of Kenya (CCAK).
CCAK engages in various activities such as advocacy, policy engagement, raising awareness, education, market development, capacity building, technical assistance, and research to promote clean cooking solutions, including electric cooking. The emphasis on electrification efforts and electric cooking initiatives during Clean Cooking Week 2022 demonstrates CCAK's dedication to advancing this cause[49].
Another key international initiative is the Paris Agreement to which Kenya is a signatory. Kenya's updated Nationally Determined Contributions (NDCs) targets are to reduce greenhouse gas emissions by 32% by 2030 compared to a business-as-usual scenario (Government of Kenya, 2020a). Scaling up electric cooking can contribute to this goal by replacing traditional biomass-based cooking methods, such as using charcoal and firewood, which produce significant amounts of emissions. To reduce the

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[48] Ministry of Energy and Petroleum. (2015). Sustainable Energy for All Kenya Action Agenda. Kenya. Retrieved from https://www.se4all-africa.org/seforall-in-africa/country-data/kenya/

[49] Chepkemoi, M., Leary, J., & Abdulkadir, S. (2021). Electrifying Kenya's Clean Cooking Week. Retrieved June 4, 2023, from Modern Energy Cooking Services website: https://mecs.org.uk/blog/electrifying-kenyas-clean-cooking-week/

health risks associated with household air pollution from cooking, heating, and lighting, the World Health Organization (WHO) has developed guidelines on indoor air quality[50]. These guidelines can help inform policies and programs aimed at promoting clean cooking in Africa. On the African front, the African Development Bank's (AfDB) launched the New Deal on Energy for Africa that aims to achieve universal access to electricity in Africa by 2025, and increase access to clean cooking energy for around 130 million households across Africa by mobilising innovative financing for energy and strengthening energy policy frameworks in Africa[51]. African Union's Agenda 2063 supports the expansion of renewable energy generation and grid infrastructure.

At the national level, the Kenyan Constitution of 2010 has provisions on environmental rights, adequate housing, sustainable development, and climate change that help create a supportive framework for promoting eCooking in the country. Similarly, Kenya's Vision 2030—the long-term development blueprint aimed at transforming the country into a newly industrializing nation—supports several key areas that can create an enabling environment for the promotion and adoption of electric cooking in the country including energy access and security, renewable energy, infrastructure development, climate change and environmental sustainability, and gender equality and women empowerment. There are various energy-related policies in Kenya that make provision for scaling electricity access and clean cooking, although they do not yet explicitly mention electric cooking.

Sessional Paper No. 4 of 2004, titled "Energy Policy Framework," was a crucial policy document that outlined the country's strategy for the development and management of its energy sector. The paper laid the foundations for developments in the legal and regulatory framework for the energy sector. The Energy Act No. 1 of 2019 in Kenya, which repealed the Energy Act No. 12 of 2006, provides a coherent legal framework for the development, management, and regulation of energy resources in the country. Its provisions on renewable energy, energy efficiency, rural electrification, and licensing and regulation can create a supportive environment for the development and adoption of clean cooking solutions, including electric cooking, in Kenya. The National Energy Policy of 2018 provides a comprehensive framework for the country's energy sector, aiming to “ensure affordable, competitive, sustainable, and reliable energy supply to meet national and county development needs while protecting and conserving the environment for inter-generational benefits” (ROK, 2018). The policy acknowledges the need for clean cooking solutions to improve public health, reduce deforestation, and mitigate climate change. It highlights the importance of transitioning from traditional biomass fuels, like firewood and charcoal, to cleaner alternatives, such as LPG, biogas, and electricity. The policy also emphasizes the importance of energy efficiency in reducing energy consumption and costs, as well as mitigating environmental impacts. This focus on energy efficiency can indirectly support the adoption of energy-efficient electric cooking appliances, which can help reduce the overall energy demand for cooking.

[50] World Health Organization. (2014). *WHO Guidelines for indoor air quality: Household fuel combustion*. Geneva, Switzerland: World Health Organization. ISBN: 9789241548885. Retrieved from https://www.who.int/publications/i/item/9789241548885

[51] African Development Bank. (2019). *The New Deal on Energy for Africa: The transformative partnership to light up and power Africa by 2025*. African Development Bank Group. Retrieved from https://www.afdb.org/en/the-high-5/light-up-and-power-africa-%E2%80%93-a-new-deal-on-energy-for-africa

Kenya's National Electrification Strategy (2018-2022) aimed to achieve universal access to electricity by 2022, focusing on both grid extension and off-grid solutions. Although the strategy primarily focuses on electrification, it has implications for electric cooking by promoting access to electricity to all households in Kenya and promoting diverse electrification options. Kenya is in the process of developing a comprehensive and integrated energy planning framework through the Draft Energy (Integrated National Energy Plans) Regulations. The objective of the INEP is to provide a coherent and coordinated approach to energy planning that encompasses all aspects of the energy sector. The Least Cost Power Development Plan (LCPDP) and County Energy Plans are part of this mechanism, and these plans could be better positioned to support electric cooking nationally and locally. The LCPDP is a strategic planning tool used by Kenya to identify the most cost-effective mix of power generation and transmission projects to meet the country's growing energy demand (Government of Kenya, 2021). Under the leadership of Kenya Power, the planning process underlying the LCPDP now takes into account the upscaling of electric cooking by considering projected growth in the adoption of electric cooking appliances and the impact on overall electricity consumption in its demand forecasts, which would influence electricity generation plans, grid expansion and reinforcement plans, and planning for decentralised energy solutions.

Table 6.1 National-Level Policies and Strategies that provide a supportive framework for promoting eCooking in Kenya:

Policy/Strategy	Relevance to eCooking
Kenyan Constitution of 2010	Provides provisions on environmental rights, adequate housing, sustainable development, and climate change.
Kenya's Vision 2030	Supports energy access, renewable energy, infrastructure development, climate change, and gender equality.
Sessional Paper No. 4 of 2004	Outlines the energy policy framework for the country.
Energy Act No. 1 of 2019	Provides a legal framework for energy development and regulation.
National Energy Policy of 2018	Emphasizes clean cooking, energy efficiency, and renewable energy adoption.
Kenya's National Electrification Strategy (2018-2022)	Aims for universal access to electricity, which is a key foundation for universal electric cooking.
Integrated National Energy Planning Framework	Aims for a coordinated approach to energy planning, including electric cooking.
Least Cost Power Development Plan (LCPDP)	Identifies cost-effective power generation projects considering electric cooking demand.

Apart from these policies in the energy sector, clean cooking is referenced directly or indirectly in other policy spheres. The 2017 National Climate Change Action Plan (NCCAP) projects that adopting improved cookstoves and alternative cooking fuels could result in annual savings of up to 5.6 million tonnes of CO2 equivalent. The plan also supports the establishment of a program that raises awareness and promotes clean cooking. The NCCAP also covers both decarbonisation of the electricity supply and clean cooking transitions. The 2010 Kenya National Climate Change Response Strategy endorses improved cookstoves and suggests subsidies and tax waivers to help impoverished households acquire energy-efficient stoves. The 2016 Forest Conservation and Management Act regulates logging and charcoal production, this act indirectly encourages the use of alternative, cleaner cooking fuels and technologies, which can help reduce deforestation and associated environmental impacts. These policies contribute to creating an enabling environment for the adoption of electric cooking solutions by addressing related challenges in climate change and environmental conservation. In 2022, an Air Pollution Centre of Excellence, also known as the NIHR CLEAN-Air (Africa) Unit has been established at the Kenya Medical Research Institute (KEMRI), based on a partnership between the Ministry of Health, KEMRI and the University of Liverpool, funded by UK National Institute for Health (NIH), to help scale adoption of clean energy to reduce respiratory and cardiovascular disease from exposure household air pollution[52]. The Kenya Gender Policy in Energy was launched in 2019 after a long collaborative journey of gender mainstreaming involving multiple local and international partners (Practical Action, 2023). It aims at ensuring that both men and women can equally benefit from the opportunities in the energy sector, participate in energy policy planning and implementation, and have access to clean and efficient energy services (Government of Kenya, 2019a), such as electric cooking.

Table 6.2 Policies and initiatives related to climate change, environmental conservation, air pollution, and gender equality in the energy sector

Policy/Initiative	Relevance to eCooking
National Climate Change Action Plan (NCCAP) (2017)	- Projects potential annual savings of up to 5.6 million tonnes of CO2 equivalent by adopting improved cookstoves and alternative cooking fuels.
	- Supports the establishment of a program to raise awareness and promote clean cooking. - Advocates decarbonisation of the electricity supply and clean cooking transitions
Kenya National Climate Change Response Strategy (2010)	- Endorses improved cookstoves and suggests subsidies and tax waivers to assist impoverished households in acquiring energy-efficient stoves.
Forest Conservation and Management Act (2016)	- Regulates logging and charcoal production, indirectly encouraging the use of cleaner cooking fuels and technologies to reduce deforestation.
Air Pollution Centre of Excellence/ Clean Air (Africa) (established in 2022)	- Collaboration between the Ministry of Health, KEMRI, and the University of Liverpool to scale adoption of clean energy and reduce health risks from household air pollution.
Kenya Gender Policy in Energy (launched in 2019)	- Aims to ensure equal access to clean and efficient energy services, including electric cooking, for both men and women.

It is worth mentioning that there is now increasing political will to formally and explicitly incorporate electric cooking in the policy agenda evidenced by the effort to develop a national electric cooking strategy and a national clean cooking strategy. A national electric cooking strategy in Kenya would play a vital role in driving the widespread adoption of electric cooking solutions in the country, leading to various economic, social, and environmental benefits.

6.2 Opportunities to integrate clean cooking and electrification policy

To create a more integrated policy framework for electric cooking in Kenya, connections can be made across various policies and national strategies in the energy sector. Clean cooking and electrification

[52] Kenya Medical Research Institute (2022, November 24). New initiative for clean air launched at KEMRI. Retrieved March 4, 2023, from KEMRI website: https://www.kemri.go.ke/2022/11/24/new-initiative-for-clean-air-launched-at-kemri/

goals need to be better aligned within existing energy policy and planning frameworks, among them, Kenya's National Energy Policy, the Kenya National Electrification Strategy (KNES), the Integrated National Energy Plan (INEP) under development, the Least Cost Power Development Plan (LCPDP) and County Energy Plans. Some potential areas for synergies and opportunities to embed electric cooking within broader policies include:

- Developing a coherent policy framework that links clean cooking and electrification goals across different policy and planning documents. This involves creating a clear narrative that connects electric cooking with broader objectives such as improving public health, reducing deforestation, and achieving climate change targets. In addition, there is need to harmonise targets and objectives by ensuring that clean cooking and electrification goals are consistently integrated and aligned across all these policy and planning frameworks. This includes setting specific, time-bound, and ambitious targets for electric cooking adoption.
- Fostering coordination and collaboration among different stakeholders responsible for implementing various aspects of energy policy and planning. The (planned?) Integrated National Energy Planning Committee, County Energy Planning Committees and LCPDP oversight committee are mechanisms that can be co-opted for this purpose. However, their membership can be made more inclusive of other actors such as civil society and such as CCAK. Alternatively, establishing a central coordination body or a multi-stakeholder platform can facilitate information sharing, joint planning, and resource mobilization. There is also a need to strengthen the capacity of relevant stakeholders on planning for both electrification and clean cooking, implementation, and monitoring. International partners such as MECS, CCG and EnDev can offer support in this regard. This could involve providing technical assistance, training, and capacity-building support to the government agencies, county governments, and other stakeholders to ensure they have the necessary skills and resources to develop and implement effective plans.
- Integrating clean cooking and electrification goals into County Energy Plans, with an added focus on electric cooking, ensuring that local needs and priorities are taken into account. This involves engaging local stakeholders, conducting local assessments, and tailoring strategies and interventions to the specific needs and opportunities of each county.
- Allocating adequate financial resources and attracting investment for clean cooking and electrification projects. This involves identifying funding sources, developing innovative financing mechanisms, and leveraging public-private partnerships to support the implementation of electric cooking and electrification goals across different planning frameworks.
- Leveraging existing monitoring and evaluation systems in energy policy processes, which already track clean cooking and electrification goals, to track progress towards electric cooking to inform future policy and planning decisions.

Table 6.3 Potential areas for synergies between clean cooking and electrification policy

Potential Areas for Synergies	Actions and Recommendations
Develop a coherent policy framework	- Create a clear narrative linking electric cooking with broader objectives such as public health, deforestation reduction, and climate change targets in all energy policies, plans and strategies.
	- Harmonize targets and objectives by integrating clean cooking and electrification goals across energy policy and planning frameworks.

Foster coordination and collaboration among stakeholders	- Foster information sharing, joint planning, and resource mobilization among established mechanisms like Integrated National Energy Planning Committee, County Energy Planning Committees, and LCPDP oversight committee.
	- Include diverse stakeholders such as civil society and organizations like CCAK and ELCOS in coordination bodies to ensure inclusivity and diverse perspectives.
	- Strengthen capacity of relevant stakeholders through technical assistance, training, and capacity-building support from international partners like MECS, CCG, EnDev.
Integrate clean cooking and electrification goals into County Energy Plans	- Engage local stakeholders in the process and conduct local assessments to tailor strategies and interventions to specific county needs and opportunities.
Leverage existing monitoring and evaluation systems in energy policy processes	- Utilize existing monitoring and evaluation systems to track progress towards electric cooking goals and inform future policy decisions.

6.3 Opportunities to embed eCooking within other national strategies

Electric cooking can further be embedded within other policy domains and national strategies can help create a more integrated and supportive environment for promoting clean cooking solutions. Here are some opportunities to incorporate eCooking into various policy areas:

Climate Change and Environmental Policies: Kenya is implementing a raft of policies, legislation, strategies, and plans to address climate change and environmental issues. Some of these key initiatives include the National Climate Change Action Plan (NCCAP) (2013-2017, updated for 2018-2022), The Climate Change Act (2016), The Environmental Management and Coordination Act (EMCA) (1999, amended in 2015), The Forest Conservation and Management Act (2016), the National Adaptation Plan (NAP) (2015-2030) and the Green Economy Strategy and Implementation Plan (GESIP) (2016-2030). Widespread adoption of electric cooking can help achieve some of the goals outlined in this policy framework, and thus, there is a need to more explicitly embed clean cooking and electrification here. As in the energy policy framework above, the following strategies could be adopted:

- Ensure electric cooking is consistently included across all relevant climate change and environmental policies, strategies, and plans. For instance, The NCCAP can connect some targets on decarbonisation of electricity genetration and supply with clean cooking transitions, and include strategies for promoting electric cooking as part of its mitigation and adaptation actions. The Climate Change Act can be leveraged to promote clean cooking and electrification by ensuring that the upcoming National Climate Change Council and the newly created State Department for Environment and Climate Change consider these issues in their policymaking and planning efforts. The Environmental Management and Coordination Act (EMCA) can support clean cooking and electrification by including these goals within its broader framework for environmental management. This may involve integrating electric cooking into pollution control measures, waste management strategies, and natural resource conservation efforts. The Forest Conservation and Management Act (2016) can help promote electric cooking by recognizing its role in reducing deforestation and forest degradation. Encouraging the adoption of electric and energy-efficient cookstoves can help reduce the demand for firewood and charcoal, thereby conserving forest resources and mitigating climate change. Where possible, a comprehensive approach that acknowledges the interrelated nature of these issues should be adopted to align the narratives in this policy framework.

- Promote collaboration between government agencies responsible for climate change and environment such as the Ministry of Environment and Forestry, National Environment Management Authority (NEMA), Kenya Forest Service (KFS), and newly created State Department for Environment and Climate Change with energy sector agencies outlined above to ensure a coordinated approach to target setting, messaging in policy documents and public awareness campaigns, implementation and monitoring and evaluation for clean cooking and electrification targets. Similarly, establishing inter-agency working groups or committees, or more feasibly, representation of energy actors within climate change and environmental bodies and vice versa can facilitate information sharing and joint planning.

Health policies: Several health policies and strategies address issues that are directly or indirectly related to cooking practices, such as indoor air pollution, respiratory diseases, and child health. Some of these policies include the Kenya Health Policy (2014-2030) and Kenya National Strategy for Maternal and Child Health (2018-2022). Kenya can align these policies to support the development of electric cooking in the following ways:

- Incorporate specific health targets related to implementing clean cooking and electrification strategies into health policies and strategies, emphasizing the importance of access to clean and affordable energy for improved health outcomes, particularly for women and children. This would include modelling the potential contribution of electric cooking adoption in, for instance, reducing the under-5 mortality rate from 52 to 35 per 1,000 live births as indicated in the Kenya National Strategy for Maternal and Child Health by minimizing indoor air pollution and the risk of respiratory infections. Stakeholders can develop and implement a robust monitoring and evaluation framework to track and measure the impact of improved access to eCooking on health outcomes to inform future policy adjustments.
- Strengthening collaboration between the Ministry of Health, the Ministry of Energy and respective county departments and stakeholders to develop a coordinated approach for target setting, implementation and messaging. For instance, energy sector policy actors can collaborate with the Air Pollution Centre of Excellence at KEMRI by leveraging their joint resources for awareness campaigns, policy formulation, and research to promote electric and clean cooking to reduce household air pollution.
- Where necessary, these actors can develop capacity-building programs for healthcare providers, policymakers, and other stakeholders to better understand the health implications of traditional cooking practices and the benefits of electric cooking. This could be achieved by for instance, connecting with the Clean Air Africa programme to integrate eCooking into their Community Health Volunteer capacity building programme. Awareness campaigns among communities could emphasize how using electricity to cook can reduce indoor air pollution, respiratory diseases, and other negative health impacts associated with traditional cooking practices.
- Establish financial mechanisms and incentives to encourage the adoption of electric cooking solutions, targeting vulnerable populations and areas with high rates of indoor air pollution and related health issues.

Table 6.4 Opportunities to embed eCooking within other national strategies

Policy Area	Policies	Opportunities for Embedding eCooking
Climate Change and Environmental Policies	• National Climate Change Action Plan (NCCAP) (2013-2017, updated for 2018-2022), • The Climate Change Act (2016), • The Environmental Management and Coordination Act (EMCA) (1999, amended in 2015), • The Forest Conservation and Management Act (2016), • the National Adaptation Plan (NAP) (2015-2030) • the Green Economy Strategy and Implementation Plan (GESIP) (2016-2030) • the new Nationally Determined Contribution (NDC) targets	• Ensure consistent inclusion of electric cooking across relevant climate change and environmental policies, strategies, and plans. • Incorporate targets and strategies for promoting electric cooking in the National Climate Change Action Plan (NCCAP) and the Climate Change Act. • Integrate electric cooking into pollution control measures, waste management strategies, and natural resource conservation efforts outlined in the Environmental Management and Coordination Act (EMCA). • Leverage the Forest Conservation and Management Act to promote electric cooking as a means to reduce deforestation and forest degradation. • Establish inter-agency working groups or committees for coordinated target setting, messaging, implementation, and monitoring of clean cooking and electrification initiatives.
Health Policies	• The Kenya Health Policy (2014-2030) • Kenya National Strategy for Maternal and Child Health (2018-2022)	• Incorporate specific health targets related to implementing clean cooking and electrification strategies into health policies and strategies. • Strengthen collaboration between the Ministry of Health, the Ministry of Energy, and respective county departments to develop a coordinated approach for target setting, implementation, and messaging. • Develop capacity-building programs for healthcare providers, policymakers, and stakeholders to raise awareness of the health benefits of electric cooking. • Establish financial mechanisms and incentives to encourage adoption in areas with high rates of indoor air pollution and related health issues.
Innovation and Industrial Policies	• Kenya's Vision 2030, • Science, Technology, and Innovation (STI) Act (2013) and draft STI policy, • Kenya's Industrial Transformation Programme (2015), • Micro, Small, and Medium Enterprises (MSMEs) Development Policy, • The Startup Bill (2020), • The draft Intellectual Property Bill 2020.	• Intensify research and innovation in eCooking technologies by supporting collaboration between academia, research institutions, and the private sector. • Enhance technical and entrepreneurial skills in the clean cooking and electrification sectors through targeted training programs. • Provide access to financing, grants, loans, and investment incentives for businesses and entrepreneurs involved in clean cooking and electric cooking projects. • Support market development for eCooking technologies through targeted interventions and a comprehensive regulatory framework. • Align policies with Kenya's Vision 2030, Science, Technology, and Innovation (STI) Act, Industrial Transformation Programme.

Innovation and Industrial Policies: Research and innovation in the clean cooking and electrification sectors is accelerating in Kenya, the intersection of which culminates in new developments around electric cooking solutions. Thus, there is a need to integrate electric cooking into industrial policies that support research and development, local manufacturing, and market development. Such policies include Kenya's Vision 2030, Science, Technology, and Innovation (STI) Act (2013) and draft STI policy, Kenya's Industrial Transformation Programme (2015), Micro, Small, and Medium Enterprises (MSMEs) Development Policy, The Startup Bill (2020), the draft Intellectual Property Bill 2020, and the Big Four Agenda which has a manufacturing component. Opportunities for synergies between these policies and development around electric cooking include:

- Intensify research and innovation in eCooking technologies by supporting collaboration between academia, research institutions, and the private sector, supporting local start-ups and manufacturers. Through mechanisms available in the STI policy, encouraging collaboration between academia, research institutions, and industry, and supporting technology transfer and capacity building in and between the clean cooking and electrification sectors.
- Enhance technical and entrepreneurial skills in the clean cooking and electrification sectors through targeted training programs and capacity-building initiatives. Lessons can be drawn from the The Pika na Power Academy which brought together and trained aspiring entrepreneurs from both the clean cooking and electrification sectors.
- Provide access to financing for clean cooking, electrification and electric cooking projects, including grants, loans, and investment incentives for businesses and entrepreneurs involved in these sectors. Encourage public and private investments in research, development, and production of eCooking technologies.
- Support market development for eCooking technologies through targeted interventions, such as incentives, subsidies, and tax waivers, to increase affordability and accessibility.
- Develop and implement a comprehensive regulatory framework that supports the growth of electric cooking while ensuring safety and quality standards.

In conclusion, embedding electric cooking within various policy domains and national strategies can create a more integrated and supportive environment for promoting clean cooking solutions in Kenya. By aligning electric cooking with climate change and environmental policies, health policies, innovation and industrial policies, the country can optimize the benefits of electric cooking in multiple areas, such as reducing mitigating climate impacts, improving health outcomes, and stimulating innovation. A coordinated approach that fosters collaboration between relevant government agencies and stakeholders, leverages resources and expertise, supports development of the innovation system, and raises public awareness will be instrumental in driving the widespread adoption of electric cooking in Kenya.

7 PATH FORWARD: RECOMMENDATIONS

This study set out to assess the status of electric cooking in Kenya so as to generate evidence that will support the development of an eCooking Strategy that will accelerate the uptake of electricity as a cooking fuel. The study mapped and synthesised the status quo of eCooking in Kenya by collecting primary data through a household survey, interviews and focus group discussion, and documentary evidence from published industry reports, academic papers, the media, and policy documents, among others. Based on the findings from the analysis, below is a list of recommendations in key areas in the sector for scaling up electric cooking in Kenya.

7.1 Barriers in the eCooking ecosystem and recommendations

7.1.1 Electrification

In the effort to promote electric cooking and harness its benefits, it is imperative to address the underlying challenges in the electrification sector. Table 6.1 below provides a look into recommendations aimed at strengthening the electricity infrastructure and enhancing consumer trust. These recommendations target issues ranging from the technicalities of grid capacity to affordability and safety concerns.

Table 7.1 Overview of Electrification Recommendations

Barriers in electricity access	Recommendations
Inadequate grid electricity capacity, availability, and reliability: in the Frontier counties, the Western, and North Rift regions.	Improve grid electricity capacity, availability, and reliability, especially in regions with lower grid capacity such as the Frontier counties, the Western, and North Rift regions. Enhance the availability of electricity, particularly during peak evening hours, and minimize unscheduled outages to encourage households to adopt electric cooking. Address voltage instability issues and improve the overall quality of electricity supply to minimize damage to electric appliances and build trust among consumers. As electric cooking appliance ownership is more pronounced in electrified regions, expanding the national grid or mini-grid coverage, and improving reliability would encourage more households to adopt electric cooking solutions. Target initial marketing for eCooking in regions of the country with surplus capacity and higher levels of availability and reliability, enabling Kenya Power and other utilities to grow their revenue in order to make the investments needed to increase capacity, availability and reliability in other parts of the country.
Risk of grid instability from widespread adoption fo eCooking, especially during peak evening hours,	To manage the increased demand, introduce price signaling mechanisms like time-of-use tariffs that encourage users to cook during off-peak hours. Additionally, energy storage solutions can be deployed to time-shift electric cooking loads

	away from the evening peak to balance the electrical load and make the scaling of electric cooking more sustainable.
Limited access to Tier 3+ off-grid solutions in rural areas	Generate demand for eCooking services among Solar Home Systems (SHS) households to encourage them to upgrade from systems designed for lighting to higher-capacity systems and other off-grid solutions, particularly in rural areas where grid access is limited. Provide incentives and support for research and development to design and manufacture affordable higher-capacity off-grid solutions suitable for eCooking.
High electricity tariffs, especially as reported by rural, low-income, and female-headed households and in minigrids	Explore options for making electricity for cooking more affordable, particularly for underserved communities, EPRA could collaborate with stakeholders to conduct pilot tests for experimental eCooking tariffs, paving the way for a suitable rate structure in forthcoming tariff reviews. Kenya Power can enhance this effort by installing residential smart energy meters to accurately track household electricity usage for cooking, enabling a more tailored tariff structure. Smart meters could also be integrated into eCooking appliances to separate cooking energy data from other household consumption, thus aiding in the effective design of the eCooking tariff. For minigrid settings, the Gold Standard methodology with smart metering could be employed to provide subsidized cooking tariffs, streamlining verification and incentivizing adoption. Financing options for electricity costs like subsidies or tailored schemes could also be explored to encourage adoption.
Informal electricity connections in informal settlements that undermine the reliability and safety of the electricity supply	Formalize electricity connections and address informality: Tackle the issue of informal electricity connections by providing incentives and support for formal connections, along with enforcement measures to discourage informality. This will help ensure a more stable and reliable electricity supply for households.
Lack of electricity safety awareness, especially in urban areas	Upgrade household electrical infrastructure for safe eCooking: Focus on upgrading household wiring and connectivity, especially in urban areas prone to incidents. These upgrades should encompass proper grounding, cables of adequate capacity, and appropriately located kitchen sockets, ensuring they can safely support eCooking appliances. Concurrently, run targeted awareness campaigns to educate households on the essential upgrades needed for the safe use of eCooking appliances, along with the benefits of transitioning to electric cooking.

	Strengthen regulation and enforcement for household electrical systems, particularly in high-risk urban areas, to ensure households are in compliance.

7.1.2 Cooking practices and eCooking appliances use

The widespread adoption and use of eCooking appliances in Kenya faces several obstacles. Cultural nuances, local culinary traditions and lack of familiarity with appliances play a pivotal role in determining the acceptance of these modern cooking solutions. Table xxx captures the major barriers identified and provides recommendations tailored to address each challenge.

Table 7.2 Addressing barriers to the use of electric cooking appliances in Kenya

Barriers	Recommendations
Prevalence of energy inefficient appliances	Promote energy-efficient cooking appliances that can allow households with lower-capacity electricity systems to utilize electric cooking. This could involve providing incentives to manufacturers and retailers to produce and sell such appliances. Implement VAT and import duty exemptions for energy-efficient eCooking appliances.
High appliance cost barrier	Offering energy-efficient electric cooking appliances at affordable prices, within the Ksh. 3,000 and Ksh. 15,500 range that households are willing to pay would help accelerate the adoption of electric cooking. The government should lower import tariffs on eCooking appliances, including DC appliances and battery storage designed for cooking purposes.
Limited uptake of eCooking although majority of the population is now grid-connected	Focus initial eCooking promotion and implementation efforts on urban areas where the infrastructure is most conducive to eCooking, supply chains are short, and there is limited dependence on fuel collection, and thus, relatively minimal investment is needed to transition households. Assist KPLC in extending their 'cooking with electricity' demand stimulation program to cater to low-income households through financial support, e.g. through utility-led financing schemes.
Lack of compatibility of some appliances to Kenyan cooking practices due to cultural practices, stove design and language barriers	Develop and promote electric cooking appliances that cater to the popular Kenyan dishes like ugali, rice, and vegetables. Work closely with local communities to understand their specific cooking practices, preferences, and challenges. This will enable the development of electric cooking solutions that are compatible with local cuisines. Conduct awareness campaigns to educate Kenyans of the compatibility of available appliances to different foods.

	Recognize that household wealth influences the choice of dishes and cooking techniques. Develop and market affordable electric cooking solutions to cater to different income levels, ensuring that even low-income households can benefit from electric cooking.
Limited knowledge or familiarity with electric cooking appliances and techniques	Conduct awareness campaigns and educational programs about the benefits of electric cooking appliances, focusing on energy efficiency, cost savings, convenience, and reduced pollution. This would help influence households' decisions to adopt electric cooking. Engage in targeted behaviour change campaigns to address cultural preferences related to food taste and cooking practices. Share success stories and testimonials from households that have successfully transitioned to electric cooking to create a positive social norm around electric cooking. Tailor campaigns to regional differences such as the emphasis on taste in the Pwani region, by tailoring promotional campaigns and electric cooking solutions to cater to these specific needs.
	Since breakfast and supper are the most popular meals in Kenyan households, prioritize scaling electric cooking for these meals. Focus on promoting electric appliances and techniques that cater to the preparation of hot beverages like tea and coffee, porridge, and supper staples such as ugali, vegetables, meat stews, rice, and cereals.
	Address misconceptions surrounding electric cooking, particularly concerning taste, cooking speed, and durability of eCooking pots.
	Provide training and support to households in using electric cooking appliances and techniques, ensuring that they can adapt to new cooking methods with ease. Support Kenya Power to further leverage their network of demonstration centres and retail outlets outside of Nairobi. Identify local champions who can establish local retail outlets and carry out cooking demonstrations with local dishes. Leverage eCooking hubs established in Kitui, Makueni, Nakuru, Kisumu and Kakamega counties
	Collaborate with individuals who can influence public opinion on eCooking adoption, such as local chefs, community leaders, and social media influencers.

7.1.3 Financing electric cooking

The widespread adoption of electric cooking in households hinges significantly on two key financing aspects: consumer and supplier. While consumers grapple with identifying and accessing suitable financing options to acquire eCooking appliances, suppliers are equally challenged by the financial and operational intricacies that affect their ability to develop innovative products and business models, meet consumer demand or adapt to changing market conditions. Tables xxx delves into the prevalent barriers in both consumer and supplier financing domains, and provides strategic recommendations to navigate these challenges.

Table 7.3 Addressing barriers to consumer financing for eCooking

Barriers to Consumer financing	Recommendations
Limited awareness and/or access to diverse consumer financing options to purchase electric cooking appliances	Promote and raise awareness of diverse consumer financing mechanisms. Educate households on the availability and benefits of various financing options such as asset financing loans, PayGo, layaway savings, and chamas/ROSCA. This can help them make informed decisions and select the most suitable financing option for their needs and circumstances. Expand the range of digitally-enabled consumer financing mechanisms, including smart appliances with PayGo functionality.
Untapped potential of microfinance institutions in facilitating electric appliance purchases	Strengthen and expand the role of microfinance institutions, particularly in rural areas. Facilitate partnerships between microfinance institutions and electric cooking appliance manufacturers or distributors to increase access to loans and financing options for households, particularly in rural areas.
Challenges faced by women in accessing credit	Foster the growth of Chamas and Self-Help Groups for women. These groups can empower women and help them overcome challenges in accessing credit, enabling them to purchase electric cooking appliances.

Table 7.4 Addressing barriers to supplier financing for eCooking

Barriers to Supplier financing	Recommendations
Financial and operational constraints limit businesses' capacity to offer electric cooking appliances on favourable terms	Leverage various supply-side financing mechanisms such as grants, equity and impact investments, results-based financing, smart-meter-enabled carbon financing, and utility-led financing to create a diversified funding ecosystem for electric cooking appliances. This will help to address the financial and operational challenges faced by businesses in the sector and make appliance ownership more accessible.
Lack of transparent and effective monitoring systems for RBF schemes	Invest in robust monitoring and verification mechanisms to ensure transparency and effectiveness

	in implementing results-based financing and carbon financing schemes. Utilize smart meter data and other digital technologies to track usage and impact metrics, facilitating data-driven decision-making and payments.
Lack of adequate funding for R&D projects and electrification	Prioritize funding and support for high-impact projects that address significant market barriers, demonstrate potential for scale, and align with national goals for clean cooking and energy access. This includes projects that promote access to energy-efficient appliances, incorporate outcome-based incentives (e.g., gender inclusion, health and climate impacts), or integrate carbon finance. Leverage much larger investments in the electrification sector to tackle the clean cooking challenge by integrating eCooking into electrification programmes, e.g. embedding eCooking into the next phase of the Last Mile Connectivity Programme.
Rigid financing programs that do not adapt to changing market conditions	Design financing programs with flexibility to adapt to market realities, such as currency devaluation or external shocks like the COVID-19 pandemic. This may involve adjusting incentive structures, timelines, or performance targets to ensure continued progress toward scaling electric cooking.

7.1.4 The supply chain

In the journey towards establishing electric cooking as a widespread practice, it is essential to address and streamline the entire value chain—from the initial manufacturing of the appliances to their eventual sale and service. A well-integrated approach that covers manufacturing, distribution, and after-sales service ensures that consumers not only have access to quality electric cooking products but also experience efficiency and satisfaction throughout their product life cycle. Table xxx provides an analysis of barriers that stakeholders encounter at each of these stages and proposes actionable recommendations to overcome them.

Table 7.5 Addressing barriers to manufacturing, distribution and after sales service and warranties

Barriers	Recommendations
Limited local manufacturing and assembly capacity for electric cooking appliances.	Support the growth of local manufacturing and assembly industries for electric cooking appliances. This can be achieved through targeted investments in infrastructure, human capital, policy framework, and logistics. Local manufacturing can lead to more affordable products, customized appliances for local needs, and job creation.

	Invest in education, technical training, and capacity-building programs to address the shortage of skilled engineers and technicians required for the entire supply chain.
Lack of localization in appliance features, which might hinder user adaptability.	Promote localization of appliance features. Encourage manufacturers to develop electric cooking appliances with preset cooking programs for local dishes and instructions in local languages. Localization can enhance user adaptability and encourage the adoption of electric cooking appliances.
Underdeveloped distribution channels for rural households connected to different grid systems.	Since grid-connected households have the capacity for immediate transition to electric cooking, prioritize them in the initial phases of scaling up electric cooking. Continue expanding the target market beyond urban dwellers by catering to rural households connected to the national grid or mini-grid and minigrid systems. Leverage County eCooking Hubs and incentivize the private sector through programs like KOSAP to extend distribution channels and after-sales services for eCooking appliances to rural households. Additionally, offer innovation challenge funds specifically for mini-grid developers to incorporate eCooking solutions into new mini-grid and microgrid projects, thus broadening the potential user base for electric cooking appliances.
Challenges faced by importers and distributors in identifying and procuring high-quality electric cooking appliances from international markets	Develop mechanisms for importers and distributors to find and verify high-quality electric cooking appliances in the international market, minimizing the risk of purchasing low-quality products.
Inadequate e-commerce infrastructure	Strengthen e-commerce infrastructure to support the growing demand for online shopping. Address concerns regarding the security of online transactions, data privacy, and trustworthiness of online sellers. Develop verified seller certifications for eCooking appliances as a trust-building measure.
Limited engagement of energy service companies in the marketing and distribution of electric cooking appliances.	Engage energy service companies to market and distribute appliances to their customers, e.g. by offering discounted eCooking appliances as part of a bundled package with electricity services; utilizing customer data to identify those most likely to benefit from eCooking for targeted marketing; offering flexible financing plans for the purchase of eCooking appliances through utility-led financing schemes; using existing customer service channels like helplines and service centers to educate customers about the benefits of eCooking and how they can transition.
Limited presence of service centers, especially in rural and semi-urban regions.	Expand service centers to rural and semi-urban areas to cater to the growing demand for eCooking appliances and make it easier for customers to access repair and maintenance services.

Lack of consumer awareness about warranties	Conduct awareness campaigns to educate customers about the importance of warranties and their rights in terms of after-sales services, particularly in rural and remote areas.
Complex and inefficient warranty claims processes.	Streamline warranty claims claim process by reducing the number of intermediaries involved and improving collaboration between manufacturers, retailers, and service providers. This could lead to faster turnaround times and better customer satisfaction.
Inaccessibility to quality spare parts and a tendency to rely on counterfeit or substandard components.	Collaborate with manufacturers to ensure the availability of quality spare parts at reasonable prices, reducing the reliance on counterfeit or substandard components.
Skill gap among technicians regarding the latest technological advancements and evolving customer needs.	The sector should invest in continuous skill development and training programs for technicians to ensure they are up-to-date with the latest technological advancements and evolving customer needs.

7.1.5 Appliance standards: testing, labelling and certification

The growth of the Kenyan ecosystem for electric cooking appliances brings to the fore the urgent need for comprehensive standards, testing, and certification protocols. With a broad consumer base increasingly relying on these appliances, ensuring their quality, safety, and efficiency has become paramount. This not only boosts consumer confidence but also paves the way for a more robust and standardized market, fostering local industry growth. However, the current system is riddled with challenges that threaten the consistent rollout of high-quality products. The table below summarises these barriers and provides recommendations.

Table 7.6 Addressing barriers in the appliance standards ecosystem

Barriers	Recommendations
No national test method requirement for electric cooking appliances.	Establish a standardized national test method requirement to ensure consistent product quality.
Electric cooking appliances are currently not a priority for testing unless they pose a safety risk. Thus, testing is done voluntarily based on retailer demand rather than being mandatory.	Implement mandatory testing for electric cooking appliances to ensure safety and quality. Allocate specific resources and attention to test DC appliances, considering their use in off-grid areas. As the market grows, introduce voluntary standards for eCooking equipment, paving the way for more comprehensive regulations in the future. This can also serve as a base for national-level market development initiatives, like reduced tariffs and subsidies.
Challenges exist in defining and contextualizing performance requirements.	Collaborate with industry experts and stakeholders to set clear efficiency parameters and benchmarks.

	Setting benchmarks can help improve the quality of products in the market.
There's limited capacity in testing facilities.	Invest in capacity building, including infrastructure, equipment, and training in the testing facilities. Support institutions like Kijani, SERC, and the University of Nairobi in developing their testing capacities, ensuring knowledge transfer and localization of tests. Provide better resources to KEBS for them to acquire the necessary equipment and skills to expand their capacity for standardization, testing, and labeling of appliances.
There's no requirement for labels on many electric cooking appliances.	Introduce mandatory labelling for electric cooking appliances, highlighting energy efficiency and safety. Expand EPRA's Kenya Energy Label to cover a wider range of kitchen appliances, including eCooking products
Consumers struggle to distinguish between appliance quality due to a lack of labeling and information. Consumers may perceive labelled products as more expensive.	Increasing consumer awareness and education about the benefits of energy-efficient appliances and the role of labelling in making informed choices can help drive demand for higher-quality products and lead to market growth.

7.1.6 Gender

The transition to electric cooking solutions is not just a technological shift; it is deeply rooted in social and cultural contexts, particularly when it comes to gender dynamics. Women, being the primary cooks in many households, stand to benefit the most from these advancements. Yet, several barriers have emerged that prevent them from fully reaping the benefits of electric cooking solutions. Table xx summarises these barriers, ranging from their exclusion in decision-making processes to disparities in eCooking adoption between male and female-headed households. More importantly, we lay out recommendations aimed at ensuring that the transition to electric cooking is inclusive, catering to the unique needs and preferences of both male and female-headed households, and capitalizing on the potential of women as key agents in driving this change.

Table 7.7 Gender dynamics in electric cooking adoption

Barriers	Recommendations
Lack of involvement of women in decision-making processes related to electric cooking solutions.	Since women are the primary beneficiaries of electric cooking appliances, involving them in decision-making processes can lead to more adoption of electric cooking solutions.
Disparities in eCooking adoption between male and female-headed households, with male-headed households having a higher adoption rate.	Empower female-headed households to adopt eCooking by lowering barriers to accessing credit, an building the capacity of women to use eCooking appliances e.g. through behaviour change campaigns and demonstration projects.

Underutilization of women in the distribution of electric cooking appliances and limited access for them to credit and appliance distribution support.
Focus on women as key agents of appliance distribution. Encourage women's participation in self-help groups for access to credit and appliance distribution and support.

Support women entrepreneurs to establish eCooking distribution businesses and to offer after sales support.

7.1.7 The policy environment

While electric cooking offers a myriad of benefits, from improved public health to environmental conservation, the absence of cohesive policy frameworks, coordination among stakeholders, and alignment with other key policies have been notable obstacles. Table xx below presents policy-related barriers and some recommended strategies to navigate them.

Table 7.8 Addressing barriers in the policy environment

Barriers	Recommendations
There's no clear linkage between clean cooking and electrification goals across various policy and planning documents.	Develop a coherent policy framework that links clean cooking and electrification goals across different policy and planning documents. This involves creating a clear narrative that connects electric cooking with broader objectives such as improving public health, reducing deforestation, and achieving climate change targets.
The targets and objectives related to clean cooking and electrification are not harmoniously integrated and aligned across different policy and planning frameworks.	Harmonise targets and objectives by ensuring that clean cooking and electrification goals are consistently integrated and aligned across all these policy and planning frameworks. This includes setting specific, time-bound, and ambitious targets for electric cooking adoption.
Lack of coordination and collaboration among different stakeholders responsible for implementing aspects of energy policy and planning, resulting in potential redundancy and inefficiency.	Foster coordination and collaboration among different stakeholders responsible for implementing various aspects of energy policy and planning. Co-opted existing cross-sector or interministerial committees for this purpose. Alternatively, establish a central coordination body or a multi-stakeholder platform can facilitate information sharing, joint planning, and resource mobilization. Coordination can further be achieved if the INEP is adopted and adhered to.
Electric cooking is not currently aligned with various other policies like those related to climate change, environment, health, and innovation. This results in missed opportunities to optimize benefits across multiple sectors.	Align electric cooking with climate change and environmental policies, health policies, innovation and industrial policies to optimize the benefits of electric cooking in multiple areas such as reducing mitigating climate impacts, improving health outcomes, and stimulating innovation. A coordinated policy approach that fosters collaboration between relevant government agencies and stakeholders, leverages resources and

	expertise, supports development of the innovation system, and raises public awareness will be instrumental in driving the widespread adoption of electric cooking in Kenya.

7.2 Conclusion

The eCooking sector in Kenya possesses enormous potential, not only as a pathway to cleaner and more sustainable cooking methods but also as an avenue to address broader developmental challenges such as public health, environmental conservation, and economic development. However, as outlined in this chapter, realizing this potential hinges on addressing a range of technical, socio-cultural, economic, regulatory, and policy-related barriers.

Central to this transition to eCooking is electricity access, which acts as the foundation upon which eCooking hinges. Ensuring widespread, reliable, and affordable electricity will not only enable the growth of the eCooking sector but will also catalyze broader socio-economic advancements. ECooking appliance ownership and use is intrinsic to the adoption curve of eCooking. The eCooking journey goes beyond mere access to eCooking appliances; it extends to its regular use, integration into daily routines, and eventual preference over traditional cooking methods. Furthermore, the eCooking transition is not solely about technological adoption; it's deeply entwined with knowledge, beliefs, and cooking practices. Efforts to promote eCooking must be sensitive to cultural and socio-economic nuances, offering solutions that resonate with Kenyan households.

By encouraging local manufacturing and streamlining importation processes, Kenya can ensure a consistent market supply, reducing costs and boosting accessibility. This naturally extends to the realm of distribution, where efficient, widespread channels can ensure that even remote households have access to eCooking solutions. Moreover, to truly scale eCooking, financial mechanisms need to be in place. Affordability is a significant concern for many Kenyan households, and introducing innovative financing models for eCooking can make the shift feasible for a larger segment of the population. Appliance standards, testing, and certification emerge as critical pillars in building trust and guaranteeing the quality of eCooking products. Strengthening these aspects will ensure that the Kenyan consumer is accessing products that are safe, efficient, and durable.

Lastly, the policy environment acts as the backbone supporting all these endeavours. A coherent, harmonized, and adaptive policy framework, which aligns eCooking with broader objectives such as public health, environmental conservation, and innovation, can expedite Kenya's journey towards widespread electric cooking adoption. Given the predominant role women play in household cooking and entrepreneurship, their needs, preferences, and challenges should be at the forefront of eCooking initiatives. By addressing these key areas in tandem, Kenya can usher in a new era of cooking that is not only sustainable but also transformative in its impact on health, environment, and overall quality of life.

A key takeaway from this chapter is the necessity for adaptability. As the eCooking market evolves, so will its challenges and opportunities. By setting clear, ambitious, and time-bound targets, while consistently revisiting and refining policies and strategies based on market realities, Kenya can ensure the success of its electric cooking initiatives. This success will not only transform the cooking landscape of the nation but will also play a pivotal role in achieving its broader sustainable development goals.

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APPENDICES

7.3 Appendix 1: Household Questionnaire

Double-click on the image below to open a PDF version of the household survey questionnaire

Kenyan National eCooking Strategy (KNeCS)

Field	Question	Answer
enumerator *(required)*	Enumerator	
INTRODUCTION		
I1	Hello, My name is [enumerator] and I am working with NUVONI CENTRE FOR INNOVATION RESEARCH. We are conducting a survey about Electric Cooking in Kenya. The information we collect will help the government to plan how to encourage more households to cook with electricity. Your household was selected for the survey. I would like to ask you some questions about your household. The questions usually take about ... to ... minutes. All the answers you give will be confidential and will not be shared with anyone other than members of our survey team. You don't have to be in the survey, but we hope you will agree to answer the questions since your views are important. If I ask you any question you don't want to answer, just let me know and I will go on to the next question or you can stop the interview at any time. If you need more information about the survey, you may contact the person listed on this card.	
I2 *(required)*	Do you want to continue?	1 Yes 0 No
Household Identification		
HI1 *(required)*	County	
HI2 *(required)*	Subcounty	
HI7 *(required)*	GPS Recording *GPS coordinates can only be collected when outside.*	
HI8 *(required)*	Does this household replace another sample household chosen for the survey?	1 Yes 0 No
HI8i *(required)*	Which household in this cluster does it replace? *Question relevant when: selected(${HI8} , '1')*	
HI8ii *(required)*	Household number of originally selected household *Question relevant when: selected(${HI8} , '1')*	
HI8iii *(required)*	Why was originally selected household replaced? *Question relevant when: selected(${HI8} , '1')*	1 Dwelling found, but no HH member could be found 2 Dwelling found, but respondent refused 3 Dwelling found, but unoccupied 4 Dwelling found, but not a residential building 5 Dwelling destroyed. 6 Dwelling not found.
Module 1: Household Demographics (HD)		
HD1 *(required)*	Name of Household Head	
HD2 *(required)*	Gender of the household head	1 Male 0 Female
HD3 *(required)*	Age of the household head (Years) *Response constrained to: .>=15 and .<=120*	
HD4 *(required)*	Name of the Respondent	
HD5 *(required)*	Gender of the respondent	1 Male 0 Female
HD6 *(required)*	Age of the respondent (Years) *Response constrained to: .>=15 and .<=120*	
HD7 *(required)*	What is the relationship of the respondent to the household head?	1 Head 2 Spouse 3 Child-Daughter 4 Child-Son 5 Grand Daughter 6 Grand Son 7 Niece 8 Nephew 9 Sister 10 Brother 11 Son-in-law 12 Daughter-in-law 13 Brother-in-law 14 Sister-in-law 15 Father-in-law 16 Mother-in-law 17 Grandfather 18 Grandmother 99 Other
HD7_99 *(required)*	Specify *Question relevant when: selected(${HD7} , '21')*	
HD8 *(required)*	What is your marital status?	1 Single/Never Married