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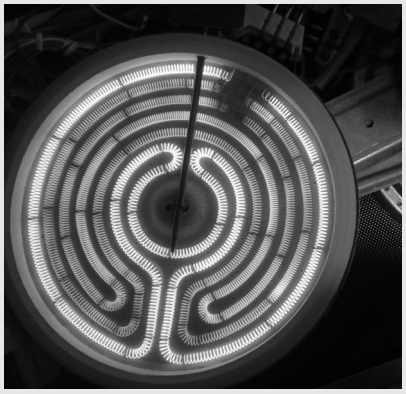

ZAMBIA CLEAN COOKING MARKET ASSESSMENT

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DISCLAIMER

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1 USD = 16.8 ZMW as of June 14, 2022, from the Central Bank of Zambia

List of Acronyms

A2C	Alternative to Charcoal
AFDB	African Development Bank
BAU	Business as Usual Scenario
CCA	Clean Cooking Alliance
CO2	Carbon (iv) Oxide
COMACO	Community Markets for Conservation
CSO	Central Statistical Office
DEG	The German Development Finance Institution
DFCA	Direct Focus Community Aid
DoF	Department of Forestry
E4A	Energy For Agriculture
EFC	Entrepreneurs Financial Centre
EPCs	Electric pressure cookers
ERB	Energy Regulations Board
ESAG	Energy Sector Advisory Group
FGDs	Focus Group Discussion
FCDO	Foreign, Commonwealth & Development Office
FiT	Feed-in Tariff
GBEC	Greenbelt Energy Limited
GEF	Global Environment Facility
GDP	Gross Domestic product
GHGs	Green House Gases
GPW	Gridded Population of the World
HAP	Household Air Pollution
ICS	Improved cookstoves
ISO	International Standards Organisation
IWA	International Workshop Agreement
KIIs	Key Informant Interviews
IRENA	International Renewable Energy Agency
IAPRI	Indaba Agricultural Policy Research Institute
KOSAP	Kenya Off-Grid Solar Access Project
LPG	Liquefied Petroleum Gas
MCFA	Modern Cooking Facility for Africa
MECS	Modern Energy for Cooking Services
MFIs	Microfinance institutions

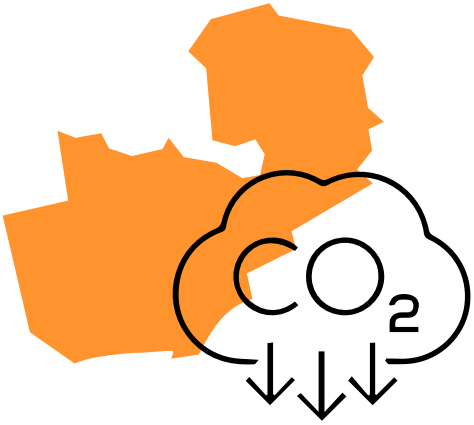
MoE	Ministry of Energy
MoF	Ministry of Finance
MTF	Multi-Tier Framework
NDC	Nationally Determined Contribution
NDP	National Development Plan
NEFCO	Nordic Environment Finance Cooperation
NEP	National Energy Policy
OMCs	Oil Manufacturing Companies
PAYGO	Pay-as-you-go
PCU	Project Coordination Unit
ProBEC	Programme for Basic Energy and Conservation
PV-eCook	Photovoltaics-electric cook
REA	Rural Electrification Authority
REEESAP	Renewable Energy and Energy Efficiency Strategy and Action Plan
RFI	Request for Information
SDGs	Sustainable Development Goals
SE4ALL	Sustainable Energy for All
SIDA	Swedish International Development Cooperation Agency
SNV	Netherlands Development Organisation
SEI	Stockholm Environment Institute
TA	Technical Assistance
TASC	The African Stove Company Limited
TDAU	Technology Development Advisory Unit
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
UTM	Universal Transverse Mercator
VAT	Value Added Tax
VPT	Voluntary Performance Targets
ZABA	Zambia Bureau of Standards
ZANACO	Zambia National Commercial Bank Plc
ZANACO	Zambia National Commercial Bank Plc
ZDA	Zambia Development Agency
ZEMA	Zambia Environmental Management Agency
ZENGO	Zambia Energy and Environmental Organization

Executive Summary

Introduction

Zambia updated its Nationally Determined Contribution (NDC) under the Paris Agreement on 30th July 2021. Under this climate action plan, the country intends to reduce greenhouse gas emissions by 25% relative to the 2010 levels and by 47% by 2030 with substantial international support. The Government of the Republic of Zambia, among other things, aims to reduce the rate of deforestation attributable to the prevalent use of charcoal and fuelwood for cooking by promoting alternative cooking solutions. Deforestation and forest degradation is a leading source of Green House Gases (GHG) emissions. This effort builds on the aspirations of the country's Sustainable Energy for All (SEforAll) Action Agenda and Investment Prospectus of 2016 which proposes a 20:40:20:20 goal for urban areas. The goal aims to have 20%, 40%, 20%, and 20% of urban households using electricity, LPG, charcoal, and firewood respectively for cooking by 2030. The World Bank seeks to support the Government of Zambia in promoting the uptake and use of cleaner cooking solutions. In this context, cleaner cooking solutions are those that attain Tier 3 performance and above stoves, as defined by the International Standards Organisation (ISO) - International Workshop Agreement (IWA) Voluntary Performance Targets (VPT).

This cooking sector market assessment covers urban residential compounds in Lusaka and the Copper Belt and forms the basis of a proposed clean cooking program supported by the World Bank in collaboration with the Government of Zambia. The market transformation program aims to systematically addresses interconnected and cross-sectoral barriers hindering the uptake and use of cleaner cooking solutions in urban areas of Zambia. This market assessment employed multiple data collection approaches, including literature review, focused group discussions, geo-spatial analysis, key informant interviews, and analysis of primary household data collected under the Multi-Tier Framework (MTF) survey.



Zambia intends to reduce greenhouse gas emissions by **25%** relative to the 2010 levels and by **47%** with substantial international support by 2030

The goal aims to have **20%**, **40%**, **20%**, and **20%** of urban households using electricity, LPG, charcoal, and firewood respectively for cooking by 2030

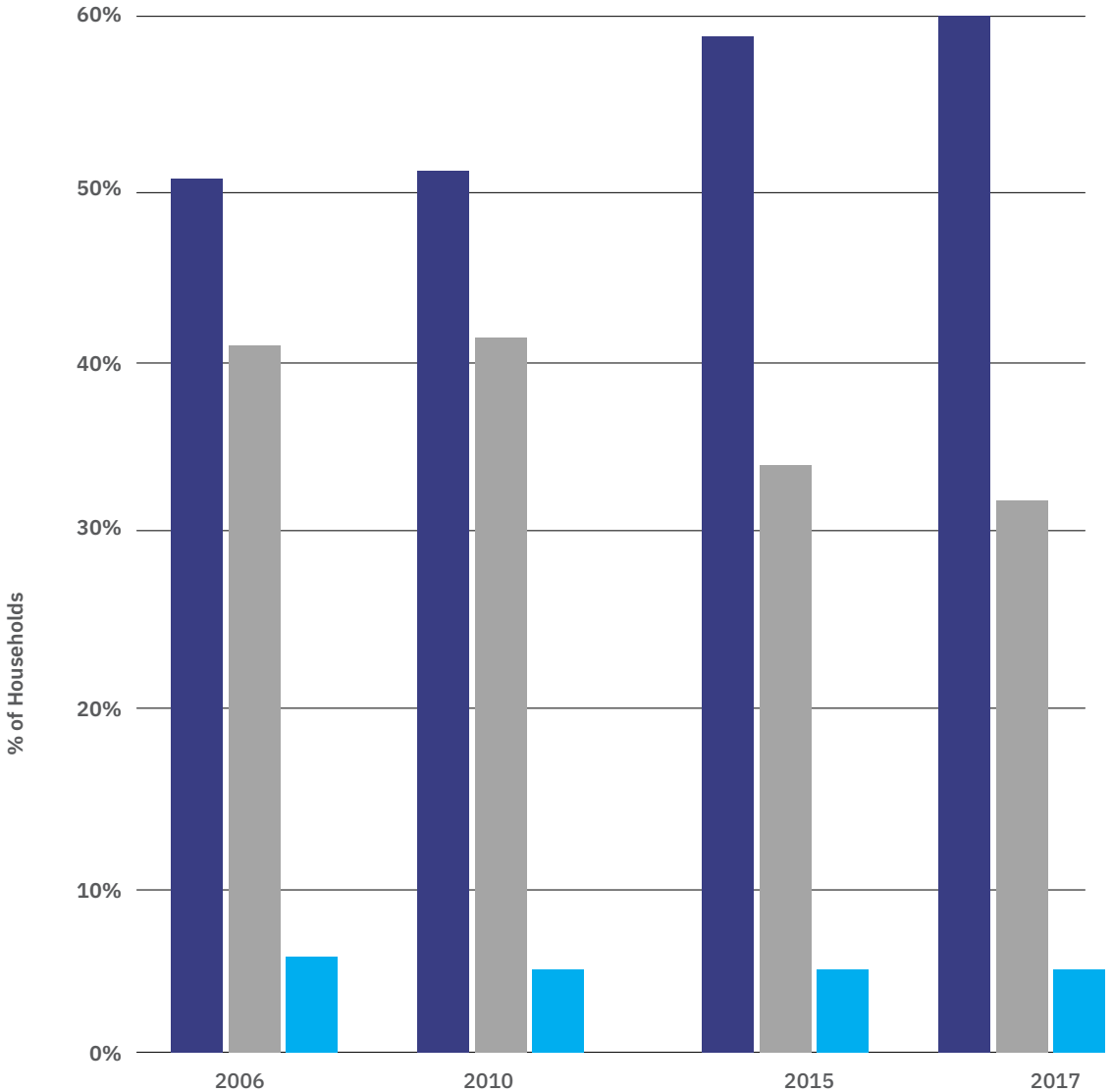
Overview of General Access Rates

Data indicates that charcoal and electricity have been the most predominant cooking solutions in Zambia's urban areas between 2006 and 2017, as illustrated below. The relative high access to affordable grid-based electricity and the availability of charcoal has been the key contributor to this.

The use of Liquefied Petroleum Gas (LPG) for cooking is limited due to a lack of adequate distribution channels, production limitations, affordability, safety concerns, and low awareness of the use of LPG appliances.

FIGURE 1 ES 1

PRIMARY COOKING SOLUTIONS TREND OVER A DECADE IN URBAN AREAS

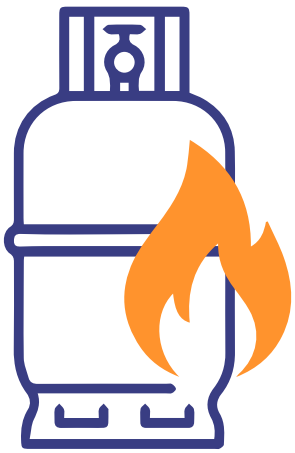


	2006	2010	2015	2017
Charcoal	51.1%	51.4%	59.1%t	60.6%
Electricity	41.8%	42.5%	34.5%	33.1%
Wood	6.4%	5.7%	6.0%	5.8%
LPG	0.0%	0.0%	0.1%	0.2%
Others	0.7%	0.4%	0.3%	0.2%

However, the proportion of households using LPG doubled in two years to 0.2%, while the aggregate number tripled by 2017 without a concerted effort to grow the sector. Other cooking solutions such as ethanol, pellets, and briquettes are still nascent, mainly because they are less cost-competitive than the alternatives, and supply chain constraints also limit the demand. Wood and biogas are predominately used in rural areas due to the design and limited size of the cooking spaces in urban areas and the requirement of livestock rearing in the case of biogas.

Analysis of the 2017 Multi-tier framework data indicates that over one million urban households in Zambia need to transition to cleaner cooking solutions. 51% of urban households who do not own an improved cooksing stoves (ICS) are willing to pay for an ICS at a given price of ZMW 979 (US$ 58).

The proportion of households using LPG doubled in two years to **0.2%**,while the aggregate number tripled by 2017 without a concerted effort to grow the sector.



This price point exceeds that of acquiring a 6 kg LPG solution or a two-burner ethanol stove (liquid or gel). Offered to pay for an ICS over 6 – 12 months, more than 90% of households in the 1st quintile (lowest income) are willing to pay for an ICS, demonstrating the potential for pay-go solutions (or similar that staggers payment across time). 83% of male-headed households were willing to pay the total price upfront of an ICS stove compared to 17% of female-headed households.

It is further noted that only male-headed households were using LPG solutions for cooking. This observation may stem from the safety concerns associated with the solutions, where women are averse to risky solutions in the household. Additionally, female-headed households are more likely to be using a biomass stove (charcoal and wood) at 69.9% compared to male-headed households at 65.4%. This finding shows the need for programs promoting uptake of cleaner cooking solutions to intentionally target female-headed households.

Policy and Institutional Frameworks

Several international, regional, and national frameworks govern the cooking sector. Zambia is a party to the following global frameworks

- **The Sustainable Development Goals (SDGs),**
- **The Paris agreement, and**
- **Sustainable Energy for All (SEforAll).**

On a regional scale, central to the energy sector in Zambia is the Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP) for Eastern Africa, Southern Africa, and Indian Ocean Region (REEESAP EA-SA-IO). The plan will enable investment in the energy sector, particularly renewable energy, and energy efficiency initiatives, achieving SDG 7. The key national framework guiding the cooking sector is the National Energy Policy (2019), which highlights strategies for promoting ICS. The government is currently developing standards for bioethanol for cooking and their associated appliances.

Various government institutions and private sector actors play a vital role in the cooking sector. The World Bank in collaboration with the Ministry of Energy is supporting a study assessing the feasibility of setting up a stove testing laboratory at the Technology Development Advisory Unit (TDAU) embedded in the University of Zambia.

Summary of Core Barriers

Barriers in the Zambia clean cooking sector can broadly be categorized as financial, policy, and awareness barriers. The initial price of improved cookstoves is high and out of reach, especially for low-income households. For instance, the mbaula charcoal stove retails for ZMW30-35 (US$ 1.79-2.08) compared to ZMW 500 (US$ 29.76) for the charcoal stove, ZMW 799 (US$ 48.42) for the 6 kg LPG cylinder, and ZMW 1,320 (US$ 78.57) for the 13 kg LPG cylinder (inclusive of deposit). Limited access to affordable capital by enterprises for business development is a significant barrier. Enterprises noted that local banks charge high-interest rates or ask for high-value collateral as security for the financing. Loans can attract interests as high as 55% and 75% per annum. Although loans denominated in $USD accrue a low-interest rate of 13% per annum, this rate is not only high but also exposed the borrowers to forex risks since the income is in Kwacha (ZMW).

The Zambia Energy Policy (2019) highlights strategies for promoting ICS, an implementation plan for the proposed strategy and a regulatory framework for the cookstoves in the market but this still leaves crucial policy gaps. For example, the lack of national standards for ethanol and the limited testing capabilities of cookstoves remain barriers affecting the quality assurance of higher tier solutions. Limited awareness constitutes a lack of knowledge or exposure but in extreme cases, a misconceived aversion to using some solutions. LPG and ethanol are, for example, perceived to be unacceptably dangerous. Without a programmatic approach that systematically removes the barriers to uptake and use, singular or univariate approaches are bound to have a lopsided effect on the sector, and are insufficient to achieve the desired impact.

The baseline data affirms that gender-neutral general interventions will not be sufficient to ensure access to universal access to clean and improved energy solutions by 2030. This conclusion is grounded in the realisation that the barriers and opportunities are structured differently across female and male headed households. While some of these barriers and opportunities are distributed evenly across households, a few are specific and require targeted interventions. Barriers such as affordability, for example, disproportionately affect female headed households.

The proposed program aims to directly facilitate the transition to cleaner cooking solutions among **100,000 households**

The Program Design

A US$ 13.3 million five-year program is proposed to assist address barriers associated with access to finance, including capital to develop extensive last-mile distribution networks among suppliers, affordability of the appliances among low-income end-users, and lack of awareness for cleaner cooking solutions. The proposed program aims to directly facilitate the transition to cleaner cooking solutions among 100,000 households and will indirectly stimulate further promotion across the market by demonstrating the viability of these solutions among underserved urban areas.

It has three main components:

1. **Enterprise Financing,**
2. **Consumer Financing, and**
3. **Technical Assistance and Facility Management.**

Specific interventions that offer gender-specific support are included in the program design. Consumer financing will be in the form of an asset finance loan through Microfinance Institutions and demand-side subsidies for households. The demand-side subsidies will be implemented through Zambia's Social Cash Transfer Programme (SCT), administered by the Ministry of Community Development and Social Services (MCDSS) through the Department of Social Welfare. Enterprise Financing will be implemented through a Challenge Fund and Results-Based Financing (RBF). For the Challenge Fund, clean cooking supply chain actors must submit a business idea proposal.

The best proposals that address the funding needs and meet the eligibility criteria will be considered for funding. For the RBF, clean cooking supply chain actors will commit to meeting predetermined outputs (results) and verification requirements before funds are earmarked. Technical assistance will offer non-financial assistance to enterprises, such as assisting enterprises with their business plans, financial models, consumer education, and market development efforts. Further assistance will be provided at the sector and policy levels.

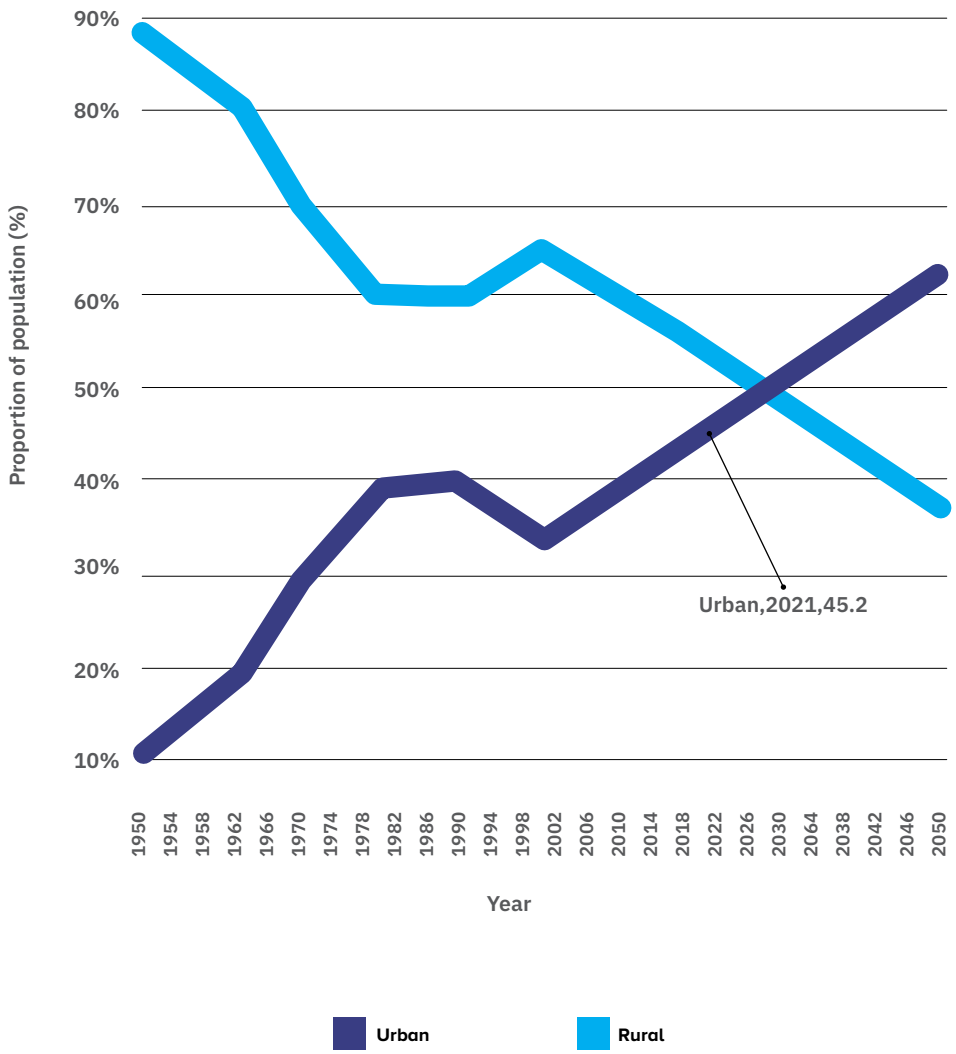
01| Introduction

1.1 Summary of cooking in urban areas of Zambia

The Republic of Zambia is a landlocked nation at the center of Southern Africa with a population of over 18.8 million (World Bank, 2018). It covers 752,612 square kilometers with a population density of 23 people per square kilometer. Zambia is one of the most urbanized countries in Sub-Saharan Africa, with an estimated 45% of the population living in urban areas (UNDESA, 2018). This percentage is estimated to exceed 50% by 2030 and 60% by 2050, as shown in Figure 1 below.

FIGURE 1

PERCENTAGE POPULATION IN URBAN AND RURAL AREAS OF ZAMBIA



Zambia covers
752,612km²

It has a population of over **18.8 million**
This percentage is estimated to exceed **50%** by 2030 and **60%** by 2050

16.5%
of the population has access to clean cooking, primarily depending on electricity

37.7%
of the population has grid-based electricity, with a higher proportion of connected households in urban areas than rural areas (74.8% in urban and 4.1% in rural areas)

37.7% of the population has grid-based electricity, with a higher proportion of connected households in urban areas than rural areas (74.8% in urban and 4.1% in rural areas) (World Bank, 2019). 16.5% of the population has access to clean cooking solutions, primarily depending on electricity. More households in urban areas cook with electric stoves at 33.1% compared to rural households at 1.9 %, mainly due to the low electrification rates in rural areas. Data indicates that electricity and charcoal have been the most predominant cooking solutions in Zambia's urban areas between 2006 and 2017, as illustrated in Figure 2 below (Republic of Zambia, 2011; Republic of Zambia, 2016; EED Advisory 2017)[1]. The relative high access to affordable grid-based electricity and the availability of charcoal has contributed to this.

Although under revision, Zambia has one of the lowest electricity tariffs in the region due to various concessions the Government provides to the sector (Cuts International, 2020). This non-cost-reflective tariff makes electricity a cost-competitive option for cooking. Charcoal is widely accessible, leveraging on an extensive distribution network, affordable due to its divisibility nature (sold in small quantities), and availability throughout the year. The charcoal subsector serves a dual role as a reliable source of livelihood for rural households and a source of affordable energy for urban homes. Mbaula charcoal stove is the most commonly used charcoal stove in Zambia. It is inexpensive, familiar across generations of users, and readily available across several markets and shops. The stove retails at 30-35 (US$ 1.79-2.08) compared to other improved biomass stoves, such as the pellet stove retailing from ZMW 430.25 (US$ 25.61) to ZMW 2,950 ($US 175.56), which are promoted as alternatives to charcoal[2] (USAID Zambia, 2022).

The percentage of households using electricity has decreased from 42.5% in 2010 to 33.1 % in 2017, and charcoal use increased from 51.4% to 60.6% (data from the living standards monitoring surveys and MTF data). The perennial droughts have contributed to lower electricity production and quality of supply.

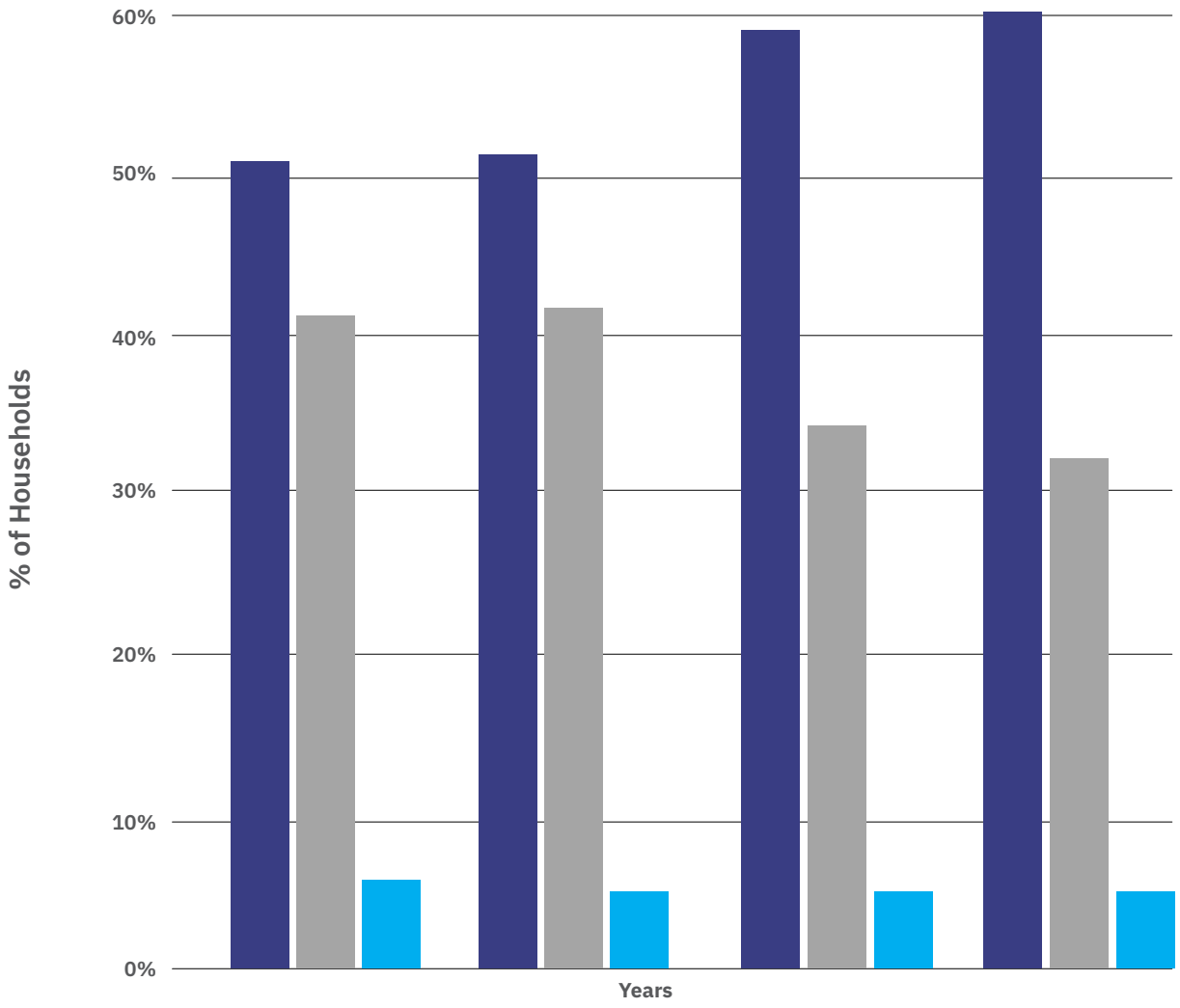
Load shedding schedules with up to eight-hour outages were typical during the 2015 Zambian energy crisis leading to many households switching or completely migrating to alternative cooking solutions. Approximately 87% of the households temporarily or permanently switched from electricity to charcoal for cooking (Robert et al. 2018). Although the percentage of households using electricity dropped from 42.5% to 33.1% between 2010 and 2017, the aggregate number of households increased from 377,767 to 514,854 during the same period.

Approximately **87%** of the households temporarily or permanently switched from electricity to charcoal for cooking

1 EED Advisory analysis of the 2017 MTF data
2 Key Informant Interviews with the cooking solution manufacturers and distributors

FIGURE 2

PRIMARY COOKING SOLUTIONS TREND OVER A DECADE IN ZAMBIA URBAN AREAS



	2006	2010	2015	2017
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Electricity	41.8%	42.5%	34.5%	33.1%
Wood	6.4%	5.7%	6.0%	5.8%
LPG	0.0%	0.0%	0.1%	0.2%
Others	0.7%	0.4%	0.3%	0.2%

The use of Liquefied Petroleum Gas (LPG) has generally been shallow, although this is changing due to the price and quality of electricity supply and Government policy changes. The Zambia living standards monitoring surveys before 2015 did not capture LPG in their analysis due to its negligible contribution. LPG use for cooking was first documented in 2015 at 0.1%. The proportion of households using LPG doubled in two years to 0.2%, while the aggregate number tripled by 2017, according to the MTF survey, as illustrated in Table 1 below. This increment was realized organically without a concerted effort to grow the sector. LPG demand is suppressed mainly due to a lack of adequate distribution channels, production limitations, affordability, safety concerns, and low awareness of the use of LPG appliances. This study elaborates on these factors in subsequent sections of this report.

TABLE 1: NUMBER OF HOUSEHOLDS IN ZAMBIA USING DIFFERENT COOKING SOLUTIONS OVER THE YEARS

#	Cooking Solution	2006	2010	2015	2017
1	Charcoal	410,689	456,876	765,818	941,594
2	Electricity	335,945	377,767	447,051	514,854
3	Wood	51,437	50,665	77,748	90,445
4	LPG	-	-	1,296	3,419
5	Others	5,626	3,555	3,887	3,730

At an estimated 6% use rate, wood for cooking in urban areas has been relatively low. Unlike LPG, electricity, and charcoal, whose uses are constrained by cost considerations, the use of wood for cooking is limited due to the design and size of the cooking spaces in urban areas. Wood is predominantly used in rural areas as housing is less congested than in urban areas. Processed biomass fuels such as pellets and briquettes, as well as improved charcoal stoves, remain less cost-competitive than the alternatives. Supply chain constraints also limit the demand for pellets and briquettes. The solutions are also not standardized (energy density versus volume), making it difficult for end-users to choose among and between them. Similar challenges face biofuel solutions such as ethanol (liquid and gel) and biogas.

Socio-cultural, economic, political, and institutional barriers limit Improved Cookstoves adoption (Inayatullah, 2012). These barriers are not only interrelated but also underpin each other. One million households in urban areas will need to transition to clean cooking technology to realize universal access to clean cooking in Zambia[3]. The over-reliance on woodfuel (charcoal and firewood) for cooking in Zambia has contributed to

8,700 annual deaths attributable to Household Air Pollution (HAP) (UNEP, 2015),

an annual deforestation rate of between **250,000** and **300,000** (Republic of Zambia, 2015), and

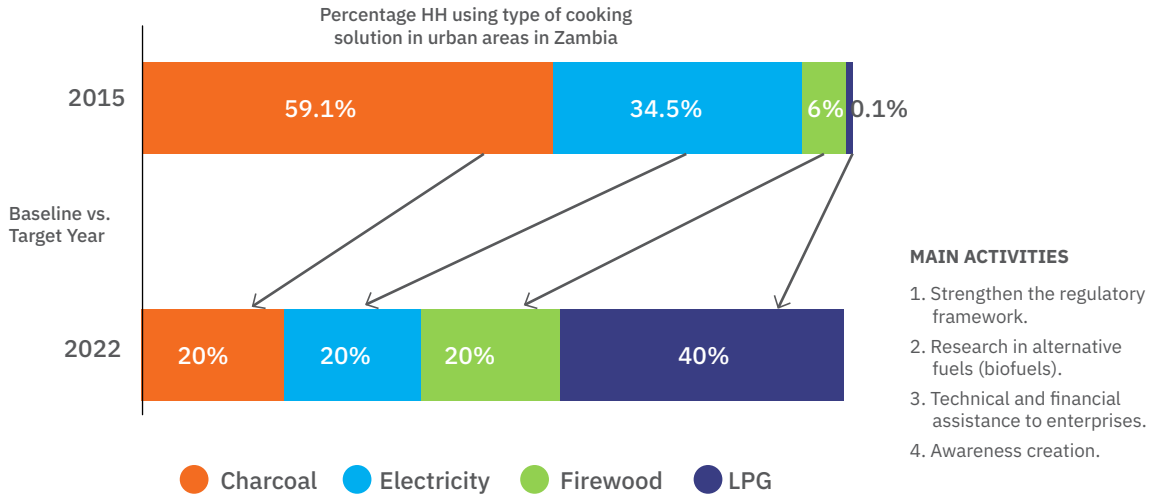
charcoal use contributes to the **61%** of GHG (Greenhouse Gas) emissions from land-use change and forestry (USAID, 2015).

Zambia's Government is keen on promoting cleaner cooking solutions because of the high urbanization rate, the effects of cooking with polluting fuels on the environment, and the adverse health effects on the population. Zambia updated its Nationally Determined Contribution (NDC) under the Paris Agreement on 30th July 2021. Under this plan, the county intends to reduce greenhouse gas emissions by 25% in a business-as-usual scenario and 47% with substantial international support by 2030 compared to 2010 (Republic of Zambia, 2021).

The Government of the Republic of Zambia, among other things, aims to reduce the rate of deforestation attributable to the prevalent use of charcoal and fuelwood for cooking by promoting alternative cooking solutions. This effort builds on the aspirations of the country's Sustainable Energy for All (SEforAll) Action Agenda and Investment Prospectus of 2016. Using the 2015 baseline, the Government of Zambia formulated an ambitious scenario (20% Electricity: 40% LPG: 20% Charcoal: 20% Firewood) for promoting cleaner cooking technologies for urban households, as shown in Figure 3 below (MoE, Zambia, 2016).

3 EED Advisory analysis of the 2017 MTF data

FIGURE 3
20% ELECTRICITY: 40% LPG: 20% CHARCOAL: 20% FIREWOOD SCENARIO



In its SEforAll Agenda, the Government of Zambia identifies and prioritizes the uptake of clean and modern cooking solutions such as LPG, electricity, high energy efficiency stoves (improved woodstoves, high energy efficiency stoves (using pellets), and biogas installations.

1.2 Purpose of the Study

The World Bank seeks to support the Government of Zambia in achieving its goal of promoting the use of cleaner cooking solutions. This cooking sector market assessment covers urban residential compounds in Lusaka and the Copper Belt.

It will form the basis of an intervention plan supported by the World Bank in collaboration with the Government of Zambia. It will promote the uptake of cleaner cooking solutions in urban areas. In this context, cleaner cooking solutions are those that attain Tier 3 performance and above stoves, as defined by the International Standards Organisation (ISO) - International Workshop Agreement (IWA) Voluntary Performance Targets (VPT), as highlighted in Table 2 below.

TABLE 2: TIER VALUES OF ISO VOLUNTARY PERFORMANCE TARGETS

Tier	Thermal efficiency (%)	Emissions CO (g/MJ)	PM2.5 (mg/MJ)	Safety (score)	Durability (score)
5	≥50	≤3.0	≤5	≥95	≤10
4	≥40	≤4.4	≤62	≥86	≤15
3	≥30	≤7.2	≤218	≥77	≤20
2	≥20	≤11.5	≤481	≥68	≤25
1	≥10	≤18.3	≤1031	≥60	≤35
0	>10	>18.3	>1030	>60	>35

This assessment aims to characterize the barriers to cleaner cooking solutions and identify practical options for advancing their uptake. This assignment aims to develop a plan to support the Government of Zambia in promoting the uptake of cleaner cooking solutions in urban areas. To achieve this objective, this study seeks to:

- Understand the drivers and determinants maintaining the current baseline use rate,
- Establish the barriers at the sectoral level and specific to the types of cooking solutions,
- Develop a programme to support higher uptake of cleaner cooking solutions, including activities, resources, and work plans.

This study employed multiple data collection approaches, including literature review, focused discussions, geo-spatial analysis, key informant interviews, and analysis of primary household data collected under the Multi-Tier Framework (MTF) survey. These data gathering methods and tools are elaborated in the section below. The information gathered was synthesised to develop this baseline report (chapters 3, 4, and 5) and ultimately create a plan (presented in chapter 6) to increase the uptake of clean cooking in Zambia's urban areas. This report also provides a general recommendation for the cooking sector in chapter 7.

02| Data Collection Activities

2.1 Literature Review

An extensive literature review contributed to this study. The review informed trends in the cooking sector, barriers and determinants of choice and preference, use rates of different technologies, policies, and cost of cooking solutions, among other things.

Table 3 provides a list of the primary documents reviewed and their highlights. We reviewed other documents and data sources which are listed in this report's References section.

TABLE 3: A LIST OF NON-EXHAUSTIVE LITERATURE CONSULTED FOR THIS STUDY

#	Author/s, Institution	Year	Title	Comments and Findings
1.	Government of the Republic of Zambia	2006, 2010 & 2015	Living Conditions Monitoring Survey Report	• Trends in the energy of cooking in nationally, urban, and rural areas • Population demographics (urbanization, growth rate, family size, etc.)
2.	World Bank	2019	Zambia Energy Access Diagnostic Report Based on the Multi-Tier Framework	• Use rates for urban areas • Gender analysis on use rate and decision making • Recommendations to grow the sector
3.	USAID	2021	Alternative to Charcoal Market Analysis Survey	• Identifies the value chains for cooking solutions in Zambia • Barriers to uptake of each cooking solution • Enabling environment • Affordability and consumer financing • Opportunities to scaling-up cleaner cooking solutions
4.	USAID	2021	Alternative to Charcoal Consumer Preferences Survey Report	• Conducted in Lusaka with 420 respondents • Consumer's knowledge, usage, perceptions, preferences, usage patterns, aspirations for different cooking solutions • Expenditures on cooking solutions
5.	Shannon Lloyd	2021	The Role of Social Capital in Improved Cookstove Adoption in Lusaka, Zambia	• Relationship between social capital and ICS adoption and the association between gender and ICS adoption. • Key variables cookstove firms could target to increase the likelihood of adoption that is not dependent on individual household connections or choices. • Gender dynamics in the adoption of clean cooking
6.	J. Leary, N. Scott, N. Serenje, F. Mwila, S. Batchelor Associate authors: M. Leach, E. Brown, F. Yamba	2019	Opportunities & Challenges for eCook Zambia	• Motivations to change behaviour to adopt an aspirational product • The charcoal stove (or even LPG) is an alternative and seemingly more viable pathway. • Solar home systems and mini-grid markets in Zambia pave the way for PV-eCook. • Several private companies are now offering pay-as-you-go solutions
7.	Arun Gopalan Barbara Otieno Peter Weston	2021	Clean Cooking: Financing Appliances For End Users	• End-User Financing • Payment models- PAY GO solutions in the clean cooking sector • technical assistance (TA) to promote end-user financing

2.2 Data Collection Tools

FGD guides, KII guides, and a Request for Information (RFI) questionnaire were developed for primary data collection. The design considered where practical, gender-disaggregated data collection approaches. The interview/discussion guides and questionnaire were formulated based on the findings from the desk review, and data collection approaches were deliberate in ensuring gender inclusivity.

These tools were used to gather information on:

1. Current cooking patterns,
2. Barriers to accessing cleaner cooking technologies,
3. Women's involvement in the cookstove value chain and decision-making process,
4. Current practices and market conditions
5. Financing available for manufacturers and distributors
6. Financing options available for end consumers of clean cooking products including loans, subsidies, layaway, pay-go, among others and
7. Institutional setup within the clean cooking sector.

RFI was an open call collecting information from supply chain actors in the cookstove market chain, including financial institutions, manufacturers, distributors at the regional level, enterprises, and last-mile distributors of cookstoves products and services. The purpose of the RFI was to gather quantitative and qualitative information on the range, type, pricing, and distribution channels of products and services.

2.3 Key Informant Interviews

The key informant interviews were conducted between 4th April and 14th April 2022. The interviews targeted various stakeholders in the clean cooking sector in Zambia. Representatives, including Government and public sector institutions, development sector, research institutions, associations, financial institutions, manufacturers, and distributors, constituted this pool of informants. The interviews were 40-60 minutes long and followed a pre-set interview guide. All meetings were recorded with permission from the respondents, and notes were taken and uploaded to EED's SharePoint platform folder. A total of 29 key informants were invited to participate in the discussions. However, only 17 key informants attended the interviews.

Request for Information questionnaires (RfIs) were sent to 18 companies manufacturing or distributing clean cooking technologies and fuel. Three of the companies responded to the questionnaires. One of the target respondents reported being involved in other data-gathering exercises and was unwilling to respond to our request for information due to interview fatigue. Inputs from the RFIs were to enumerate the supply chain products, prices, markets, and distribution channels. Due to the low response rate on RFIs, the gaps will be filled through a literature review of recent reports collected similar or related data from these stakeholders.

2.4 GIS Analysis

Geospatial analysis was applied to estimate the population living near an LPG refill station in Lusaka District. The process involved downloading and processing 2020's Gridded Population of the World (GPW), v4, which has a spatial resolution of 30 seconds (approx. 1 km) (SEDAC, 2022). This raster data was clipped to the area of interest (Lusaka district) and projected to The Universal Transverse Mercator (UTM) 35S. The petrol stations in Lusaka were identified using a combination of Google Earth Pro and Google Maps, which assisted in identifying 163 petrol stations. Buffers with a radius of 500m and 1000m were generated using ArcMap to compute the population within the specified distance. The Zonal Statistics tool in ArcMap was used to intersect the attributes of the population density raster with the different buffers (vector data). This analysis is essential in characterizing the proximity of users to LPG refill stations which are only sold at fuelling stations according to the LPG standards. The last-mile distribution network is one of the barriers to the uptake of LPG for cooking.

2.5 MTF Data Analysis

Analysis was done on Multi-Tier Framework (MTF) Zambia data (data collected between September 2017 and March 2018). Our study focused on data collected in Zambia's urban areas, with a reported sample size of 1,791 households. The analysis covers five cooking categories: LPG, charcoal, wood, electricity, and others (piped natural gas, sawdust, and solar). Households were characterized based on the primary cooking solutions, expenditure quintiles (an indication of wealth), willingness to pay for an improved cooking solution, gender, and education level of the household head. This information is vital in designing the financing component for the demand side. The data will assist in structuring a demand-driven capital support facility as part of the proposed clean cooking programme. Outcomes of this analysis form the basis of characterising the market dynamics, structuring various forms of subsidies, pricing the subsidies, and setting impact targets.

2.6 Focus Group Discussions

Six (6) Focus Group Discussions were held; three (3) in Lusaka and (three) 3 in the Copperbelt region, as shown in the map below (Figure 5). The participants were drawn from different neighbourhoods within the two provinces. A set guide with questions was used to lead the conversations.

Table 4 shows the number of participants disaggregated by gender who participated in the FGD. Female-only groups participated in the focus group discussion group (FGD 2), and a mix of females and males participated in FDG 1 and 3. Both groups needed to be part of the discussion, together and apart, to capture different gender dynamics associated with cooking.

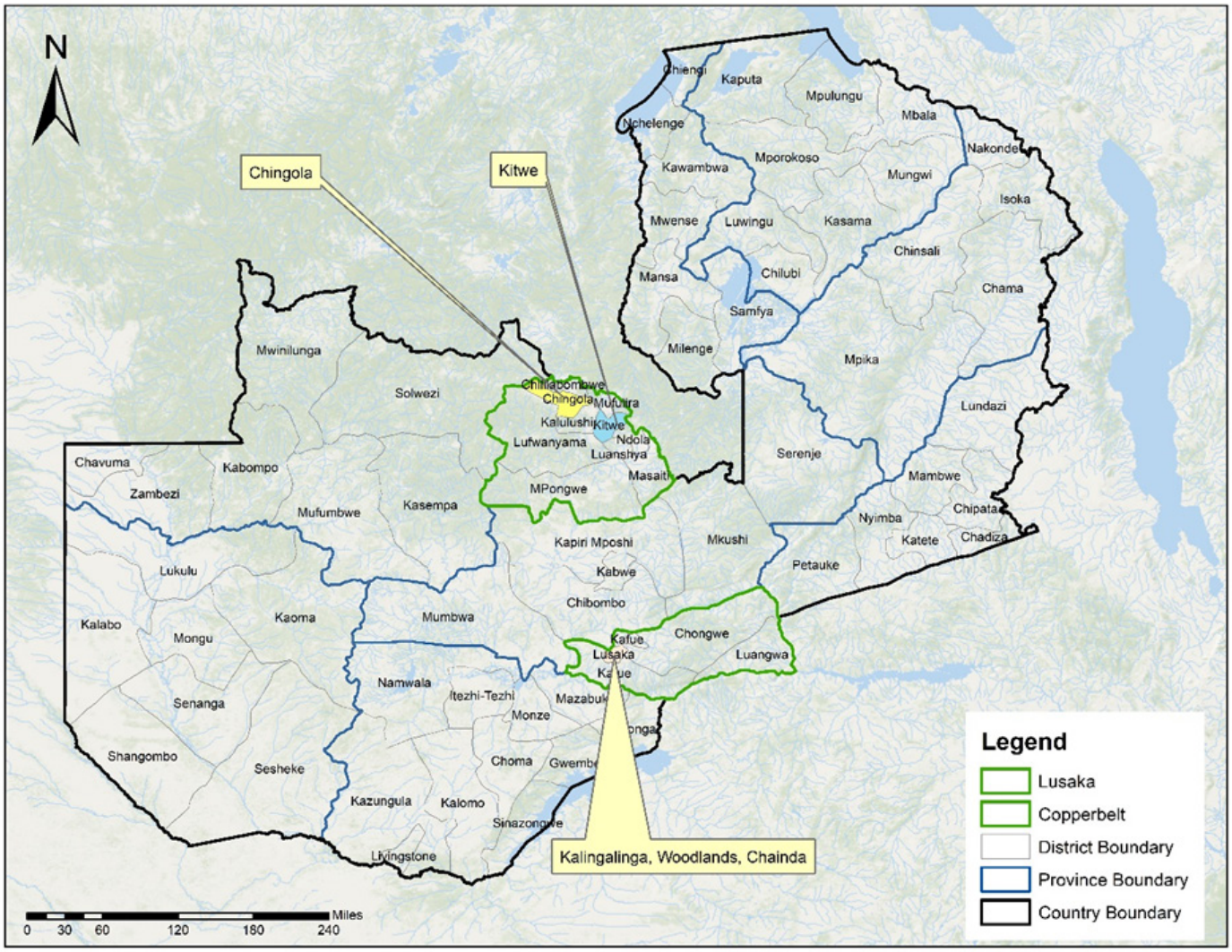
TABLE 4: FOCUS GROUP DISCUSSIONS PARTICIPANTS

#	Location	FGD 1	FGD 2	FGD 3
1	Lusaka	1 (M), 5 (F)	9 (F)	3 (M), 11 (F)
2	Copperbelt	4 (M), 5 (F)	5 (F)	11 (F)

(F) – Female (M) – Male

FIGURE 4

FOCUS GROUP DISCUSSION SITES



03| State of Cooking in Urban Areas

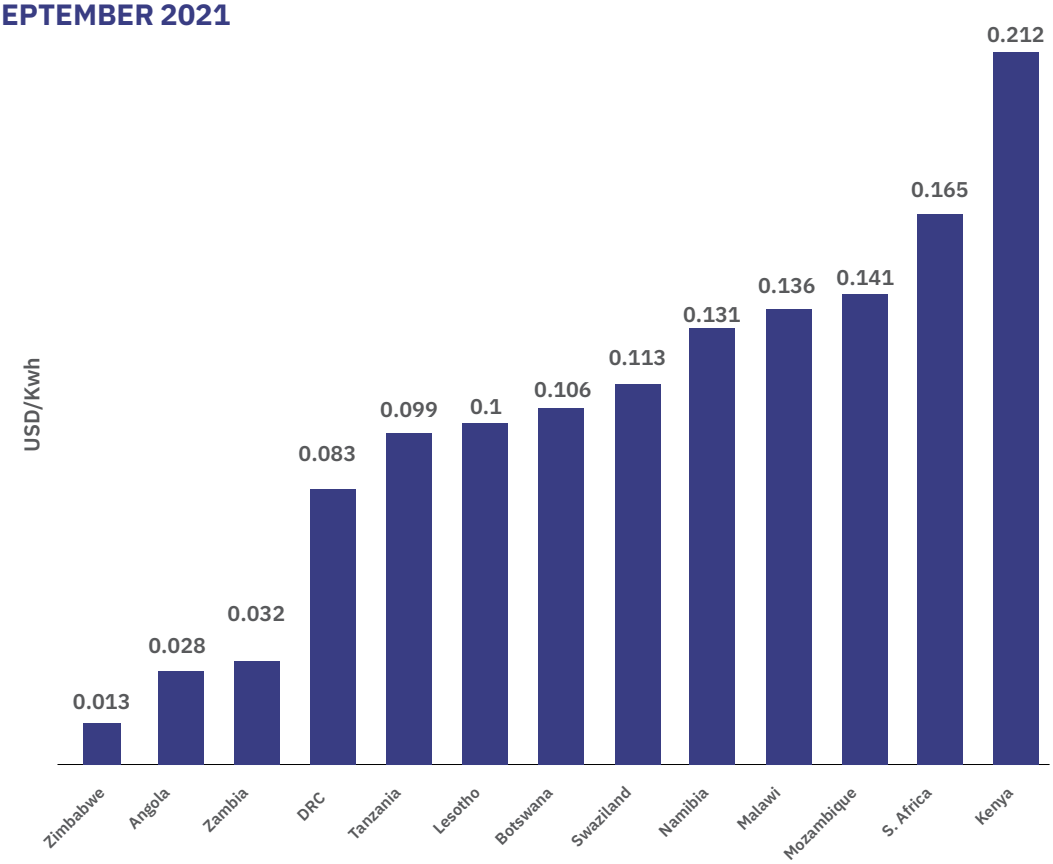
3.1 Electric Cooking

Although the percentage of households using electricity dropped from 42.5% to 33.1% between 2010 and 2017, the aggregate number increased from 377,767 to 514,854 households during the same period. Electric cooking is the most popular solution in urban areas next to charcoal. The solution does not suffer from supply chain constraints because most urban households are already connected to the national grid. It is clean, easy to use, and safe, with zero emissions associated with household air pollution.

The electricity tariff, although changing, is still one of the most affordable in the region, as shown in Figure 5 below (GlobalPetrolPrices.com, 2021). Domestic consumers of electricity in Mozambique, South Africa, and Kenya pay four (4), five (5), and seven (7) times more per unit, respectively, compared to the households in Zambia. The low cost of electricity is due to several concessions provided by the Government of Zambia to the electricity sector. It is estimated that ZESCO Limited loses approximately ZMW 1.8 billion (US$ 107.14 million) in revenue annually through subsidies to household consumers (Cuts International, 2020).

FIGURE 5

COST OF ELECTRICITY ACROSS DIFFERENT AFRICAN COUNTRIES IN SEPTEMBER 2021

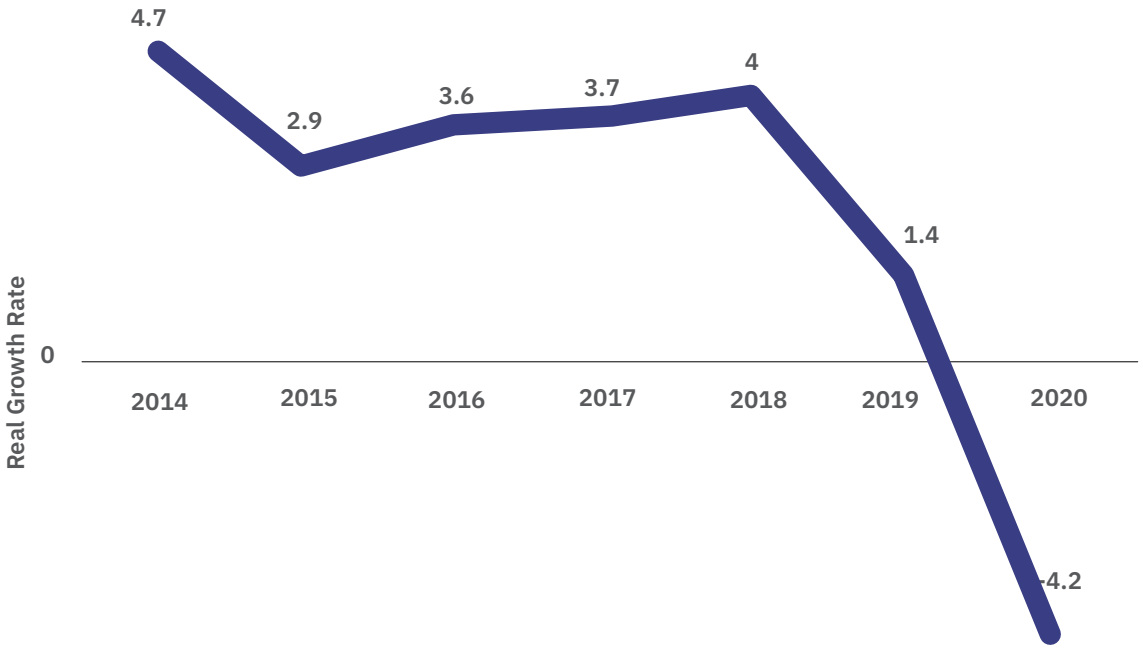


The Government aims to reduce the dependency on electricity for cooking from an estimated 34.5% in urban areas to 20%. The 2015-2019 energy crisis, characterized by extended load shedding, significantly impacted the energy-intensive extractives industry. For example, mining which contributes to about 14% of GDP (Oxfam, 2021), suffered from decreased output directly linked to power supply interruptions.

The Government's strategy now aims to deflect electricity demand from cooking to secure supply to this vital sector. Figure 6 below shows the sharp decline in real GDP between 2014 and 2015, then between 2018 and 2019, partly attributed to the energy crisis. Although the global decrease in the demand for copper contributed to the GDP decline, the drop in power supply leading to outages of up to twenty (20) hours across eight months in 2019 (Cuts International, 2020) was the main driver.

The Government aims to reduce the dependency on electricity for cooking from an estimated **34.5%** in urban areas to 20%

FIGURE 6
REAL GDP GROWTH RATE IN ZAMBIA



Since most electric stoves in the market have a basic design and are less efficient, e.g., hot plate electric stoves and ovens, ZESCO Limited cannot meet the growing peak demand from households, businesses, and the mining sector, especially during droughts. Households use about 2.5kWh per day, with 60% of this taken up by cooking (USAID Zambia, 2021). With the high inflation rate at 17.4% in 2020 (AFDB, 2021), depreciation of the Kwacha, high public debt, impacts of Covid 19 pandemic, and negative economic growth rate, it is unlikely that the Government will continue to sustain subsidies for the domestic consumers. There are several energy-efficient electric cooker options, including electric pressure cookers, but these are relatively more expensive than the base version (Jon et al. 2019).

Households that own electric cookers typically use them alongside charcoal stoves. In such cases, meals that take longer are cooked with charcoal stoves, e.g., boiling beans, and quick meals such as breakfast are cooked on electric stoves.

Although cost is a crucial consideration when stacking different cooking solutions, the ease of use contributes to the choice of solution. Cooking activities that require a short time, e.g., making tea, are better done using electric options. Using charcoal for making tea not only includes the time it takes to light the stove, but there will inevitably be charcoal leftovers from the tea making, leading to fuel wastage.

Electric pressure cookers (EPCs) can be used to make most meals, but not all. Meals that require longer cooking durations can be cooked on Electric Pressure Cookers (EPCs) replacing the charcoal stoves thus creating an opportunity to replace rudimentary electric burners with EPCs. A Modern Energy for Cooking Services (MECSs) research on the viability of PV-eCook (a battery-supported electric cooker) targeting off-grid regions is ongoing. The cost of PV-eCook solutions is highly prohibitive. Basic electric cookers and burners are purchased in retail outlets such as Game stores, Shoprite, and Radian. Table 5 below shows some of the electric appliances and costs in the market.

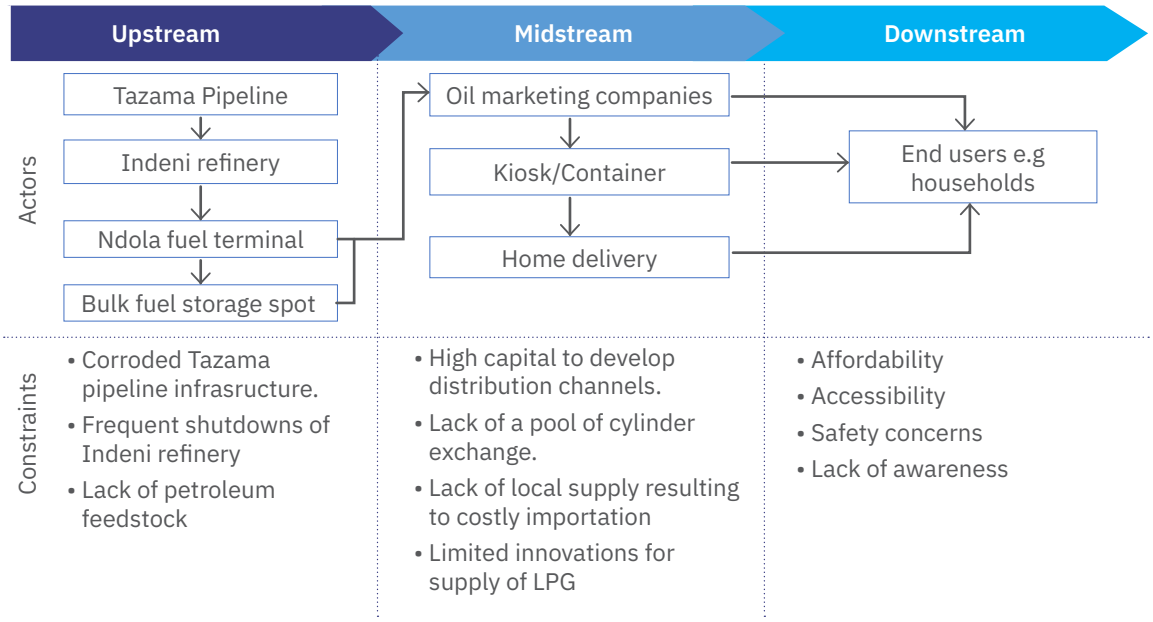
TABLE 5: ELECTRIC APPLIANCES IN THE MARKET (USAID ZAMBIA, 2021)

Photo	Product	Price (ZMW)
	Two plate electric hob	275-677 (US$ 16.37-40.30)
	Two plate electric hob with oven	1,295-3,123 (US$ 75.25-181.46)
	Four plate electric hob with oven	4,560-6,499 (US$ 264.96-377.63)
	Electric pressure cooker	1,499-2,082 (US$ 87.10-120.98)
	PV-eCook	NA

3.2 Liquefied Petroleum Gas

According to the MTF data, 0.2% of urban households (514,854 households) use LPG as their primary cooking solution. The Government of Zambia foresees LPG as the most viable clean cooking alternative in Zambia, especially in urban areas. As discussed earlier, LPG, as an alternative to electric cooking and charcoal, would reduce pressure on forests and electricity demand. The LPG fuel and stoves are tax-exempt aimed at promoting the use of LPG. Oil Marketing Companies (OMCs) can directly import petroleum products (including LPG) without incurring the 25% import duty (ERB Zambia, 2020). However, LPG cylinders accrue 15% import duty and 16% VAT. Although the Government is keen on promoting the uptake of LPG for cooking, constraints across the LPG value chain have restricted growth in the sector over the years. The challenges are summarized in Figure 7 below.

FIGURE 7
CHALLENGES ACROSS THE LPG VALUE CHAIN IN ZAMBIA



0.2%

of urban households (**514,854 households**) use LPG as their primary cooking solution

3.2.1 Upstream Value Chain Challenges

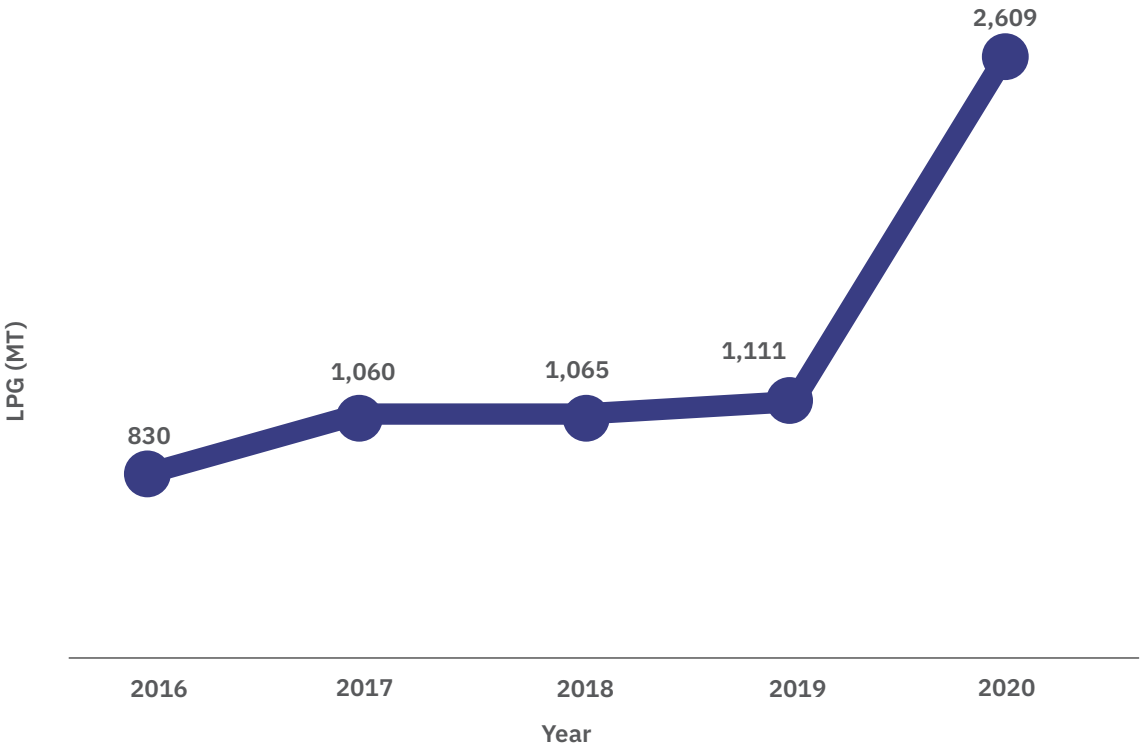
The main challenges in the upstream include:

1. Insufficient supply of crude oil,
2. The frequent shutdowns of the Indeni refinery and erratic operation, and
3. The ageing Tazama pipeline (over 50 years) contributing to the low supply of LPG[4] (Cuts International,2020).

This has, over time, led to low local production of LPG and the country having to import to meet the deficit. It is recorded that in 2020, there was a spike (doubled) in the LPG imported (see Figure 8) as the refinery was closed for eight (8) months. Currently (2022), the refinery is under maintenance, so LPG production is not ongoing.

Importation of LPG increases the cost of supplying end-users with fuel as extra costs are incurred in transport.

FIGURE 8
LPG IMPORTATION IN ZAMBIA 2016 – 2020



4 Key Informant Interviews

These costs are transferred to the end-users. It is noted that there has been a 111% increase in the price of LPG from 2019 (ZMW 17 (US$ 1.01) to ZMW 36 (US$ 2.14) in 2021 (USAID Zambia,2021). Other factors, such as the high inflation rate and depreciation of the Kwacha, have also increased the cost of LPG in Zambia (Cuts International, 2020).

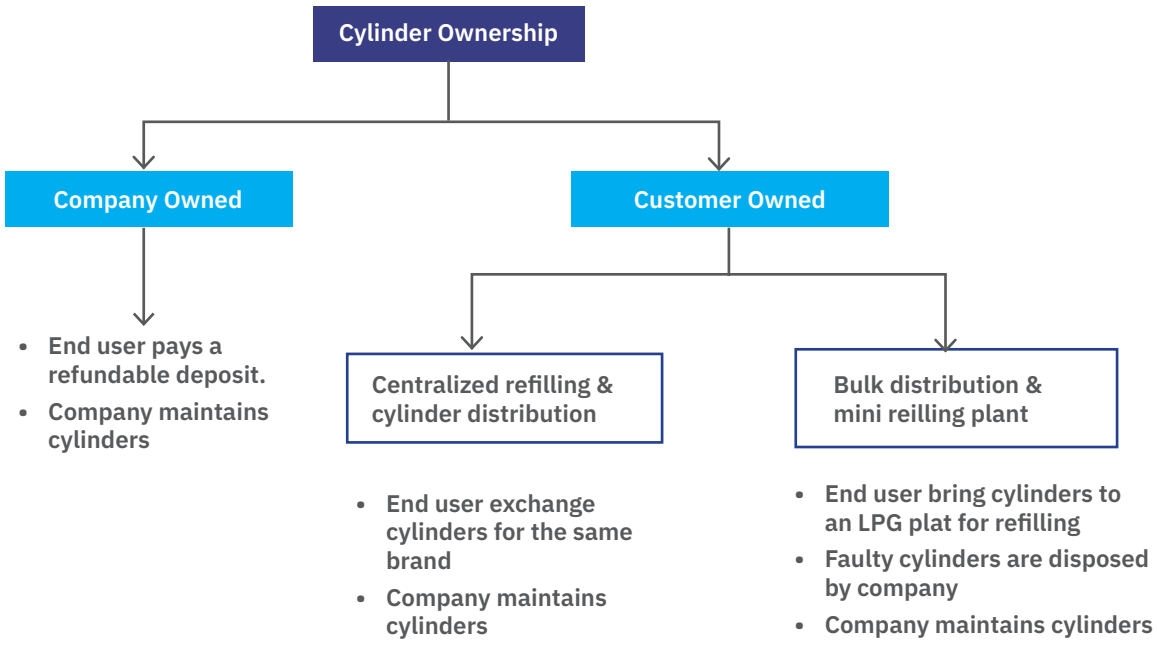
LPG bulk facilities are in two forms Indeni oil refinery and Oil Marketing Companies (OMC). As of 2020, the LPG storage was at 2,518 MT. 71% (1,800 M) from the Indeni oil refinery, and the remaining 29% (718 MT) was distributed across nine OMCs. The top three companies with extensive storage facilities are Afrox Zambia Limited (143 MT), Oryx Gas (134 MT), and Mount Meru (100 MT) (ERB Zambia, 2020). Oryx Gas and Mount Meru are among the top five companies that supply retail LPG (sell to households). At the same time, Afrox Zambia Limited is the leading company supplying commercial LPG (USAID Zambia, 2021). The Government has been expanding its storage for petroleum products by constructing fuel storage depots in the ten provinces of Zambia (ERB Zambia, 2020).

Two have already been commissioned, one in the Northern provinces and the other in Lusaka (Cuts International, 2020). This plan aligns with their 2019 National Energy Plan, which aims to ensure a constant supply of petroleum products, including LPG.

3.2.2 Midstream Value Chain Challenges

Oil Marketing Companies are the distributors of LPG. Some companies have developed innovative mechanisms to improve last-mile access by opening retail kiosks and home delivery (USAID Zambia, 2021). LPG cylinders are stocked in over ten (10) sizes (1.4 Kgs, 3 Kgs, 5 Kgs, 6 Kgs, 7 Kgs, 9 Kgs, 13 Kgs, 15 Kgs, 19 Kgs, 38 Kgs, 48Kgs). CADAC is the only stockist that sells the 3 Kg cylinder. Companies decide which cylinder sizes to stock. Cylinder ownership in Zambia is in two forms: company-owned and consumer-owned (USAID Zambia, 2021). Details are provided in Figure 9. A fundamental limitation of cylinder ownership is the lack of an LPG cylinder inter-exchange pool. A cylinder inter-exchange pool allows end-users to swap their cylinders at any distributor, regardless of the brand.

FIGURE 9
CYLINDER OWNERSHIP IN ZAMBIA




14KG

It is one of the reasons there was a spike in the use of LPG in Kenya (MoE Kenya, 2020), as it made LPG accessible at many points. Stockists did not have to stock all brands of LPG, and end-users did not have to travel long distances to exchange their specific cylinders if the brand was not within their vicinity.

Consumers' refilling at the LPG plant is an innovative approach for making the LPG affordable as end-users can purchase the fuel in small quantities depending on available finances.The most common LPG cooking appliances are captured in Table 6. Consumers can purchase these stoves in stores such as Shoprite, pick n' pay and Game, Radian, and Fidelity.

TABLE 6: LPG APPLIANCES IN ZAMBIA

Photo	Product	Price (ZMW)
	Single burner on cylinder	235-270 (US$ 13.99-16.07)
	Two burner cooker	395-770 (US$23.51-45.883)
	Four burners with oven	4,450-5,723 (US$ 264.88-340.65)
	Combination of gas and electric with oven	3,950-6,372 (US$ 235.12- 379.29)

Most Oil Marketing Companies in Zambia are groups of companies and, therefore, can finance their investments from within the group and shareholders. Oil Marketing Companies have more access to debt financing from commercial banks. However, small-scale entrepreneurs in the LPG sector fund their businesses (kiosks) from personal finances since it is difficult to access financial support (USAID Zambia,2021). There is a need for financing in the industry. An interview with the A2C (The USAID Alternatives to Charcoal) project implementers indicated that A2C works closely with Direct Focus Community Aid (DFCA) and Collaborative Labelling and Appliance Standards Program (CLASP). This project's funding will be directed to financing the LPG companies. The project has a grant program with a strong proposal and keen interest in the Pay as You Go program to address the affordability issues. A2C is looking at starting savings and loans plus give approach where the distributors save money in a pooled account from which they can borrow and scale their businesses.

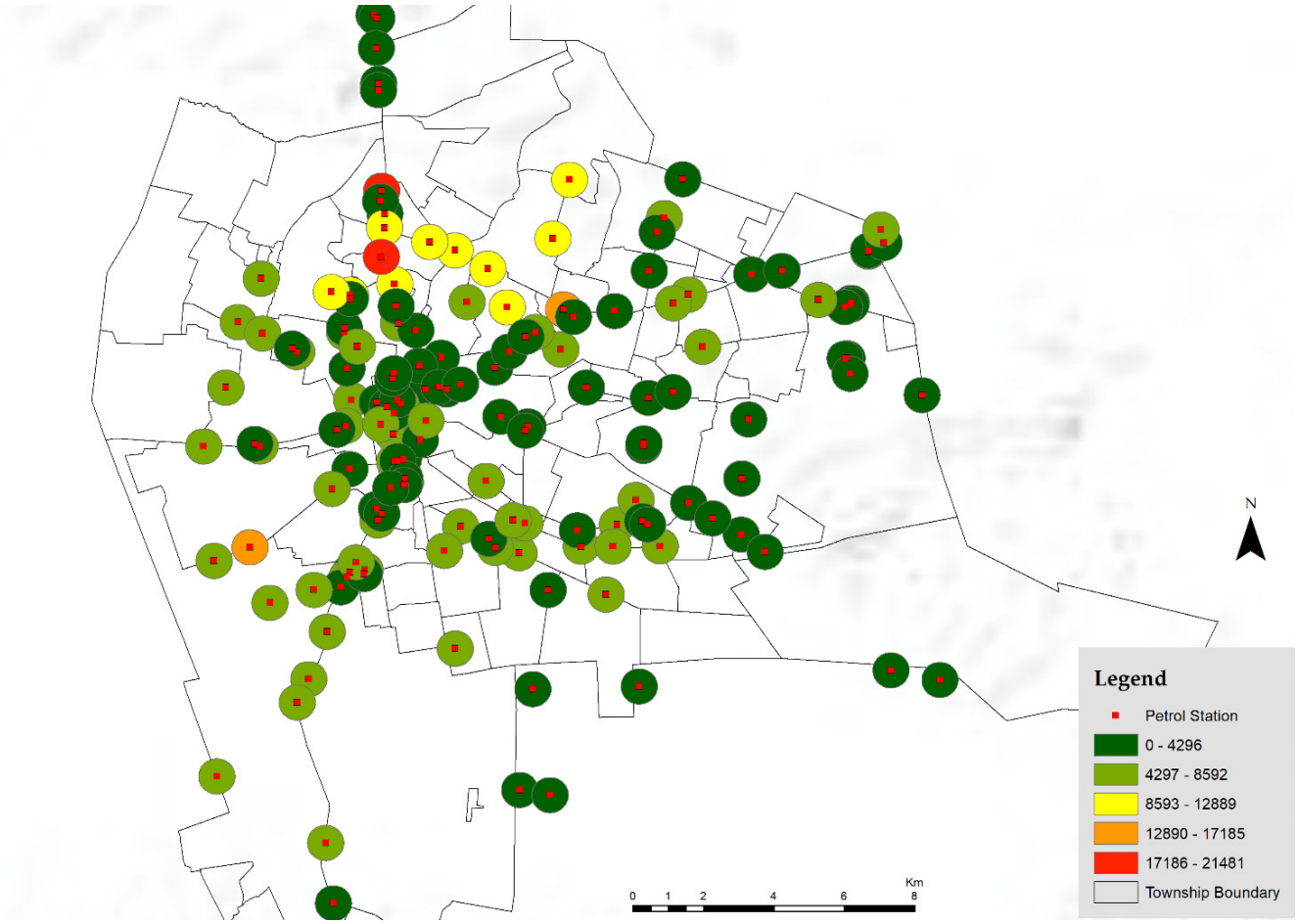
In addition, Development Finance Corporation (DFC) is about to sign an agreement with Absa Bank Zambia of about 10 million dollars, and a portion of it will go into clean cooking. The project is also supporting the cylinder exchange mechanism physical waiver.

3.2.3 Down-stream Value Chain Challenges

The main issues of concern for end-user are affordability, accessibility, lack of awareness, and safety concerns. As discussed earlier, LPG prices have fluctuated due to shortages in local production, inflation, and global prices. Although, the availability of small-sized cylinders (1.48Kgs) and refilling in small amounts may address fuel affordability. The affordability of LPG appliances is more pronounced in low-income households[5]. Based on the geospatial analysis, it is estimated that of the 3.4 million (Knoema, 2022) residents in Lusaka District, only 0.6 million live within a radius of 500 metres from a fuelling station (see Figure 10). More than half the population lives more than 1 kilometre from a refuelling station. The analysis conducted did not disaggregate fuel stations that sell LPG and those that do not sell LPG; therefore, it is likely that even a smaller number than 0.6 million live close to an LPG exchange point.

FIGURE 10

POPULATION IN LUSAKA LIVING WITHIN A RADIUS OF 500M FROM A REFILL STATION



5 EED Advisory MTF Data Analysis

Based on the geospatial analysis, it is estimated that only

0.6 million

of **3.4 million** live within a radius of **500 metres** from a fuelling station with more than half the population lives more than **1 kilometre** from a refuelling station.

Focus Group Discussion (FGDs) data also indicate that most households are not aware of LPG appliances. They also have safety concerns for LPG and perceive it as a bomb waiting to explode in the house.

With several interventions by the government, private sector, and development partners to promote clean cooking in Zambia, significant use of clean cooking fuels is expected to increase in the coming years. To meet the increased demand, there will be need to expand the existing clean cooking infrastructure. This includes storage and distribution infrastructure. LPG, in particular, will require expansion of storage capacity.

As of 2021, oil marketing companies in Zambia had a storage capacity of 718 tons, with Afrox, Oryx and Mount Meru holding the largest storage capacity (USAID Zambia, 2021). This will have to be increased to meet the expected increased uptake. Additionally, LPG marketers will have to increase cylinder circulation in the market to account for refilling turnaround times by consumers. Also, bespoke last-mile distribution infrastructure will need to be enhanced to cater to the diverse population's needs. LPG enterprises will require substantial capital to improve their infrastructure to meet expected demand.

3.3 Charcoal

Charcoal is the most prevalent cooking solution in urban areas. 60.6 % (941,594 households) use charcoal as their primary cooking solution[6]. Charcoal is stacked with other cooking solutions such as electric stoves and LPG. The high use rate is attributed to fuel and stove availability, affordability, and accessibility.

The most popular charcoal stove is the *mbaula* charcoal stove, a traditional metallic stove perforated on the sides. The charcoal stove industry has remained dominant due to the *mbaula* stove, which, although it has efficiencies of as low as 10%, remains the most used charcoal stove due to its cost (Azel, 1998). In addition, the stove has no insulation and does not retain temperatures due to many perforations (World Bank, 2019). For this reason, most households prefer using it outside the house during the warm seasons. In the 1980s, the University of Zambia had worked to improve the models (Azel,1989), but not much has been done to improve the *mbaula* stove since then, and the skills required to produce one are minimal (SEI, 2013).

Additionally, raw materials are locally assembled or purchased and meet minimum requirements. Scrap metal from old vehicles suffices to manufacture the stove. With all materials ready, you require one hour to produce the stove (SEI, 2013). The stove has a lifespan of two years (Techno-Share Associates, 2007) and is made by tinsmiths who are not registered in any organization. The stoves are purchased at the point of production, primarily in open markets.

In 2017, Eco-zoom introduced the zoom jet economy stove to Zambia to provide a more efficient charcoal stove than the *mbaula* stove. They estimated that the zoom jet charcoal stove was 90% more efficient than *mbaula*. They partnered with Vitalite and Live Well Social Business Ltd for distribution (Ecozoom, 2017). Reports on the success of expansion to Zambia are not available. One of the significant challenges in scaling up improved charcoal stoves is the price competition with traditional stoves (see Table 7). Other emerging charcoal stoves include the Ceramic Jiko and the UPENERGY stove. Their prices are shown in the table below.

60.6 %
(**941,594 households**)
use charcoal as their primary cooking solution.

6 EED Advisory MTF Data Analysis

TABLE 7: CHARCOAL STOVES AVAILABLE IN THE MARKET

Charcoal stove	Distributor	Retail price (ZMW)
Mbaula 	Local artisans	30-35 (US$ 1.79-2.08)
Ceramic jiko 	Local artisans	500 (US$ 29.05)
UPENERGY stove 	UPENERGY	103.26 (US$6- highly subsidized from carbon credits)
EcoZoom charcoal 	Vitalite and Live well	495 (US$ 28.76)

Recent data on charcoal consumption is lacking, but data from 2010 estimated that urban households consume 16,518.1 tons of charcoal every month (IAPRI, 2015). The divisibility of charcoal allows it to be sold in small quantities and therefore cater to low-income households. In Zambia, charcoal is sold in sizes from small plastic bags of approximately 2 Kg to large 50kg bags with raised tops. The price for the small bag is estimated at ZMW 6 (US$ 0.36), and the 50 Kg bag is ZMW 314 (US$ 18.69), respectively (USAID Zambia, 2021). This data aligns with the information gathered from FGD, where households whose average household size is five persons (Zambia Statistics Agency, 2019) indicated that they use approximately 50kgs of charcoal per month, retailing at ZMW 200-300 (US$ 11.90-17.86) when purchased in urban areas. The price is lower when they buy in rural areas.

The price is higher during the rainy season due to the increased demand from the cold season. The FGD participants also mentioned that charcoal could be bought in small quantities like 2Kgs, for instance, which cost ZMW 3-5 (US$ 0.18-0.30) hence the high preference and usage.

3.4 Firewood

The use of firewood in urban areas is restricted by the setting of households in urban areas (houses built close to one another with no open spaces to set up an open fire. As a result, only 5.8 % (90,445 households) use firewood as primary cooking in Zambia's urban areas. Firewood is more common in low-income areas, although households in higher-income areas still use firewood for cooking[7].

7 EED Advisory MTF data analysis

The reason for use is the affordability of the stove (which requires three stones that can be collected at no cost) and fuel (in some cases collected for free), ability to offer additional benefits such as space heating the house, adjusting the stove depending on the size of the cooking pots, among others. Energy Regulation Board (ERB) officials noted that the improved wood fuel stoves do not meet these desirable qualities of the available firewood stove. Consumers, however, dislike the immediate effects of smoke (irritation of the eyes and a headache) and the soot that forms on the cooking pots after use (USAID Zambia, 2021).

Development agencies such as United Nations Agencies promote other fixed efficient forms of firewood stoves (GEF, 2019). However, these programmes are mainly in rural areas where alternative forms of cooking are more challenging to encourage.

3.5 Others

Other cooking solutions include biofuels (ethanol and biogas), pellets, and briquettes. These cooking solutions are still in the nascent stage. They, therefore, have less support from the regulatory environment, fewer suppliers in the market, limited awareness among the consumers, and low levels of awareness among the end-users. Biogas is considered a rural fuel due to the infrastructure required to set up the biodigesters and sourcing feedstock for their operation. Bioethanol is less known, making it a hard-to-sale product. The leading barrier bioethanol manufacturers and distributors identified was the lack of policies addressing bioethanol as cooking fuel.

The current policy treats ethanol as a product for making alcoholic beverages. As a result, ethanol for cooking attracts the same exercise duty as ethanol for beverages (previously 125%, now revised to 60%). Through the Energy Regulatory Board and the Zambian Bureau of Standards, the Government is developing standards for bioethanol for cooking and their associated appliances. The standards will involve denatured ethanol for cooking fuel, non-pressurised ethanol cooking appliances using liquid fuel, ethanol gel for cooking, and other gel-burning appliances and gel fuelled appliances.

Kainos Green Energy is a local company that produces ethanol using Molasses as the primary feedstock and distributes ethanol stoves. The ethanol production plant has a capacity of 1,000 litres of ethanol per day which is sold in quantities of 250 ml, 750ml, and 1 litre. A litre retails at US$ 0.86. Two-burner gel and fuel stove cost ZMW 250 (US$ 14.88) when imported, while two-burner liquid fuel locally produced by Kainos Green Energy retails at ZMW 120 (7.14) USAID Zambia, 2021). There is an opportunity to develop local production to reduce the cost of the stove to end-users. The major challenge for ethanol solution suppliers includes the unavailability of financiers who can support manufacturers and distributors of ethanol for cooking, especially those in their early growth stages.

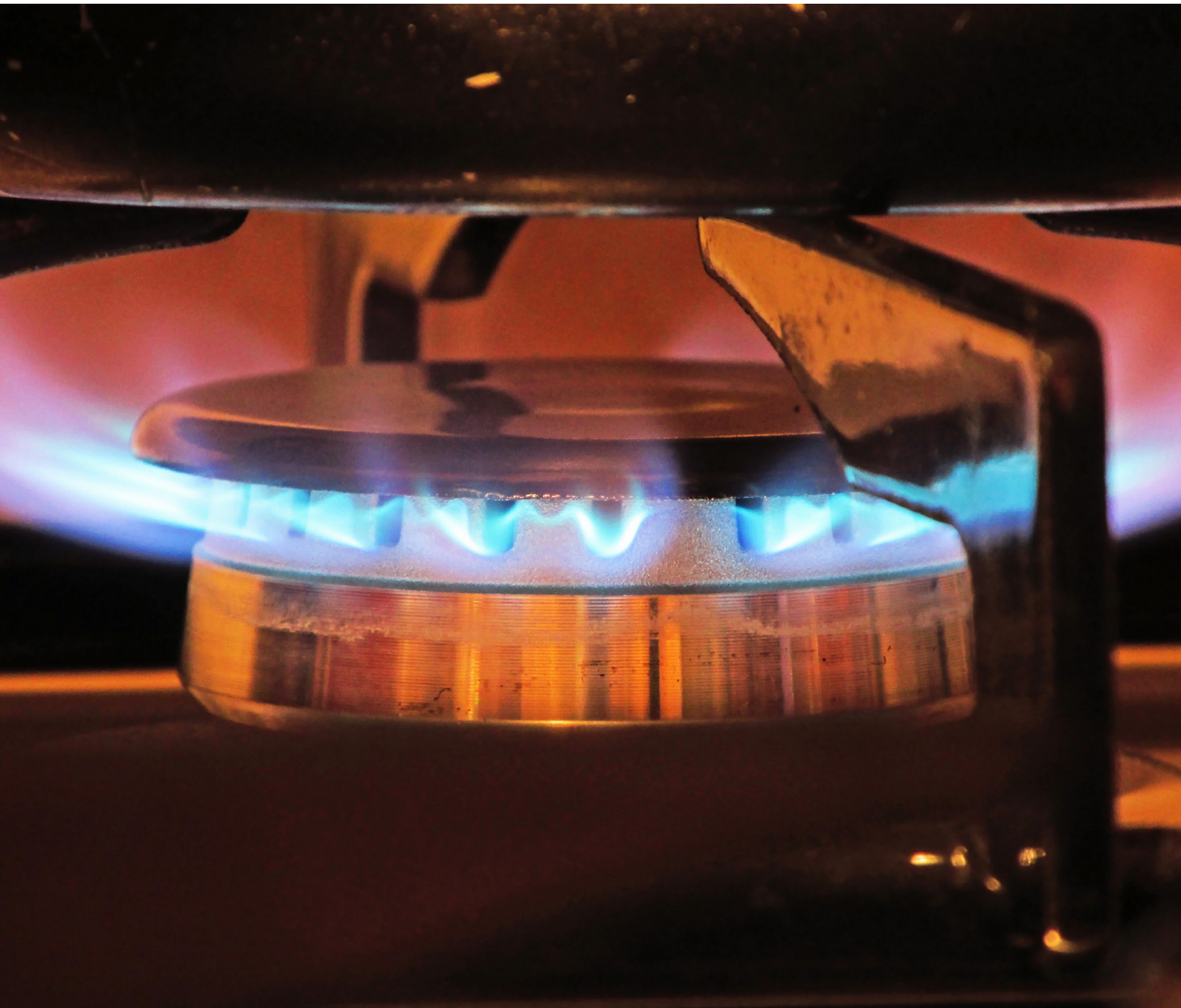
The pellets market in Zambia is still in its early stages. The cost of the stove is the main challenge in the uptake of pellets as a cooking solution. For instance, a pellet stove from Emerging Cooking Solutions (leading pellet producer and distributor of the Mimi Moto branded stove and Supamoto brand pellet fuel) retails at ZMW 2,950 ($US 175.60) (USAID Zambia, 2021). This cost is 13 times higher than a burner on an LPG cylinder's 235-270 (US$ 14.00-16.07) cost. They have introduced two types of stoves at different prices. The low-cost gasifier stoves cost approximately ZMW 430.25 (US$ 25.61), while the higher-quality ones with clean combustion cost roughly ZMW 1204.7 (US$ 71.70), exclusive of factory cost. Before Covid-19, the company would develop a repayment plan for end-users to pay a monthly fee of between ZMW 60 and 100(US$ 3.57 to US$ 5.95). There was high defaulting, and the company rented the stove to the end-user with the condition that every month they purchase a bag of 30 Kg pellets at ZMW 130 (US$ 7.74).

Renting a stove can range from ZMW 85 (US$ 5.06) to ZMW 65 (3.87), depending on the type of stove. If households are willing to rent a stove at ZMW 82.99 (US$ 4.94), paying in instalments to own the stove can be attractive to the end-user ultimately. The instalment must be the same price as the supplier, maintaining the exact condition of continuous fuel purchase. A bag of 20kg of pellets from Emerging Cooking Solutions retails at ZMW 60 (US$ 3.57) and lasts for about two weeks for full-time cooking in the household. Table 8 below shows other cooking solutions present in Zambia.

Briquettes are primarily used in charcoal stoves and do better in improved charcoal stoves with good aeration, such as the Eco-zoom charcoal stove. However, most briquette solution promoters concentrate on the fuel, not the stove.

TABLE 8: OTHER COOKING SOLUTIONS IN ZAMBIA

Product	Distributor	Retail price (ZMW)
Gasifier pellet stove 	Supamoto, Supermarkets, and retail stores	2950 (US$ 175.60)
Kainos Green Energy ethanol stove 	Kainos Green Energy company	120 (US$ 7.14)

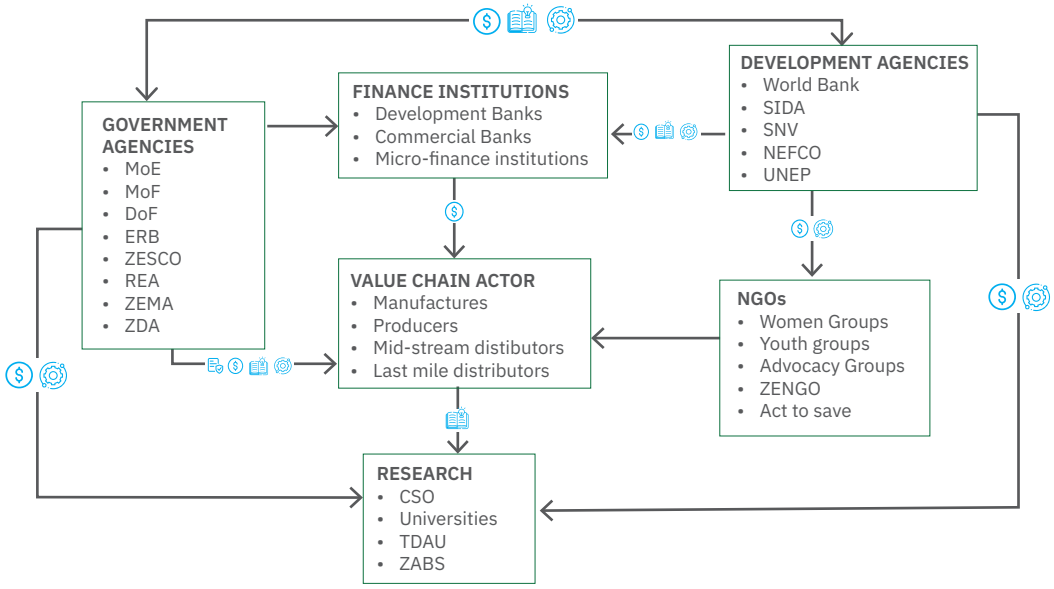


04| Policy, Institutional Framework, and Ongoing Initiatives

4.1 Institutional and policy environment

The network of Zambian cooking sector actors is summarised in Figure 11. These stakeholders include the national Government that develops policy and regulations, development agencies, financial institutions, non-Governmental institutions, and actors in the clean cooking sector.

FIGURE 11
LANDSCAPE OF ACTORS IN THE COOKING SECTOR IN ZAMBIA



ACRONYMS

MoE	Ministry of Energy
MoF	Ministry of Finance
DoF	Department of Forestry
ERB	Energy Regulatory Board
ZESCO	Zambia Electricity Supply Corporation
REA	Rural Electrification Authority
ZEMA	Zambia Environmental Management Agency
ZDA	Zambia Development Agency
CSO	Central Statistical Office
TDAU	Technology Development and Advisory Unit
ZABS	Zambia Bureau of Standards
SIDA	Swedish International Development Cooperation Agency
SNV	Netherlands Development Organisation
NEFCO	Nordic Environment Programme
UNEP	United Nations Environmental Programme
ZENGO	Zambia Energy and Environmental Organization

KEY

- Capital
- Policy and Regulations
- Knowledge and Information
- Technical Assistance and Assurance

The different actors in the cooking sector landscape play a vital role in promoting cooking solutions. These roles include;

- Development of policies, regulations, and strategies to guide the sector,
- Advocacy and information dissemination platforms,
- Source of financing,
- Manufacturing and distribution points for cooking solutions, and
- Funding and implementation of the programmes to promote clean cooking.

Table 9 highlights the role of the Government institutions that influence the energy for the cooking sector.

TABLE 9: ROLE OF GOVERNMENT INSTITUTIONS AND ASSOCIATIONS[8]

No	Name of the institution	Role
1.	Ministry of Energy	• Provide policy and strategic guidance relating to the different energy sources in the country • Promote efficient use and conservation of energy across all sectors of the economy, e.g., LED bulks, efficient cookstoves, and Liquefied Petroleum Gas (LPG) • Mandated with the development of renewable energy sources • Supervises other agencies in the energy sector REA, ERB, Zambezi River Authority (ZRA); INDENI Oil Refinery; TAZAMA Pipelines Limited, and ZESCO Limited. • Buy-in by the ministry of energy is critical to the success of the project in the energy sector by the donor
2.	Ministry of Green Economy and Environment	• Provides policy and strategic guidance related to climate change and forest matters. • Responsible for programs and projects that seek to promote investment in economic activities that are low carbon, resource-efficient, and socially inclusive.
3.	Energy Regulations Board (ERB)	• Develop standards and regulatory frameworks for energy and its products in partnership with relevant stakeholders such as the Zambia Bureau of Standards
4.	ZESCO Limited	• Oversee the generation, transmission, and distribution of electricity on the grid • Promoting the switch to LPG for cooking to ease the burden off the grid.
5.	Ministry of Finance and National Planning	• Budget allocation to the Energy sector • Provides guidance on revenue, e.g., tax waivers, import duties, VAT imposed on cooking solutions • Public debt management
6.	Technology Development Advisory Unit (TDAU)	• Testing stove efficiency and emission and fabricating prototype stoves using local materials. • Promoting alternative cookstoves or parts of and training communities on the production of fuels (esp. biomass related such as briquettes, pellets • TDAU indicated that it would mass-produce LPG cylinders and improved cookstoves if well-equipped
7.	Oil Manufacturing Companies (OMCs)	• The companies (importers/transporters and marketers of petroleum products, including LPG) distribute high-quality petroleum and related products to their retail and wholesale customers • They can play a vital role in growing the distribution channels in Zambia through the opening of Kiosks/containers as distribution points to reduce the last mile distribution distance
8.	Biofuels Association of Zambia	• Providing a platform for information sharing and advocacy on behalf of its members, who are producers and marketers of bioethanol for both transport and cooking
9.	Biogas Association of Zambia	• Providing a platform for information sharing and advocacy on behalf of its members (installers of bio-digesters and promoters of biogas for heating and cooling)
10.	Rural Electrification Authority	• Facilitate availability and access to electricity by all Zambians living in rural areas by extending the national grid and through the installation of isolated grids using renewable energy sources such as mini-hydros, solar, wind, and others

8 These roles are obtained from institutions websites and Key Informant Interviews

11.	Zambia Environmental Management Agency	• Advising Government and the private sector on environmental management and pollution control matters • Licensing undertakings and processes involving wastewater, hazardous waste, Ozone Depleting Substances, and chemicals • Gathering and disseminating information to the public on environmental protection and pollution control • Coordinating the implementation of activities of ministries & other authorities in environmental management
12.	Zambia Development Agency	• Promoting and facilitating investment. • Regulating and facilitating the development of multi-facility economic zones and industrial parks in Zambia and monitoring their performance. • Encouraging public-public, private-private, and private-to-public dialogue • Establishing a database of facilities and promoting accessibility to industry
13.	Zambia Energy and Environmental Organization (ZENGO)	• Training and information dissemination to local communities • Capacity-building activities in communities involve training individuals to construct improved stoves using their local materials, develop and manage a business for the sale of the stoves • Influence and encourage communities to conserve the environment and natural resources management through the development and adoption, and use of Energy efficient techniques • Promote guidance in the field of biomass energy and the Environment in Zambia

i) Global frameworks

Zambia is a party to the following global frameworks

1. The Sustainable Development Goals (SDGs),
2. The Paris agreement, and
3. Sustainable Energy for All (SEforAll).

SDGs are seventeen (17) goals that aim to provide a better future by 2030. SDG 7 is essential to the cooking sector as it seeks to ensure universal access to affordable, reliable, sustainable, and modern energy by 2030.

The Paris agreement focuses on reducing the impacts of climate change by reducing greenhouse gas emissions while limiting the global temperature increase in this century to below 2oC (UNFCCC, 2015). Countries that are party to the agreement must detail their efforts for adaptation and mitigation (including reductions in emissions) in what is termed the 'Nationally Determined Contributions' and regularly report against these commitments. The SEforAll is an initiative that seeks to promote the achievement of SDG 7 while ensuring the objectives of the Paris agreement are adhered to. In line with these global initiatives, Zambia has formulated the following national strategies and reviews.

Zambia SEforAll Action Agenda and Investment Prospectus. The document

1. Sets a baseline and trajectory of uptake of clean, modern cooking solutions;
2. Identifies the gaps in the uptake of clean and modern cooking solutions,

SDG 7 is essential to the cooking sector as it seeks to ensure universal **access to affordable, reliable, sustainable, and modern energy** by 2030.

3. Determines the opportunities in the sector, and
4. Assess risks in promoting clean cooking and mitigation measures, among others.

Zambia submitted its first NDC in 2016 and revised it in 2021. The NDC pledges to reduce greenhouse gas emissions by 25% by 2030 in a Business-as-Usual Scenario (BAU) scenario with limited international support or by 47% (38,000 Gg CO2 eq.) in a scenario with considerable help from the international community. Charcoal and fuel wood are identified as causes of deforestation. Sustainable forest management, sustainable agriculture, and promoting renewable energy and energy efficiency are the three programs promoted as mitigation actions (Republic of Zambia, 2016).

Zambia's Voluntary National Review on Sustainable Development Goals (SDGs) updates the Country's performance against the SDGs (Ministry of National Development Planning Zambia, 2020). Zambia has set an SDG National Coordination Framework, which compiled the SDG baseline indicators to track progress, and performed its first review in 2020.

The first review discussed:

1. The integration of SDGs into national planning,
2. The establishment of an institution for coordinating the implementation of the SDGs, and
3. Identified successes, challenges, and lessons in the implementation of SDGs.

The Government will be conducting the reviews periodically.

ii) Regional frameworks

On a regional scale, central to the energy sector in Zambia is the Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP) for Eastern Africa, Southern Africa, and Indian Ocean Region (REEESAP EA-SA-IO).

The plan will enable investment in the energy sector, particularly renewable energy and energy efficiency initiatives, achieving SDG 7. The renewable energy component will consider

- cooking/heating with alternative fuel sources and technologies and
- (biofuels and blending arrangements and standards.

The energy efficiency component vital to the cooking sector considers

(i) standards, labelling, and testing,

(ii) use of ICS, and

(iii) cooking with alternative fuels such as LPG, biogas, biofuels, and

(iv) charcoal production-kiln designs (COMESA 2020).[9]

The target market is households and industries (both small and large scale)

iii) National frameworks

Various policies and regulations at the national level impact the Zambia cooking sector. These are highlighted in Table 10:

TABLE 10: COOKING SECTOR POLICY, PLANS, AND STRATEGIES IN ZAMBIA

No.	TITLE	HIGHLIGHTS
1	National Energy Policy formulated in 1994.	• Promoting optimal supply and utilization of energy, especially indigenous energy forms, for socioeconomic development in a safe and healthy environment.
2	Poverty Reduction Strategy Paper 2002. (IRENA, 2013)	• Acknowledged the importance of harnessing renewable energy resources, mainly hydropower, to meet the country's energy needs,

9 Renewable Energy and Energy Efficiency Strategy & Action Plan.

3	National Energy Policy formulated in 2008. (Republic of Zambia, 2013)	• Ensuring the energy sector's potential to drive economic growth and reduce poverty is harnessed. • Create conditions that will ensure an adequate energy supply from various dependable sources at the lowest economic, financial, social, and environmental costs consistent with national development goals. • Improving charcoal production and utilisation technology through developing efficient, convenient stoves for users and producing minimal emissions. However, much of the implementation of this policy has been carried out by donor organisations through Improved Cookstove (ICS) projects
4	Sixth National Development Plan 2011-2015. (IRENA, 2013)	• Increase electricity access to 15% in rural areas and 40% in urban areas by 2015. • Provided for introducing a cost-reflective electricity tariff regime, establishing an open and non-discriminatory transmission access regime in the electricity sector, and introducing an appropriate, cost-effective renewable energy feed-in tariff (FiT). • Laid out the framework for developing a Biomass Energy Strategy to improve the sustainability and effectiveness of biomass supply, as well as how to upscale biogas technologies for cooking, lighting, and electricity generation while targeting a 10% biofuel blending mix with petroleum
5	Zambia's Vision 2030 Policy Framework. (Republic of Zambia, 2020)	• The national target of households to be electrified is embedded in Zambia's Vision 2030 policy framework of becoming a prosperous middle-income nation by the year 2030
6	National Energy Policy 2019:	• Promoting cost reflective tariffs, scaling up clean energy technologies and energy efficiency, establishing an open and non-discriminatory transmission access regime, and increasing access to energy services in urban and rural areas.
7	Renewable Energy Strategy and Action Plan (COMESA et al, 2020)[10]	• Investment in energy sources' diversification in Zambia to meet increased demand for modern energy services ensures the country's energy security.
8	Gender Strategy and Action Plan (Green Climate Fund, 2018)[11]	• Promote gender balance in energy issues at all levels. It will ensure that gender mainstreaming in the energy sector has sufficient leadership and resources to be implemented. • Women's decision-making role in the household energy choice
9	Seventh National Development Plan (7NDP) (Republic of Zambia, 2017)	• The country's strategic direction is to improve energy production and distribution for sustainable development. The goal is to ensure universal access to clean, safe, reliable, and affordable energy at the lowest cost, consistent with national development aspirations. • Subsidy energy reforms may be tested to tax charcoal while reducing the cost of and promoting alternative clean or improved cooking energy.
10	Energy Regulations Act No. 16 of 1995. (IRENA, 2013)	• Established the Energy Regulation Board (ERB) as a corporate body whose primary role is to license entities that intend to produce energy.
11	The Electricity Act (IRENA, 2013)	• Provides for regulating the generation, transmission, distribution, and electricity supply.
12	The Petroleum Act (Jon, 2019)	• Provides for importing, conveying, and storing petroleum and other inflammable oils.; including LPG
13	Act of Parliament No. 20 of 2003	• Rural Electrification Authority was formed to undertake the Zambian Government's mission to increase access to electricity in rural areas and electrify 51 percent of the rural regions by 2030.

10 Renewable Energy and Energy Efficiency Strategy & Action Plan Summary Report for Policy Makers.
11 Gender Assessment and Action Plan Zambia Renewable Energy Financing Framework

4.2 Programs

Several programs/activities have and are still taking place in Zambia. Table 11 below provides information on past, current, and expected programs that seek to increase the adoption of cleaner cooking solutions in Zambia.

TABLE 11: LIST OF COOKING PROGRAMS IN ZAMBIA

#	NAME	OBJECTIVES	VALUE	LEAD PARTNERS
1.	ProBEC - Programme for Basic Energy and Conservation (Trickle out Africa, 2015). 2004-2010	ProBEC aimed to ensure that low-income population groups satisfy their energy requirements socially and environmentally sustainable. It targeted the thermal energy needs of rural and urban households, small businesses, and institutions using biomass energy (wood fuel, agricultural residues) for thermal processes. Interventions focused on the demand side and included using energy-efficient devices, profitable production and marketing of these devices, efficient wood fuel use and kitchen management, and substituting renewable energy sources.	-	German Agency for Technical Co-operation (GTZ)
2.	Improved Cookstoves Program for Zambia (Cquest capital, 2022). 2013- to date	Works with Community Markets for Conservation (COMACO) to help install the stoves, half-wall kitchens, and project monitoring.	-	C-quest Capital/ Community Markets for Conservation (COMACO)
3.	TASC clean cooking POA – VPA 1 Zambia 2020 to 2025 (TASC, 2022)	The project's goal is to distribute improved cookstoves in households in Zambia. The program is being implemented in communities where wood fuel is the primary energy source for cooking, and open 3-stone fires are commonplace. The program aims to distribute 45,000 ICSs by April 2021.	-	The African Stove Company Limited. (TASC)
4.	Alternatives to Charcoal (A2C) (USAID Zambia, 2022) 2021 to 2026.	It aims to reduce deforestation related to the production of charcoal. A2C takes a market-driven approach to this challenge by catalyzing a shift in household cooking from charcoal to private sector-led, low-emission technologies and fuels. In partnership with several line ministries in the Zambian Government, it hopes to affect this behaviour change by reducing market barriers to scale up clean cooking, strengthening the business-enabling environment, and leveraging investment in alternative fuels and technologies to protect Zambia's precious forest resources.	US$ 24.9 million	ARD Inc. (TetraTech)
5.	Zambia Biomass Cookstove Project (UpEnergy Group,2022) (GS id 11007) 2021 onwards	It brings efficient biomass stoves to urban and rural communities across Zambia. Leveraging UpEnergy's carbon-financed smart distribution platform, it can sell SmartHome cookstoves at affordable prices, invest in social marketing, and develop robust distribution channels that boost the local commercial ecosystem.	-	UpEnergy

6.	Energy For Agriculture (E4A) (SNV,2021). 2015 to 2019	The project helped develop the biogas market in Zambia to increase access to renewable energy for households, public services, and businesses. The project supports the development of viable biogas markets, improving livelihoods through increased fuel savings and income generation.	EUR 6.5 million	SNV
7.	Scaling of Clean Cooking Solutions programme (NEFCO,2020).	The first phase is to conduct a detailed scoping in Zambia, looking into ways to test Results-Based Financing (RBF) to incentivise the development and sales of innovative clean cooking solutions at scale. A design phase will follow this phase.	EUR 480,000 for Zambia	SIDA and Nordic Environment Finance Corporation (NEFCO),
8.	Modern Cooking Facility for Africa (NEFCO,2022)	The Modern Cooking Facility for Africa aims to provide over 3 million Africans access to clean cooking solutions, improving overall health and increasing economic growth. The MCFA will do this by financially incentivising Cooking Service Providers to engage in the business of offering affordable, high-quality, and energy-efficient clean cooking services and thereby accelerating the creation of a long-term sustainable market.	EUR 13.8 million for Zambia	SIDA
9.	Zambia Integrated Forest Landscape Project (The World Bank,2022). 2017-2022	To improve landscape management, increase environmental and economic benefits for targeted rural communities in the Eastern province, and improve the recipient's capacity to respond promptly and effectively to an eligible crisis or emergency. Among other things, the program distributed fuel-efficient cookstoves as an intervention to reducing deforestation.	US$ 32.80 million	The World Bank
10.	Clean Flame Fund (Michael, 2022)	This grant program will help commercialize pellet gasification cooking in Sub-Saharan Africa. The fund will make targeted grants to support up to five pellet gasification firms across sub–Saharan Africa to reach commercial scale and profitability.	US$ 15,000	Heza
11.	Bioenergy and Food Security (BEFS) Assessment and Capacity Building for Zambia	This program enhances the national capacity to identify sustainable bioenergy supply chains and analyse existing options for developing a sustainable bioenergy sector in Zambia. Among other things the program provided training on BEFS approach and tools to enable the country to understand what is required to develop sustainable bioenergy supply chains.	-	Food and Agriculture Organisation

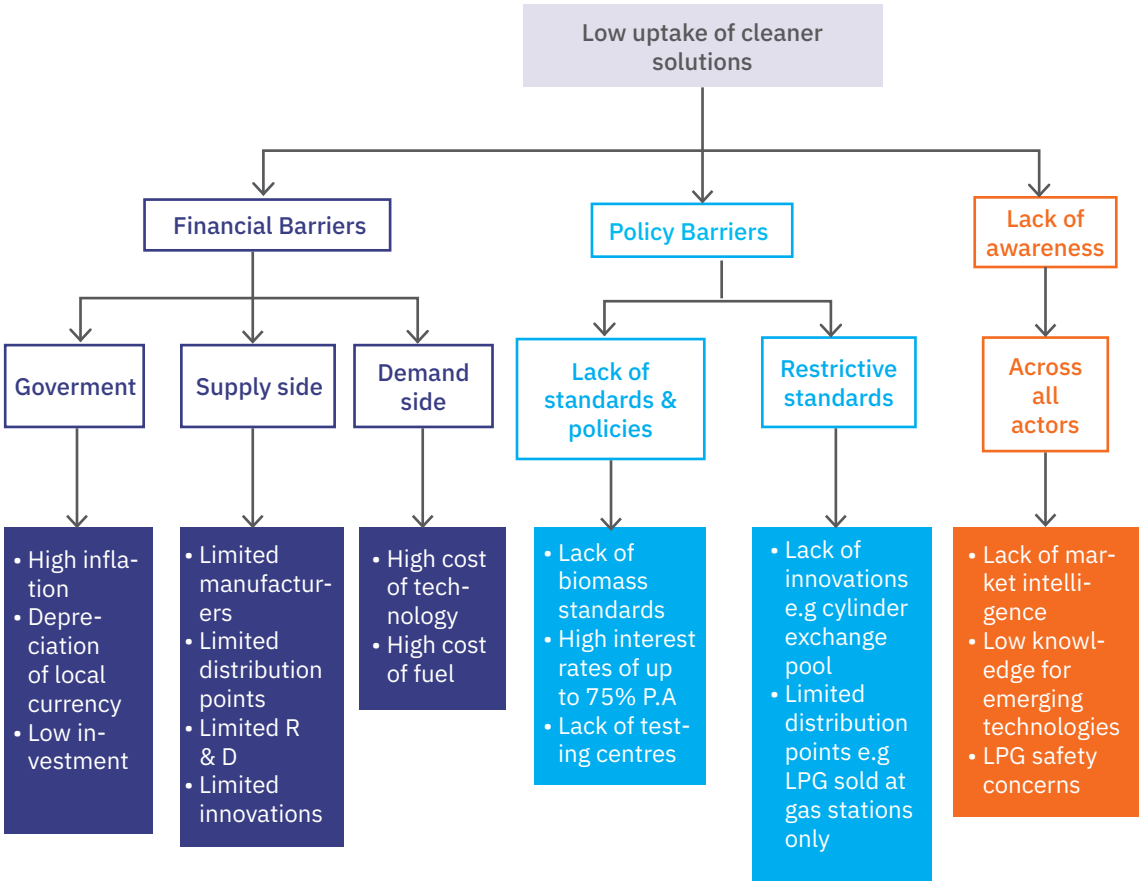
05| Pathways to Clean Cooking Solutions

This chapter analyses the barriers and the energy for cooking market opportunities and estimates the market size for cooking solutions and characterization. In the market characterization section, households using specific cooking solutions are analysed to identify trends that will inform solutions to the barriers identified.

5.1 Barriers to clean cooking in Zambia

The barriers to Zambia's clean cooking are summarized in Figure 12 below.

FIGURE 12
SUMMARY OF BARRIERS IN ZAMBIA'S COOKING SECTOR



5.1.1 Financial barriers

From the demand side, the critical factor is affordability, the initial cost of the stove, and the recurrent fuel expenditure. The initial price of Improved Cookstoves (ICS) is high and out of reach, especially for low-income households. For instance, the initial cost of purchasing an LPG cylinder and stove, and the recurrent cost of refilling are considered high compared to electricity and more expensive than charcoal (Elisa et al. 2020).

> For example, the ***mbaula*** stove goes for ZMW30-35 (US$ 1.79-2.08) compared to the ceramic charcoal stove that goes for ZMW 500 (US$ 29.76), and the 6 kg LPG cylinder goes for ZMW 799 (US$ 48.42), and the 13 kg goes for ZMW 1,320 (US$ 78.57) (inclusive of deposit) and the refill at ZMW 420 (US$ 25.00)[12]. The willingness to pay data shows that when prices increase, fewer people are willing to purchase an ICS, with 60% of the households willing to pay ZMW323 (US$ 18.77) compared to 51% willing to pay ZMW980 (US$ 58.33) (Lucia et al. 2019).

During the Focus Group Discussions, respondents indicated that they do not have regular sources of income; therefore, the high cost of clean cooking solutions directly impacts household savings. A high inflation rate compounds the high price of cooking solutions at 17.4% in 2020 and the Kwacha depreciation (AFDB, 2021).

From the supply side, high capital expenditures are required to set up a factory, create consumer awareness, and distribute product distribution channels. Limited access to capital by enterprises for business development is a significant barrier. Enterprises noted that local banks charge high-interest rates or ask for high-value collateral as security for the financing. Macro-loan (ZMW 20,000 to ZMW 1 million; US$ 1,190 to US$ 60,606 and micro- loan (ZMW 5,000 to ZMW 20,000; US$ 298 to US$ 1,190) can attract interests as high as 55% and 75% per annum.

Although loans offered in $USD accrue a low-interest rate of 13% per annum, it is noted that this is still high for businesses to remain profitable. Some financial institutions have a high-ticket size for their minimum loan threshold, which locks out small enterprises. For example, the minimum loan from the Development Bank of Zambia is ZMW 1 million (US$ 59,523).

Also, banks and Micro Finance Institutions in Zambia have limited information on the market and the risks involved in the Improved Cookstoves business and therefore are hesitant to lend to such enterprises. Access to grants from development agencies is challenging due to the relatively long and complex application process and contract terms and conditions to be met before obtaining a grant—high-interest rates coupled with the increasing cost of fuel translate to higher prices for the end-user.

5.1.2 Awareness barriers

There is a lack of awareness of cleaner forms of cooking solutions such as pellets, briquettes, ethanol, LPG appliances, and improved cookstoves in Zambia (Alessandro et al. 2021). Consumers are unaware of these options and how they can meet their households' cooking needs and therefore are slow to adapt to such solutions. For LPG, most participants have misconceptions that it is dangerous due to the risk of explosion. Training consumers on the usage of LPG appliances would likely help clear the misunderstanding and enhance the adoption of LPG cooking solutions.

During the Focus Group Discussions, participants noted that people might not know the long-term health effects of exposure to polluting fuels or the savings from using the efficient cooking solution. Access to such knowledge would encourage a higher adoption rate for clean cooking. In general, large-scale awareness-raising and behavioral change campaigns should be conducted to ensure the long-term adoption of clean cooking solutions.

12 Key Informant Interviews

5.1.3 Supply chain barriers

Unreliable or unavailable last-mile distribution hinders the uptake of clean cooking solutions. The charcoal distribution chain is exceptionally efficient, making charcoal much more accessible to the end-user than LPG, mainly sold in filling stations in Zambia and therefore inaccessible for consumers far from refilling stations. Distances travelled to purchase or reload a cylinder could deter end-users. The closure of the Indeni oil refinery has contributed to increased costs of LPG due to the high costs incurred by Oil Marketing Companies importing the finished product from other countries. Over the last three years, prices of LPG have been on the increase in Zambia. A kilogram of LPG was retailing for ZMW 17 (US$ 1.01) on average, which increased to ZMW 24 (US$ 1.43) in 2020 and ZMW 36 (US$ 2.14) in 2021 (USAID Zambia, 2021). This price increase has made it hard to attract new LPG users and has led some existing ones to stop using LPG for cooking.

There are also limited suppliers for emerging cooking solutions such as briquettes, pellets, and ethanol. Some of these suppliers have been on and off the market due to low margins from low sales of their products. Lack of finance also inhibits research by the manufacturers of the cooking solution to assist in incorporating user insights into the design of their cooking solutions and distribution channels.

5.1.4 Policy barriers.

Although the Zambia Energy Policy (2019) highlights strategies for promoting Improved Cookstoves (ICS), an implementation plan for the proposed strategy and a regulatory framework for the cookstoves in the market are lacking. The ICS sector does not get as much attention as hydropower, coal, and renewable energy sources. The lack of internationally recognized standards (e.g., biomass solutions standards) and limited testing capabilities of cookstoves in the country is a significant barrier to scaling up the adoption rates. This would be important for certification to validate the efficiency and emission reduction claims of the ICSs. In addition, donor-funded initiatives insist on proof that the ICS is supported to impact health- e.g., Beyond the Grid Fund Zambia, which is difficult to demonstrate without testing centre[13]. An on-going study on laboratory testing assessment estimate that the set-up cost for a testing laboratory ranges between US$ 37,000 and 230,000. The cost covers equipment purchase and capacity building of the staff. One of the setup cost determinants is the testing laboratory's goal. The cost is lower if the goal is to test stoves using the existing protocols compared to a laboratory that provides research and development services. The laboratory also has to cater to the annual costs of running, maintaining qualified staff, and ensuring constant demand in a market that lacks diversity in cooking solutions. However, there exist challenges in setting up a testing laboratory in Zambia, the benefits outweigh the costs involved.

The current National Energy policy 2019 is the only policy that addresses biofuels, not as a cooking fuel but for blending with gasoline for the transport sector (Republic of Zambia, 2019). Standards for ethanol as a cooking fuel do not exist in Zambia; and only standards related to bioethanol as a blending fuel exist. Only recently (May 2022), the ERB drafted standards for bioethanol for cooking and their associated appliances (ERB Zambia, 2022). Additionally, the current policy treats ethanol as a product for making alcoholic beverages. As a result, ethanol for cooking attracts the same exercise duty as ethanol for beverages (previously 125%, now revised to 60%).

These taxes increase the retail price of bioethanol, making it unaffordable to end consumers. Zambia has no policy on the exchangeability of LPG cylinder brands at retail outlets. Consumers can only refill or exchange their cylinder at depot licensed outlets which bear the brand of the cylinder to be exchanged/refilled (USAID Zambia, 2021). Introducing a cylinder exchange pool would make LPG more accessible to consumers. However, for this to be effective, there will be a need for standard LPG cylinder exchange guidelines with instructions on checking for damaged cylinders and other safety requirements that need to be met before another brand accepts the cylinder.

13 Key Informant Interviews

5.1.5 Research and Development

The most popular charcoal stove is the *mbaula* charcoal stove, a traditional metallic stove perforated on the sides. The stove was introduced in the 1980s and still has a low energy efficiency of 10% (Azel, 1989). It is noted that not much has gone into improving the model to have more improved options. In the 1980s, the University of Zambia had worked to improve the models, but not much has been done since to improve the mbaula stove.

There are a few ceramic charcoal stoves in the market. There were concerns about the durability of these ceramic varieties compared to the mbaula. Spilling water on the ceramic charcoal stove damages the stove (cracking the ceramic part) and requires a specialist to repair the clay lining. With technical and financial support Technology Development Advisory Unit (TDAU) can develop better-improved models of the mbaula and ceramic charcoal stoves.

5.1.6 Gender-specific barriers

Financial difficulties were identified as a critical barrier,with income distribution disproportionately skewed income distribution towards men. Therefore, in most households, men's views on cooking solutions will inevitably affect the cooking practices in the house even though they are less involved in the cooking. Analysis of the MTF data indicates that LPG (costly options) are in male-headed households only. It was also noted that 83% of male-headed households were willing to pay the total price upfront of an ICS stove compared to 17% of female-headed households. Female-headed households are more likely to use a biomass stove (charcoal and wood) at 69.9%, compared to male-headed households at 65.4%. See more details on the gender of the household Vs. type of cooking solution under section 5.4.1 The Focus Group Discussions participants also noted that lack of a monthly income hinders females from taking loans or buying instalment cooking solutions. This information indicates that access to finance is a crucial determinant for access to clean cooking in Zambia for female-headed households[14].

Women were also perceived to be less willing to try modern cooking solutions (especially LPG) than men. This may stem from safety concerns, where women are more likely to avoid risky options. Therefore, the awareness campaigns should primarily target women as this approach has the potential to provide the highest impact returns. From a business perceptive, access to finance was identified as a general barrier but more acute to women-led enterprises. The requirement of collateral is also a significant hindrance to acquiring loans. However, some financial institutions, such as Development Bank Zambia and Entrepreneur Financial Centre, have loan products specific to women with fewer conditions, such as fixed collateral.

Women in Zambia are involved in table banking groups through the village and workplace banking groups. Once one has paid a membership fee, they agree to contribute a specific amount of money on specified days of the week. Members can then take a loan from the consolidated funds at a much lower interest than banks. The groups can be avenues to scale up Improved Cookstoves (ICS) micro-lending, given their ability to reach different low-income segments.

Upfront cost (particularly for LPG) is a crucial barrier to adopting ICS. Lack of reliable fuel supply, distance from the point of sale, and ignorance of operating these stoves affect ICS adoption and sustained use. Through these table banking groups, distributors can reach and supply ICS products massively, cutting operational costs of targeting and delivering products to a single person.

The mbaula charcoal stove was introduced in the 1980s and still has a low energy efficiency of **10%**

14 A female-headed household is a household where a female is the bread winner and makes most of the decisions. In most cases the husband is deceased. In other cases the parents are deceased, and the eldest child is a daughter who takes the role of leading the household.

Female-headed households are more likely to use a biomass stove (charcoal and wood) at

69.9%,

compared to male-headed households at

65.4%

5.2 Emerging opportunities

5.2.1 Innovative business models

Clean cooking enterprises continue to be innovative with their business models to penetrate new markets and attract financing for businesses. Some of the innovative business models in the clean cooking sector in Zambia include.

- **Full vertical integration model.** In this model, the company owns the supply chain activities and controls other business operations, increasing its market share and lowering transaction costs (Richard et al. 2017). In Zambia, one enterprise that has adopted a fully integrated fuel production and stove and fuel distribution model is Supamoto. This model offers many advantages in that enterprises have maximum control over all phases of a business, including fuel supply and one-on-one interaction with the end-user.

- **Business to Business (B2B) operating model**. In this model, clean cooking enterprises focus on marketing the fuel instead producing or distributing the fuel (Richard et al. 2017). One B2B operating model that relies on digital technology at the pilot stage is the GasItApp, a mobile application running on Android and IOS mobile devices. This mobile app allows customers to order LPG and LPG-related appliances and accessories. Also, customers can request a technician to come to their homes for gas installation. The app also allows one to input their current location via google maps to ensure easy access by delivery personnel (USAID Zambia, 2021).

- **Cookstove integration model.** This is a standard business model, especially for biofuel distributors, where they sell cookstoves in addition to fuel. One such company is Kainos Green Energy, which produces ethanol for cooking and produces ethanol cookstoves to sell to consumers.

The choice of pricing model varies among distributors; some of the distribution and pricing models include: providing the consumer with a stove at no cost or at a subsidized rate to encourage uptake and use of fuels; retailing the stove at the total price paid in advance by the consumer; provide instalment payments until the cost of stove is fully paid; or offer the stove at no cost with the stove belonging to the enterprise. Subsidizing cookstoves aims to secure a stable revenue stream from fuel sales.

Table 12 summarises the various global clean cookstoves production, distribution, and marketing models that will inform the proposed approaches for the programme design.

TABLE 12: PRODUCTION, DISTRIBUTION, AND MARKETING MODELS FOR CLEAN COOKSTOVES (SNV, 2015) IN ZAMBIA

#	MODEL	GENERAL FEATURES
1	Production	
	i. Industrial model	• In-house research and development. • High degree of mechanisation. • It may involve cross-regional manufacturing. • Extremely cost-intensive, requiring large-scale initial and operational capital. • An example is Emerging Cooking Solutions (Supamoto)
	ii. Semi industrial model	• Less mechanised compared to the industrial model. • Workshop-based production. • Assembly is hand-done using standardised designs, tools, and processes. • An example is Kainos Energy
	iii. Artisanal model	• Cookstoves are produced locally by small enterprises and artisans. • Production is limited. • Distribution and after-sales services are easier since most producers are part of the local communities. • Examples are tinsmiths for mbaula charcoal stove

2	Distribution		
	i.	Village-level entrepreneur model	• Utilises local resources to distribute clean cookstoves and fuels within their localities. • Low investment costs • Low costs of last-mile distribution • Allows enterprises to factor in insights from their customers. • Limited customer base, therefore limited opportunities for product diversification. • To scale up, this model requires financial support to build its capital and limit their financial risk
	ii.	Piggyback model	• Suitable for markets with low demand for ICS. • ICS companies partner with local organisations, e.g., community-based organisations, supermarkets, MFIs, etc. • Leverage on existing networks of such organisations minimises costs of last-mile distribution infrastructure. • Market limited to a market size of partner organisations.
	iii.	Proprietary sale network model	• This is a direct sales model. • Establishing new distribution networks, including transportation, hiring, and training sales personnel, and building physical infrastructure, e.g., warehouses, to serve target customers. • The company has complete control of the distribution network. • It is the most expensive model to set up and run due to the high upfront capital requirements. • Effective distribution model to push for new products and offer after-sale services.
	iv.	Renting stoves	• Supamoto pellet stove distributors are rolling this model out. • Households are given a stove for use, provided every month they purchase a 30 Kg bag of pellets • Renting a stove can range from ZMW 85 (US$ 5.06) to ZMW 65 (3.87), depending on the type of stove. • 30 Kg pellets at ZMW 130 (US$ 7.74)
3	Marketing		
	i.	Influencer endorsement	• Utilise influencers (a person with the ability to influence potential buyers of a product or service by promoting or recommending the item) for endorsement of the company's products. • In rural areas, village elders or village chiefs act as influencers. • In urban markets, local celebrities may be used as influencers.
	ii.	Manufacturing initial demand	• Create demand by giving away free product trials accompanied by promotional activities to increase visibility • Demonstrations and tutorials on how to use clean cookstoves and their benefits.
	iii.	After-sales support	• Effective in ensuring customer retention to build the brand and boost demand. • After-sale services such as warranty periods can increase consumer confidence among first-time buyers.
	iv.	Above-the-line marketing	• Utilises indirect marketing approaches such as adverts on radio and television. • It is appropriate in urban areas where customers are concentrated, and their content consumption through such media is high. • Expensive but effective in creating general awareness of a product.
	v.	Below-the-line marketing	• Utilises direct communication to increase product awareness. • Such techniques include word of mouth and door-to-door product promotion.

Several market development and innovations in the clean cooking sector have been established. These include:

1. **Pay as you cook business models/ smart metering systems;** Smart meters allow consumers to purchase LPG in small volumes. This innovation seeks to resolve the affordability barrier that consumers who cannot pay for the stove's upfront cost face. This model offers households the payment flexibility needed to maintain clean cooking when income is low. Apart from improving affordability by lowering the upfront cost of LPG, most pay-as-you-go LPG companies also offer home delivery services for LPG cylinders that are made efficient through accurate time tracking of LPG consumption. Home delivery of LPG cylinders removes the burden of getting refills every time the gas runs out (Matthew et al. 2021). The model is already working in Kenya and Tanzania, where users pay a small amount for the initial installation of a stove. Using mobile money, they can purchase cooking gas for any amount (e.g., Mpesa in Kenya). Similar models are also in Latin America, where payment is through electronic payment systems. The PAYG model is also being tested in pellet stoves such as SupaMoto's stove, which has an integrated, cloud-connected smart card that allows subscribers to 'pay-as-you-go' with mobile money to activate the stove's internal fan.

2. **Stove renting.** Because of the high defaulting rates, some clean cooking companies such as SupaMoto have introduced a stove renting model on the condition that consumers purchase a 30kg pellet bag every month. The model allows the company to gain revenues from selling pellets rather than selling stoves. This also reduces the upfront cost of purchasing a stove which can be a barrier to adopting pellet stoves.

3. **Vending Machines for clean cooking fuel.** This model of vending cooking fuel has been applied for ethanol, where fuel dispensing vending machines are strategically located across towns. These machines provide fuel in small quantities for daily cooking. Through these machines, the barrier of accessibility and affordability is minimized. One such company employing this model is Koko Networks (Standard Group, 2022).

4. **Composite cylinders are a recent development.** For many years LPG cylinders have been manufactured in steel material in different sizes and with varying sizes of valves. The steel LPG cylinders have various limitations like handling, risks of bursting, rust, and leakage issues (Biradar, 2017). One alternative to carbon steel cylinders is composite cylinders from advanced polymeric and composite materials (Hexagon, 2020). Composite cylinders are lighter, explosion-proof, corrosion-free, and have a translucent body that helps customers check the LPG level accurately (CCA, 2020). The price gap between composite and steel cylinders has decreased over the years making composite cylinders an attractive alternative to steel cylinders (World LP Gas Association, 2013).

5. **Cylinder exchange;** Under the LPG exchange scheme, consumers can swap one brand of LPG cylinder for another at any LPG supplier. The scheme has been implemented in Kenya. The resellers and dealers must sell LPG standardized cylinders fitted with standard safety valves. This scheme promotes price competition by enabling consumers to exchange cylinders at any retail station. On the other hand, retailers must return cylinders not bearing their brand to a centralised location where they exchange with cylinders bearing their brand. Each retailer is responsible for maintaining its cylinders (Van den Berg 2018).

6. **Flexible refilling;** refill points/kiosks allow flexibility in the amount of gas purchased. This approach is common in Zambia and can reach more consumers if Oil Marketing Companies are allowed to refill cylinders that do bear their brand.

7. **Informal women financing groups.** Groups of women organized in informal financing groups have been noted to be essential in assisting women in accessing technologies that may otherwise be unaffordable. Members in these groups co-guarantee each other and save to buy household equipment (Hsu et al. 2021).

5.2.2 Carbon finance

Carbon financing refers to funding acquired through the sale of carbon credits. To claim carbon credits, an enterprise must be registered in the compliance or voluntary market. The credits can be earned by companies involved in clean cooking by reducing the CO^2 released compared to a baseline figure. The credits can then be sold to companies to offset their carbon emissions. The two ways that improved cookstoves can reduce the amount of CO^2 being released into the atmosphere are by reducing CO^2 emissions through improved combustion efficiency and decreasing non-renewable sources' use. Reducing CO^2 translates to minimising climate impacts and, in turn, generates carbon credits that can be used to compensate for emissions discharged elsewhere (Freeman and Hisham, 2015).

Carbon credits offer the chance to support projects with financial incentives and operational guidelines. In the past few years, carbon crediting has grown in popularity. By 2020, over 60 carbon pricing initiatives and more than 14,500 registered crediting projects will be implemented internationally across all industries (Stritzke et al. 2021). Carbon finance is often commended as a beneficial way to stimulate penetration of imroved cookstoves in the market and facilitate adoption at the household level and growth in the sector.

However, carbon credit financing in the clean cooking sector has been strained because of price volatility, complex procedures, and high certification expenses, making it difficult for companies to apply for them. In 2021, carbon markets were unsustainably low at US$3-5 per tonne of CO^2 and needed to increase significantly if they have to have an environmental impact. With an expected increase in voluntary carbon market demand, average prices could rise to US$20-50 per tonne of CO^2 by 2030. This will spur investments in new projects to reduce emissions (Turner et al. 2021).

The change from the Kyoto Protocol to Paris Agreement has had implications on the market activity, including the voluntary carbon markets. The Paris Agreement introduced a cross boarder market-based framework and a new crediting mechanism similar to Kyoto's Clean Development Mechanism. To ensure the continued integrity of the credits generated, issued, and used, the voluntary carbon market must align with the new context under the Paris Agreement. Principles forming the foundation of quality of carbon credits, such as additional and conservative baseline settings, are affected by the Paris Agreement. Therefore, existing criteria across the voluntary agreement market will need reviewing. Since these adjustments are likely required, countries may face challenges when developing a strategy for negotiating the clean development mechanism transition (Asia Development Bank, 2021).

Discussions with clean cooking companies in Zambia, especially the small-sized companies revealed that the challenges faced when applying for carbon finance was the complicated application process, which took a long time and required technical know-how they did not possess.

5.2.3 Finance institutions

Commercial banks and Microfinance institutions (MFIs) are the primary sources of finance for enterprises and consumers in the clean cooking sector. Two types of financing are involved in the clean cooking sector, i.e., enterprise and consumer financing. Enterprise financing allows clean cooking distributors/manufacturers to support their operations, especially during the early stage through loans (Ablorh, 2019). Consumer financing is a loan provided by a commercial bank, the company itself, or a retail outlet to a customer to purchase a cookstove.

They might otherwise be unable to raise the upfront cash to buy a clean cookstove (Shrimali et al. 2011). Another form of financing is from development financial institutions. Several development agencies, such as SIDA, USAID, and The World Bank, are known to provide funding to the clean cooking sector in Zambia.

The effectiveness of these financing models in achieving clean cooking solutions has been suboptimal. Microfinance institutions mostly invest in income-generating assets as opposed to consumer goods, notwithstanding that improved cookstoves are likely to result in savings for the consumer due to their fuel-efficiency (Bailisi et al. 2009). This limits consumers' ability to purchase ICSs. For enterprise financing, access to loans is limited due to challenges of collateral requirements and high-interest rates (World Bank, 2011).

During an interview with an MFI, they reported considering lower loan ticket sizes {ZMW 5,000-20,000 (US$ 297.62-1,190.48} borrowed by enterprises as risky due to high defaulting rates. As a result, they attract high-interest rates of up to 55-60% per annum and can go as high as 75% per annum. For large ticket size loans, {ZMW20, 000-1,000,000 (US$ 1,190.48- 59,523.81)} interest rates are at 55% per annum. The manufacturers/ distributors of ICS interviewed noted that Zambian Banks charge high-interest rates for loans. Therefore, they prefer other funding sources other than bank loans.

5.3 Role of smart financing

5.3.1 Enterprise financing

The funding landscape for clean cooking has evolved significantly over the last couple of years. Historically, most companies have relied on selling cookstove appliances alone for revenue generation. Recently, this has changed, and cookstove enterprises retail both the appliance and related fuel to make the cooking needs of low-income households cost-effective while increasing revenue generation for the enterprise (Stritzke et al. 2021). However, despite all developments in the business models, access to finance remains the most significant barrier for companies in the clean cooking sector (Bricknell et al. 2022). As a result, companies have been sourcing external funding from different financiers such as Development Finance Institutions (AFD, DEG, EEP, United Nations Capital Development Fund), Private Investors (private equity funds, venture capital funds, angel investors, debt funds, banks), Crowdfunding Platforms (trine, kiva, betervest), Government entities, programs and initiatives (Beyond the Grid Fund, USAID, KOSAP, Innovate UK, Innovation Norway, US EPA) and Foundations (Shell Foundation SNV, Clean Cooking Alliance, Lundin Foundation).

The funding is in the form of equity, debt, and grant. According to The Clean Cooking Industry Snapshot Report, between 2017 and 2019, the private sector (private equity, venture capital, and angel investors) invested USD114 million in clean cooking enterprises, representing 75% of the total funding. The next source of financing was from Development Financial Institutions (multilateral and bilateral) with 9%, followed by direct Government sources with 8%, foundations with 5%, and crowdfunding with 2% (CCA, 2021).

Regarding funding among the cookstove subsectors, over half of the capital from 2017-to 2019 went to LPG and biomass cookstove subsectors, with biogas, ethanol, and pellet & briquette following in that order. Much of the funding raised between 2017 and 2019 went to companies serving urban and peri-urban populations (43%), while 21% went to companies servicing rural customers and 36% to companies serving urban and rural areas. Regional-wise, 75% of overall capital raised went to companies with operations in East Africa during the three years.

5.3.2 Consumer financing

The type of consumer financing options can significantly influence willingness to pay and adopt improved ccokstoves and fuels. While some households may be able to afford the costs of cookstoves because they have disposable income to transfer their expenditure on polluting fuels to cleaner alternatives, many low-income households cannot afford the upfront cost of modern cooking technologies.

The Clean Cooking Industry Snapshot Report, between 2017 and 2019, the private sector invested **USD114 million** in clean cooking enterprises, representing **75%** of the total funding; Development Financial Institutions **9%**, followed by direct Government sources with **8%**, foundations with **5%**, and crowdfunding with **2%**.

To overcome this price barrier, several end-user financing mechanisms have been established. These include:

- **Installment payments:** Allowing consumers the option to pay for the stove or fuel over a period of time – weeks or months. The disadvantage is that, especially for distributors with inadequate cash, the instalment payment model ties up essential working capital that would have otherwise been directed towards buying new stock or other daily business operations.

  Additionally, this payment model comes with administrative costs such as carrying out customer background checks which may raise the stove cost when factored in.

- **Pay-as-you-go (PAYGO):** This is a consumer finance model that relieves the upfront price barrier of the cooking kit by allowing consumers to pay a deposit or none at all, followed by reasonably priced instalments over time. Enterprises can use their PAYGO model for end-users (business-consumer model) or offer their PAYGO solution to intermediaries (business-business model). PAYGO model includes the following features: the enterprise rents/sells the end-user a cooking kit; the end-user makes payments on a daily, weekly, or monthly basis using mobile money or other means; the enterprise tracks customer payments and can remotely enable or disable the cooking kit if a customer tops up or falls behind on payments. In addition, the distributor repossesses the cookstove if the customer defaults on their payment since the cooking device are remotely managed with fuel/ electricity tracked by smart meters, allowing for arrangements to be made by the business to dispatch refills to customers before it runs out.

- **Micro-Finance Institutions (MFIs):** Affordability is a critical constraint in adopting and sustaining the use of clean cooking technology and fuel (Pye et al. 2020). The microfinance sector includes various formal and informal institutions, including regulated microfinance banks (SACCOs), informal money lenders, credit associations, and rotating savings groups (where individuals contribute an agreed amount of money regularly while one member withdraws the funds at each meeting). Typically, their clients are low-income customers who are unable to access commercial financing. Microfinance intervention in the clean cooking sector has been shown to increase the adoption of clean cookstoves given their ability to reach different low-income households and their nationwide presence and by mitigating the upfront cost of cookstoves by offering manageable loans (Hsu et al. 2021).

  A Census of Financial Cooperatives in Zambia indicates 749 cooperatives (55%-SACCOs, 36% multi-purpose cooperative, 8% agriculture, and 1% other) with 93,036 members. Lusaka and Copperbelt provinces accounted for 66% and 1.6% of the membership, respectively (Mulenga, Bwalya, and Mwenge, 2020).

5.4 Market sizing and characterization

This section aims to determine the demographic characteristics and habits of clean cookstoves appliances and fuel consumers and identify the motivational factors for consumption. Raw data analysis of the Multi Tier Framework (MTF) (see methodology explanation under section 2.5) has informed this report section. According to the MTF data, charcoal is the predominant primary cooking fuel in Zambia's urban areas at 60.6%, followed by electricity (33.1%), wood (5.8%), LPG (0.2%), and 0.24% accounting for others (solar, sawdust and piped gas see Table 13).

TABLE 13: PRIMARY COOKING FUEL IN ZAMBIA'S URBAN AREAS

No.	Fuel	Percent	Population	Households
1	Charcoal	60.6	4,425,494	941,594
2	Electricity	33.1	2,419,815	514,854
3	Wood	5.8	425,093	90,445
4	Others (solar, sawdust, piped gas)	0.24	17,530	3,730
5	LPG	0.2	16,069	3,419
	Total	**100**	**7,304,000**	**1,554,043**

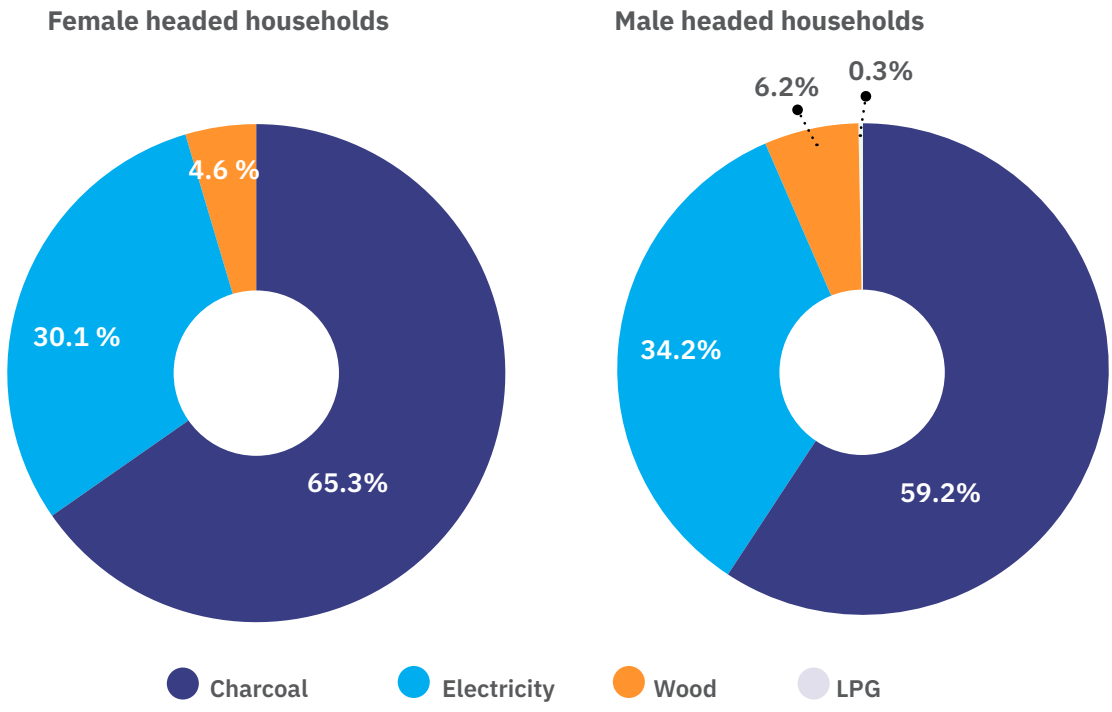
The average household size is estimated as 4.7 persons (Zambia Statistics Agency, MoH and ICF 2019), and the average was used to calculate the fuel use per household. The population is estimated at 16.6 million households, with 44% living in urban areas (Lucia et al. 2019). From the above analysis, approximately one million urban households will need to transition to cleaner cooking solutions. Discussions from the Focus Group Discussions and literature review indicate that the solution should be affordable (fuel and stove), easily accessible and always available, and generally accepted by households (no safety concerns) (Mulenga et al. 2019).

5.4.1 Primary cooking solution vs. gender of household head

There are more male-headed (76%) households than female-headed households (24%) in Zambia's urban areas. All (100%) of households using LPG are male-headed. Female-headed households are more likely to use a biomass stove (charcoal and wood) at 69.9% compared to male-headed households at 65.4%, as shown in Figure 13 below. The high usage of LPG among male-headed households could be explained based on the dialogues at the Focus Group Discussions, where men were more willing to try newer technologies than women and were more likely to have higher income sources.

FIGURE 13

FUEL USE BY GENDER OF THE HOUSEHOLD HEAD (URBAN CENTRES) IN ZAMBIA



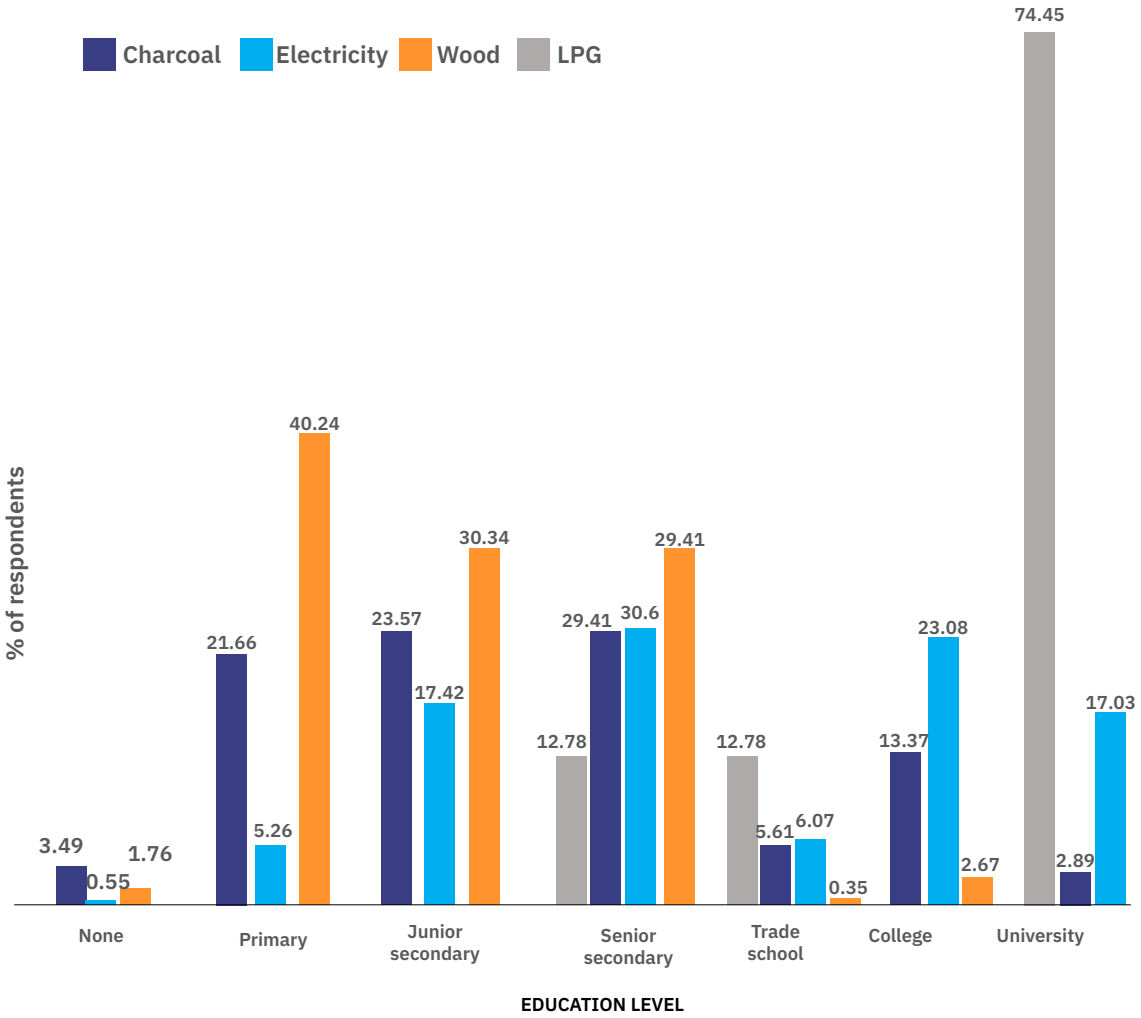
5.4.2 Primary cooking solution vs. education of household head

Education is highly linked with increased adoption of health-promoting interventions, including cleaner cookstoves (Hahn, Robert and Benedict 2015). Higher levels of education can lead to increased chances of securing employment and reduce poverty levels that can negatively impact health (Ross and Wu, 1995). Results from this analysis (Figure 14) indicate that household heads with a higher level of education majorly use LPG. 74% of participants with university-level education use LPG compared to 2% using charcoal and 17% who use electricity. None of the university-level participants used wood for cooking.

Household heads with no level of education have very low usage of charcoal (3%), electricity (0.5%), wood (2%), and LPG (0%). This could be because they use other forms of traditional fuels, such as crop residue and cow dung. A higher level of education is strongly correlated with a higher income level, so this is not necessarily a choice based on greater awareness but rather the level of disposable income. This suggests that low levels of education can be an indicator to guide the targeting of demand-side financing options (e.g., demand-side subsidies).

Figure 14

DISTRIBUTION OF FUELS USED BY THE EDUCATION LEVEL OF THE HOUSEHOLD'S HEAD



5.4.3 Expenditure quantile vs. primary cooking solutions

Affordability (upfront stove and recurrent fuel cost) hinders households from using clean cooking solutions. Penetration of clean fuel stoves increases with the household expenditure quintile. According to the MTF data, the quintiles are divided into five (5) groups based on a household's monthly expenditure. The expenditure quintile indicates household wealth which translates to the availability of disposable income for purchasing cooking solutions. Table 14 shows the 5 quintiles and their associated expenditures per the MTF data.

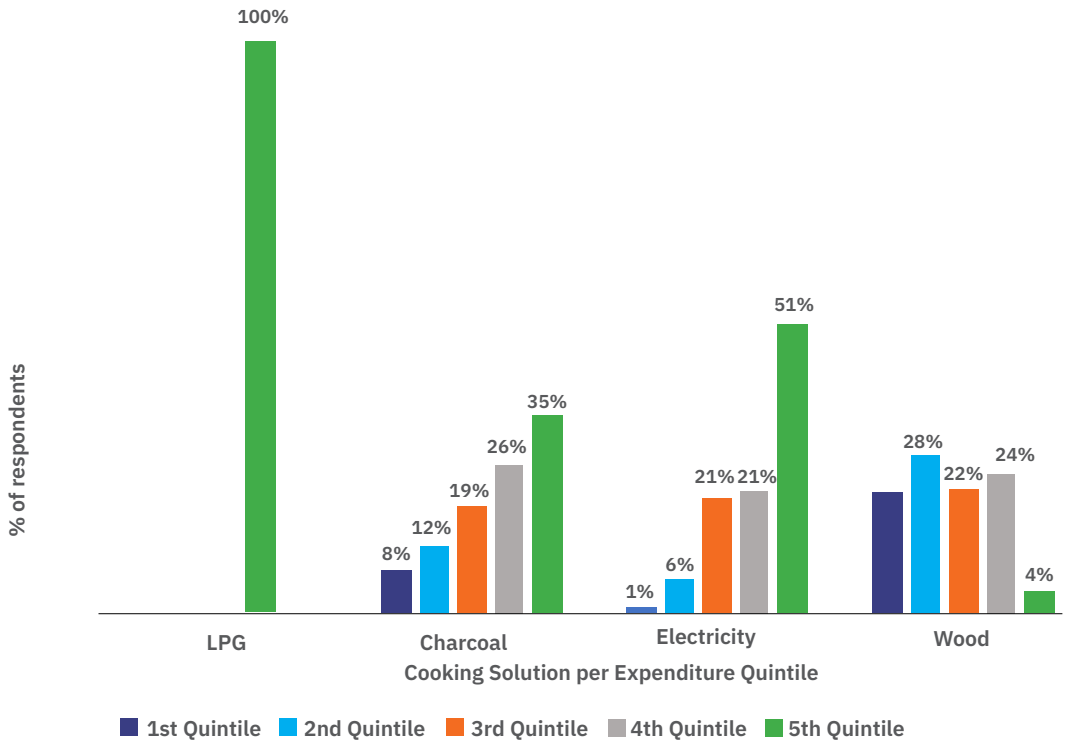
TABLE 14: HOUSEHOLD EXPENDITURE QUINTILES AS PER THE MTF DATA

Household expenditure quintile	Expenditure per month
1st quintile	<ZMW 219.18 (US$ 13.05)
2nd quintile	ZMW 227.78 – 678.17 (US$ 13.59 – 40.37)
3rd quintile	ZMW 684.65 – 1,338.97 (US$ 40.75 – 79.70)
4th quintile	ZMW 1,340 – 2,347.08 (US$79.76 – 139.707)
5th quintile	ZMW 2,350 – 7,417.05 (US$139.88 -441.45)

Figure 15 shows that all households using LPG are only in the 5th wealth quintile. Electricity use is also high in the households in the 5th quintile (51%) compared to the 1st (1%), 2nd (6%), 3rd (21%), and 4th quintiles (21%). Generally, the use of LPG, charcoal, and electricity increases household expenditure. However, it is still noted that 4% and 35% of households in the 5th wealth quintile use wood and charcoal as the primary cooking solution.

This observation implies that other factors besides affordability (e.g., accessibility, availability awareness, perceptions of safety, and other key concerns) are critical determinants of the uptake of cleaner cooking solutions. Combining the analysis above, it can be concluded that LPG is used in male-headed households, falls in the highest expenditure quartile, and is used by those with the highest education level.

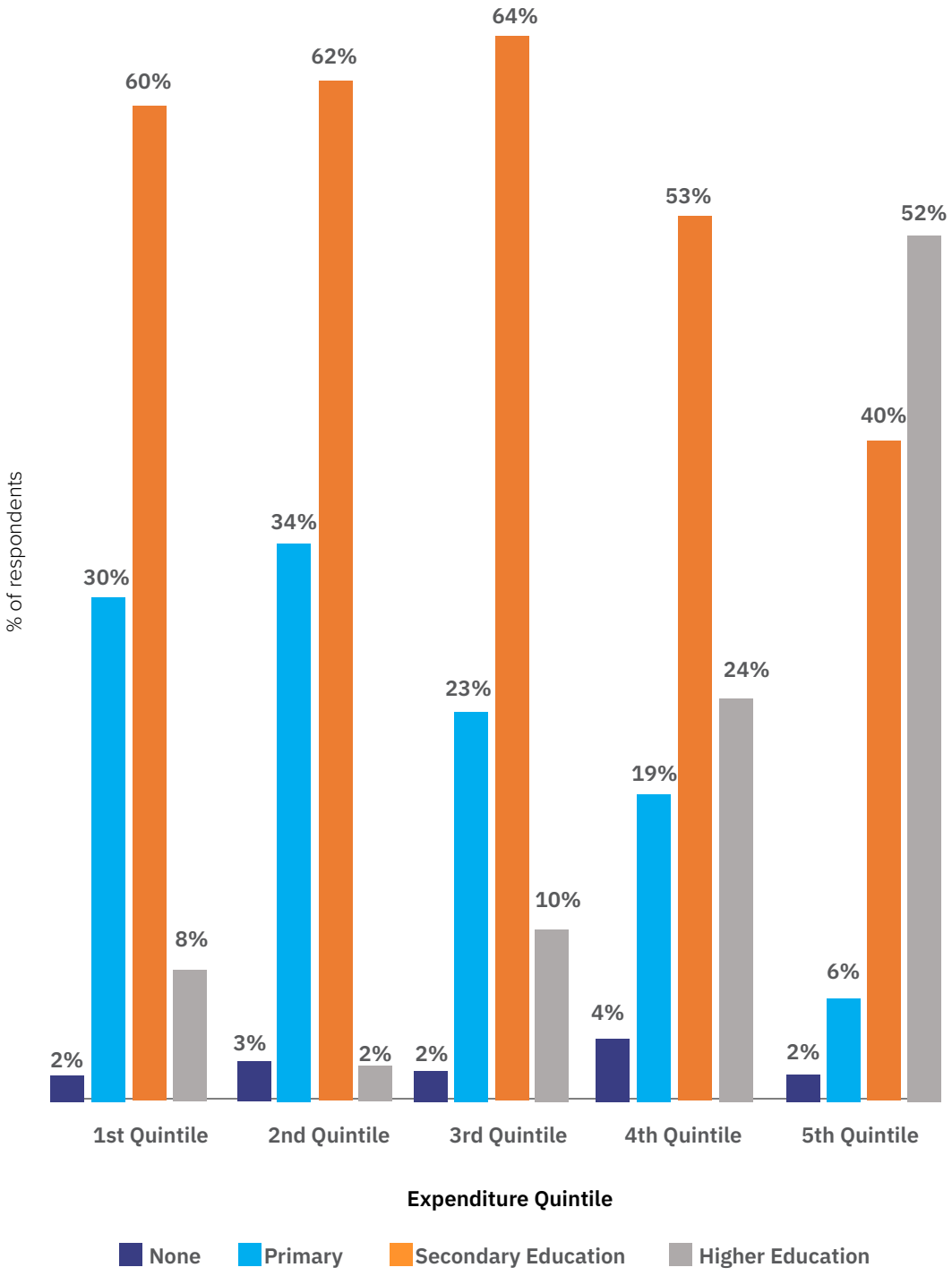
FIGURE 15
DISTRIBUTION OF FUEL USED BY HOUSEHOLD EXPENDITURE QUINTILE



5.4.4 Distribution of education level across quintiles

Household heads in the 5 quintiles had higher levels of education (trade school, college, university) at 52%. Secondary level education was more prominent in the 1st, 2nd, and 3rd quintiles. On average, 3% of household heads did not have any education across the 4 quintiles (see Figure 16).

FIGURE 16
EDUCATION LEVELS ACROSS QUINTILES

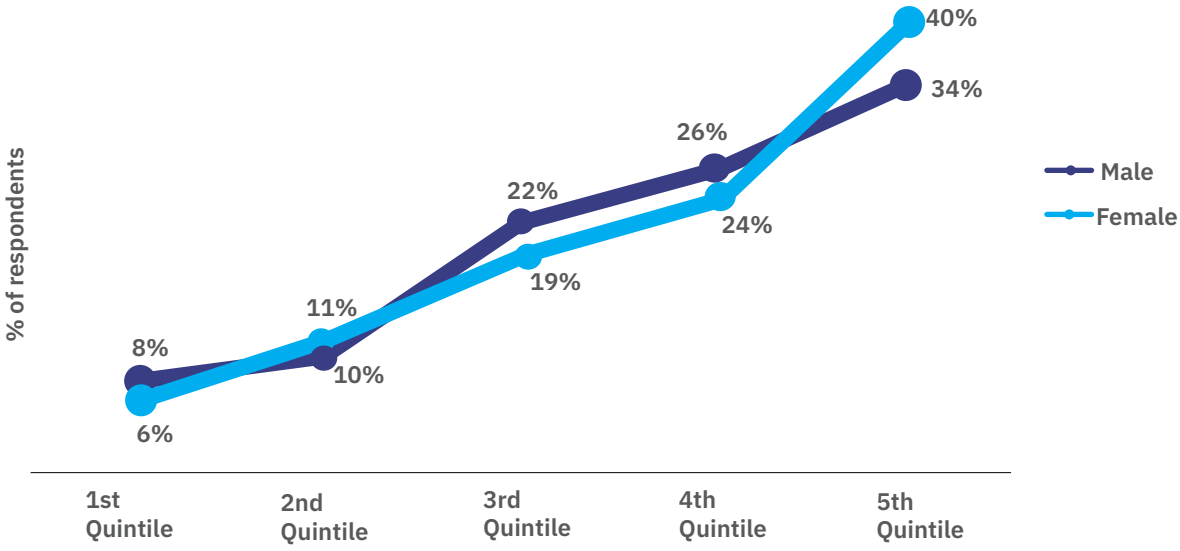


5.4.5 Distribution of household expenditure quintile by gender of household head

Comparing the distribution of households across the five quintiles based on the gender of the household head indicate that for both genders, more households fall in the 3rd, 4th and 5th quintile.

As shown in Figure 17, female-headed households (82%) are almost the same as male-headed households (83%) in the 3rd quintile. This analysis indicates that most households (both male and female-headed) are likely to have disposable income as they fall between the middle and the highest expenditure quintile. Other factors beyond affordability may hinder the uptake of cleaner cooking solutions in urban areas.

FIGURE 17
EXPENDITURE QUINTILE BY GENDER



5.4.6 Willingness to pay

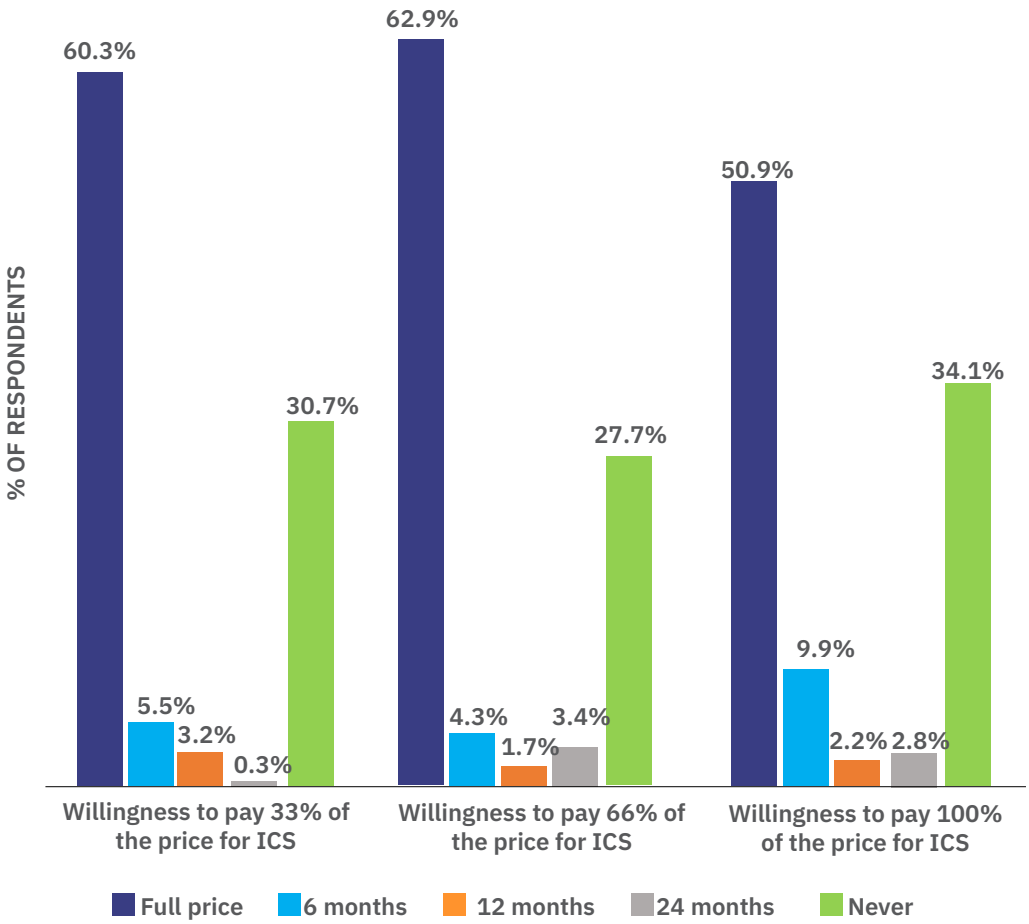
The Multi Tier Framework questionnaire only asked about the willingness to pay among households that did not own an improved cooking solution (households using charcoal and firewood) .The improved cookstove (ICS) was a pellet gasifier stove at a base price of US$ 58.31/ ZMW 979.6. The assessment determined willingness to pay at different price points of an ICS, i.e., 33%, 66%, and 100% of the base price. Acquisition of an improved cookstove could be enabled by lowering the cost of the stove and allowing payment over a given time.

51% of households who do not use an ICS are willing to pay the total cost (ZMW 979.6/US$ 58.31) of the pellet gasifier stove upfront.

The willingness increased (63%) when the stove was priced at ZMW 646.5(US$ 38.48) and slightly dropped (60%) when the stove was priced at ZMW 323.2 (US$ 19.24). One of the gas distributors (Falcon Gas) was selling a 6 kg LPG gas cylinder at ZMW 200 (US$11.90) with a deposit of ZMW 500 (US$29.76) for the cylinder bringing the total to ZMW 799 (US$ 47.56), including the regulator and grill. Two burner ethanol stoves (for both liquid and gel) range from ZMW 120 to ZMW 250 (US$ 7.14 to 14.88). Comparing the prevailing market prices for improved cooking solutions and the willingness to pay, most households can afford a cleaner cooking solution.

34% of the households were not willing to pay for the stove at its total price (ZMW 979.6/ US$58.27) even when the stove was provided in instalments (50.9% willing to pay at full price, 9.9% in six months, 2.2% in twelve months, 2.8 % in twenty-four months). It further dropped (by 28%) when the stove was priced at ZMW646.5 (US$ 38.48) (see Figure 18).

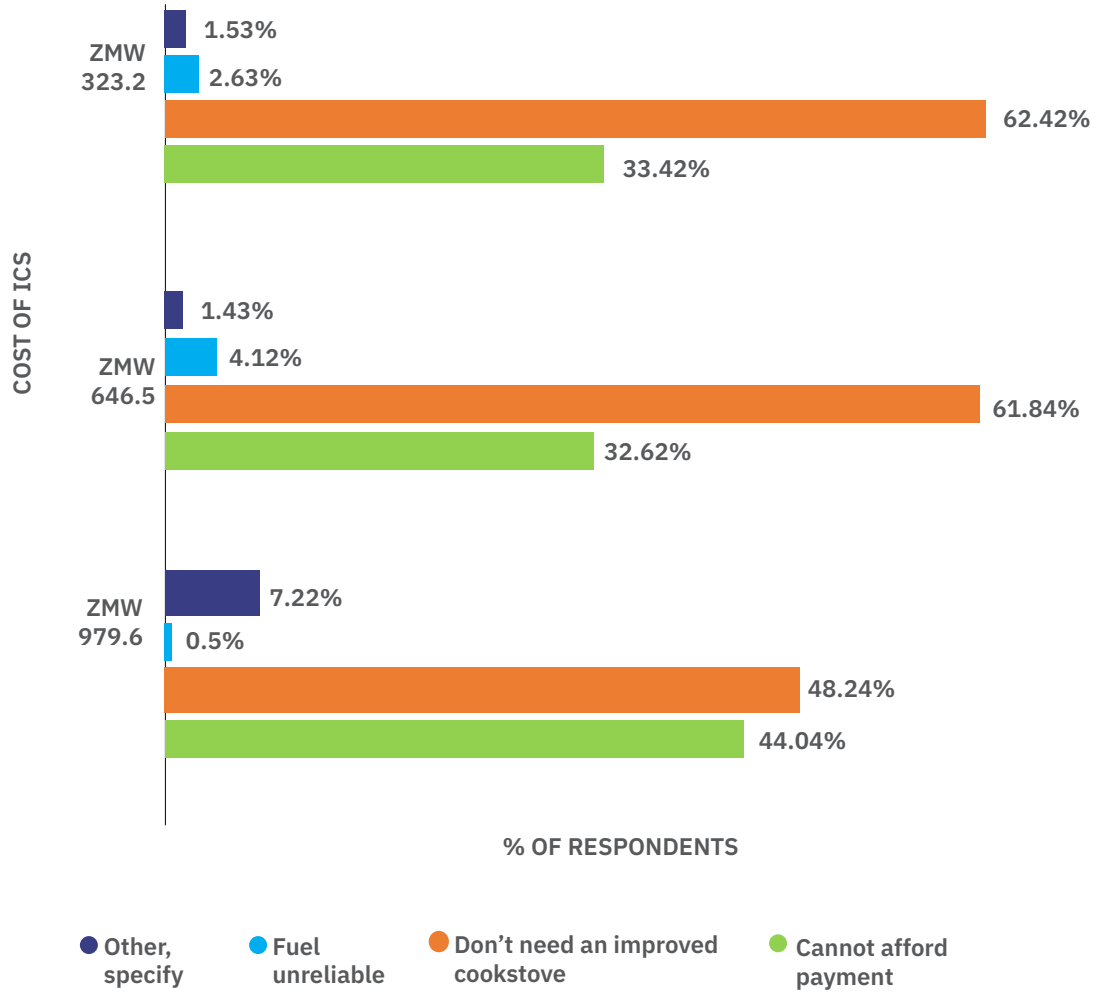
FIGURE 18
WILLINGNESS TO PAY FOR IMPROVED COOKING STOVES



Most of those unwilling to pay for an improved cookstove (ICS) under any price or payment plan believed they did not need an improved one. Enhancing public awareness of ICS benefits is essential in ensuring increased adoption of ICS. The affordability of ICS was noted as a reason for the unwillingness to pay for an ICS. At a higher price cost (ZMW 979.6/ US$ 58.31), 44% indicated affordability as a barrier, while 33% agreed to pay when the price cost of the ICS is at ZMW323.2 (US$ 19.24) (see Figure 19).

FIGURE 19

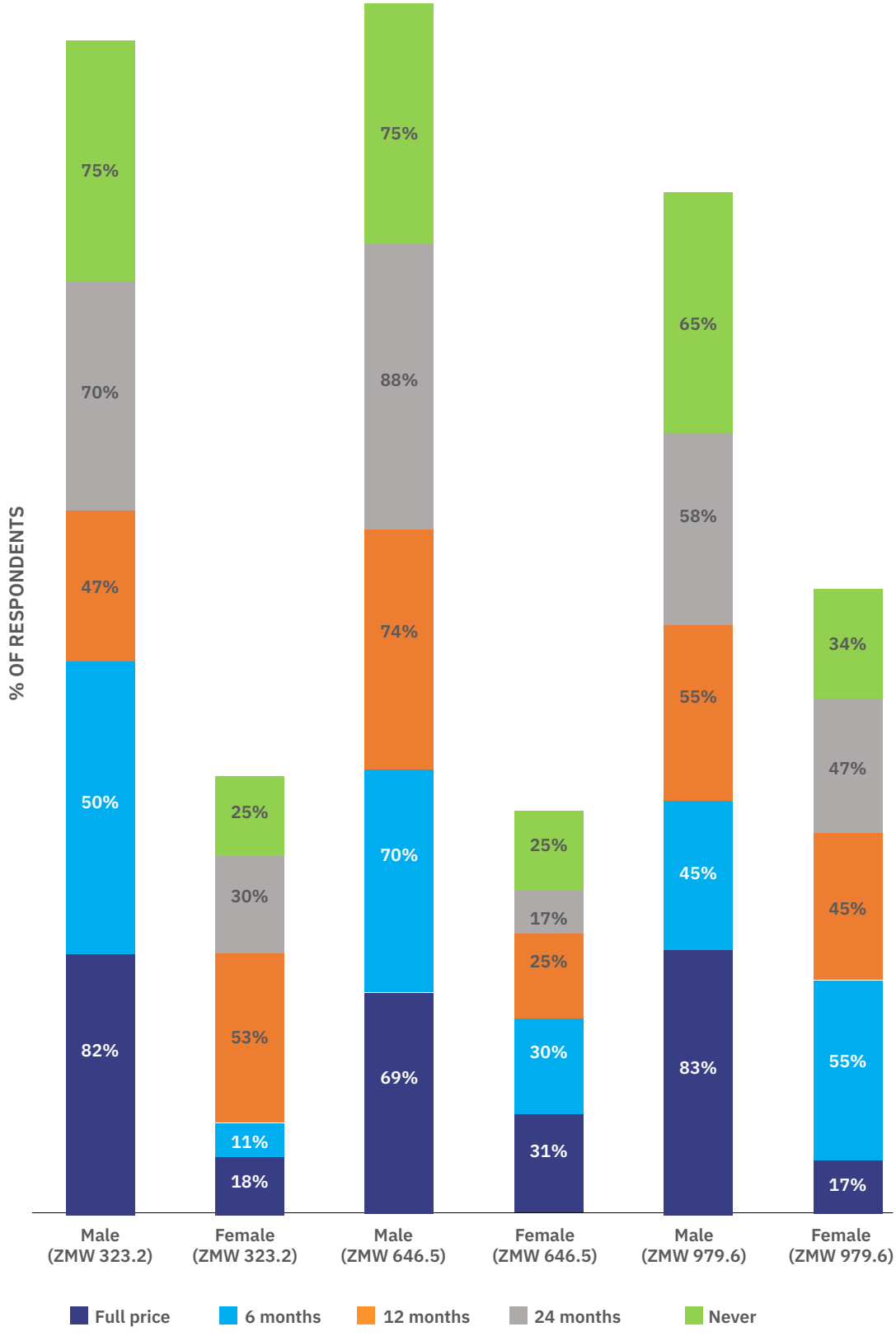
REASONS FOR NOT BEING WILLING TO PAY FOR AN IMPROVED COOKSTOVE



83% of male-headed households were willing to pay the total price upfront for an ICS stove compared to 17% of female-headed households. This household head indicator could be used as a guide to target demand-side subsidies. Willingness to pay for an ICS was generally lower among female-headed households: 18% were willing to pay a third of the price upfront, and 17% were willing to pay the total price upfront (see Figure 20).

FIGURE 20

WILLINGNESS TO PAY FOR AN IMPROVED COOKSTOVE BY GENDER OF THE HOUSEHOLD HEAD



Willingness to pay for ICS at the 3 different price points (ZMW 323.2, 646.5 & 979.6 / US$ 19.24, 38.48 & 58.31) against the 5 expenditure quintiles was analysed. Willingness to pay ZMW323.2 (US$ 19.24) at the total price was highest in the 4th expenditure quintile at 29%, followed by the 3rd expenditure quintile.

Figure 21 shows that willingness to pay ZMW323.2 (US$ 19.24) over 6, 12, and 24 months was highest in the 2nd expenditure quintile and lowest in the 5th expenditure quintile. The assumption is that households in the 2 quintiles have lower income levels and prefer to pay for the ICS instalments spread over months, while households in the 5th expenditure quintile have higher incomes and prefer to pay for the ICS upfront.

This demonstrates that combining subsidies and extended payment periods can make alternatives such as LPG and ethanol accessible to low-income households (1st quintile).

However, LPG promotion interventions in Mexico demonstrate that due to an inability among some beneficiaries to continue refilling the subsidized gas cylinders, most revert to traditional forms of cooking eventually (Troncoso et al. 2019). Poorly structured subsidies can also distort commercially viable markets, thus negatively impacting what would be considered a sustainable model for advancing energy access solutions. Subsidy recipients, especially if they receive products and services at no cost, demonstrate little to no ownership due to their detachment from the solution promoted (Dupas, 2014).

FIGURE 21

WILLINGNESS TO PAY ZMW 323.2 AMONG THE 5 EXPENDITURE QUINTILES

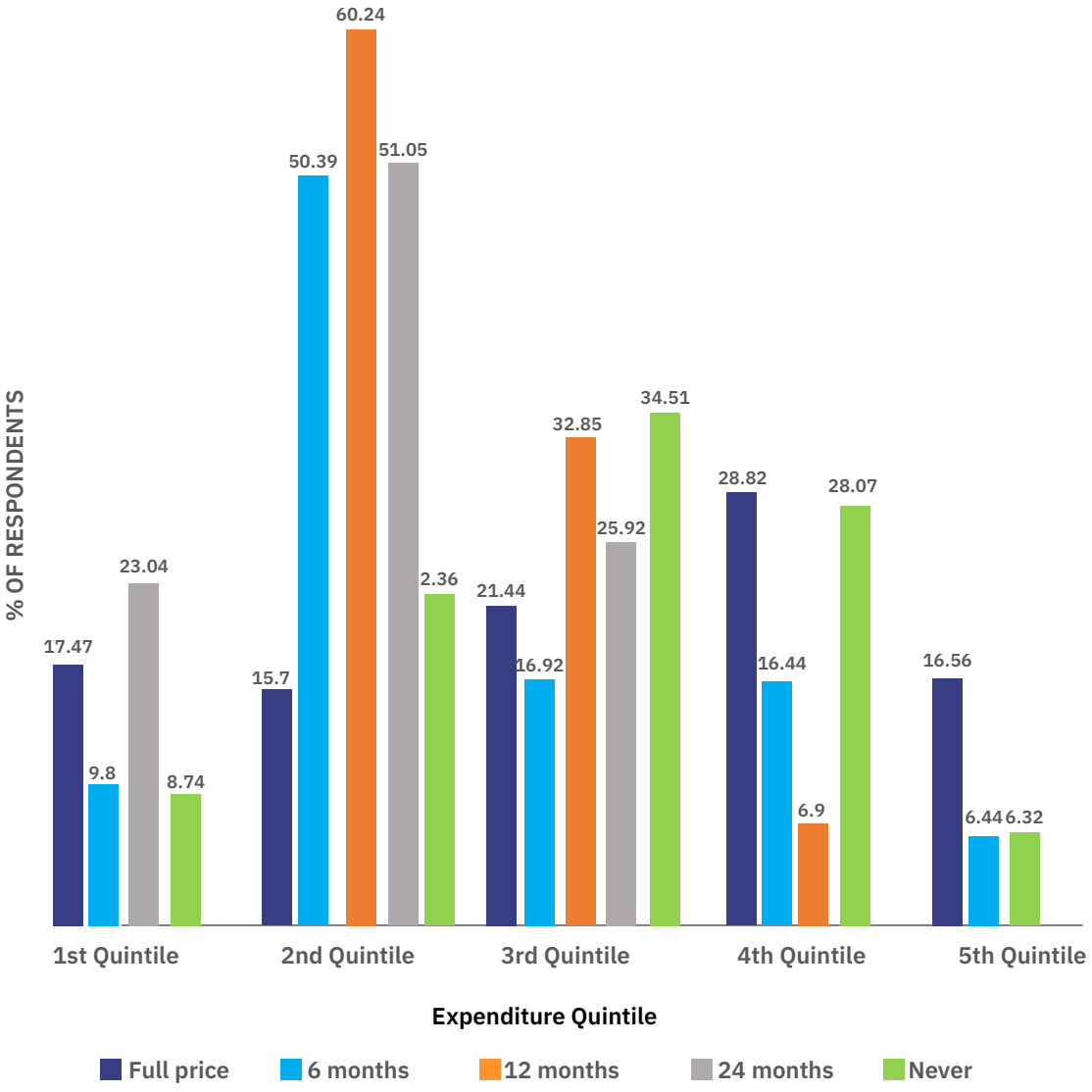


Figure 22 shows that at a price cost of ZMW 646.5 (US$ 38.48), the willingness to pay the total price increases systematically from the 1st to the 5th expenditure quintile. This reflects that households in the 1st expenditure quintile will be slow to adopt ICS, especially if the manufacturer/ distributor is unwilling to offer extended payment plans.

The same trend is also observed in the willingness to pay for the ICS over 6 and 12 months. The willingness to pay gradually increases from the 1st expenditure quintile to the 4th expenditure quintile.

FIGURE 22

WILLINGNESS TO PAY ZMW 646.5 AMONG THE 5 EXPENDITURE QUINTILES

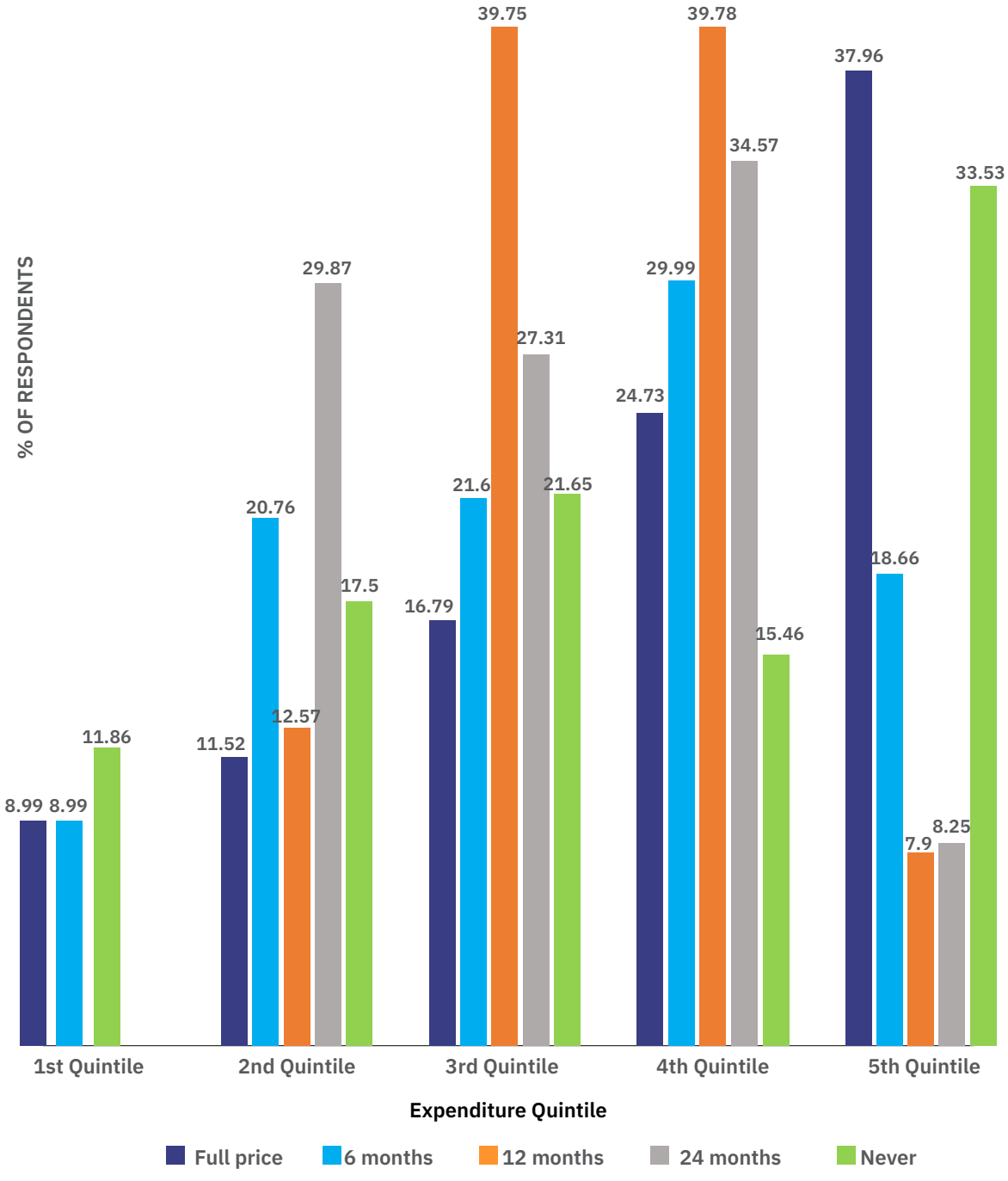
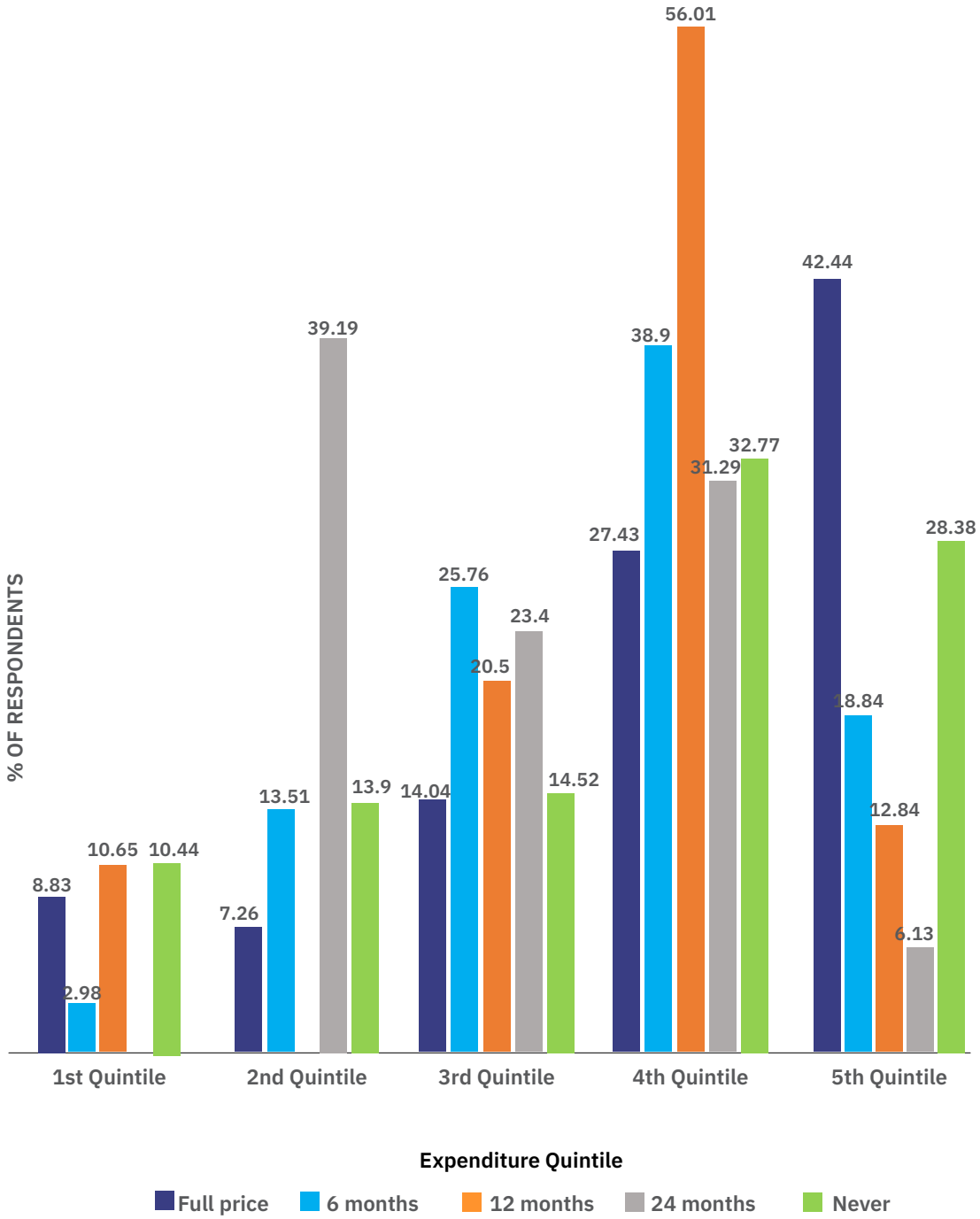


Figure 23 indicates that at ZMW 979.6/ US$ 58.31 (total cost of ICS), households in the 5th quintile are more willing (42%) to pay the total cost upfront than households in the 1st and 2nd expenditure quintiles 9%, and 7%, respectively. Unlike households in the first four expenditure quintiles, households in the 5th expenditure quintile demonstrate a declining willingness to pay the cost of the ICS with payment extended over 6 to 12 months. The assumption is they have disposable income to pay for the ICS upfront.

FIGURE 23

WILLINGNESS TO PAY ZMW 979.6 (US$ 58.31) AMONG THE 5 EXPENDITURE QUINTILES



06| Program Design

6.1 The rationale for promoting LPG, ethanol, and pellet solutions

6.1.1 Evaluating cooking solution options

As shown in Table 15 below, LPG is ranked highest among the 20:40:20:20 technology options when using the evaluation criteria outlined:

- GHG abatement potential,
- Government support,
- Risk of duplication, and
- Stoves performance (Tier 3 and above).

The'20-40-20-20' cooking scenario initiative by the Zambian Government, would see electric cooking reduce to 20% by 2030 and see the LPG sector grow to meet 40% of cooking needs in urban areas. Charcoal would be reduced to 20% by 2030, and the final 20% of the market is filled by firewood.

Although not part of the 20:40:20:20 mix, ethanol is also rated high, with biogas, pellets, and electricity receiving the same rating. Further examination of these solutions shows that there is no one perfect solution, as depicted in Table 16 on the strengths and weaknesses of the solutions. A program that cuts across multiple solutions is preferred instead of a one-solution approach.

TABLE 15: EVALUATION CRITERIA FOR COOKING FUELS

#	Cooking Solution	GHG abatement potential	Government support	Risk of duplication	Stove performance (Tier 3 +)	Average Score
1	Electricity	3	0	3	3	2.25
2	LPG	2*	3**	3	3	3.67
3	Charcoal	1	1	1	1	1
4	Firewood	1	1	1	1	1
5	Other: Ethanol	3	3***	2	3	2.75
6	Other: Pellets	2	2****	2	3	2.25
7	Other: Biogas	2	1	3	3	2.25

*Assuming LPG displaces charcoal and firewood, which have significantly higher GHG emission factors per energy output

**LPG fuel tax exempt

***Excise duty reduced from 125% to 65%

**** Viewed as a pathway to reduce deforestation

TABLE 16: MERITS AND DEMERITS OF THE DIFFERENT COOKING SOLUTIONS

#	Solutions	Strengths	Weaknesses
1	Electricity	• Cheap to cook with (Zambia has one of the most affordable tariffs in the region). • Available to most urban residents.	• The current tariff is not cost reflective, and plans are underway to adjust the cost. • Government to scale down urban use rate from 35% to 20%. • Significant load shedding to ensure the grid is not overburdened.
2	LPG	• Different LPG cylinder sizes ranging from 1.4kgs to 48kgs, providing consumers with variety. • Flexible refilling allows one to purchase small amounts of gas for low-income households. • Import of LPG fuel and stoves is tax exempted. • Proposals to remove import duty (15%) and VAT (16%) on cylinders.	• Operational challenges due to the closure of INDENI therefore 100% dependent on imported LPG, thus increasing the cost of LPG. • There are currently not enough exchange/refill points. • Users perceive it to be a fire hazard.
3	Ethanol	• Completely clean burning so cooking can take place in the house, and not isolated outside. • Stoves can be easily and safely operated, with simple filling and lighting, no spillage or danger of pressurizing and explosion.	• The high upfront cost of stoves. • Upstream production at its nascent stages. • Midstream distribution chains are limited in scope. • It falls under the same taxation class as alcohol which is considered a luxury commodity. • There are plans to develop ethanol standards, but the timelines remain unclear.
4	Pellets	• A cleaner cooking solution compared to traditional cooking solutions such as Mbaula and three stone open fire.	• Production concentrated in the Copper Belt province of Zambia. • Not widely and readily available across most urban areas. • Nascent stage of development. • The stove is expensive and retails at US$ 175.50.
5	Biogas	• Provides not only access to clean energy but also potent organic fertilizer for thousands of rural families.	• The sector is still underdeveloped in Zambia. • More suited for rural areas. • Fixed dome biodigesters in Zambia tend to be rather expensive due to high construction costs.

From the analysis in Table 16 above, biogas and electric solutions for cooking are eliminated as solutions to be considered for the program. Biogas is mainly suited for cooking in rural areas, and the government is keen on reducing electricity use for cooking from 35% to 20 %. The factors of consideration are further explained below.

GHG abatement potential

LPG, ethanol, and pellet cooking solutions are cleaner than charcoal and firewood. Studies indicate that pellets stoves with an internal fan reduce emissions by 90% to 99%, comparable to traditional stoves due to their high efficiency in fuel combustion (Bailis et al. 2020). Switching to bioethanol or LPG in Kenyan urban households is estimated to reduce 3 to 5 tonnes of Green House Gases (GHG) emissions annually (Dalberg, 2018).

Although LPG is a fossil fuel, the GHG abatement potential associated with shifting households from depending on charcoal for cooking is substantial.

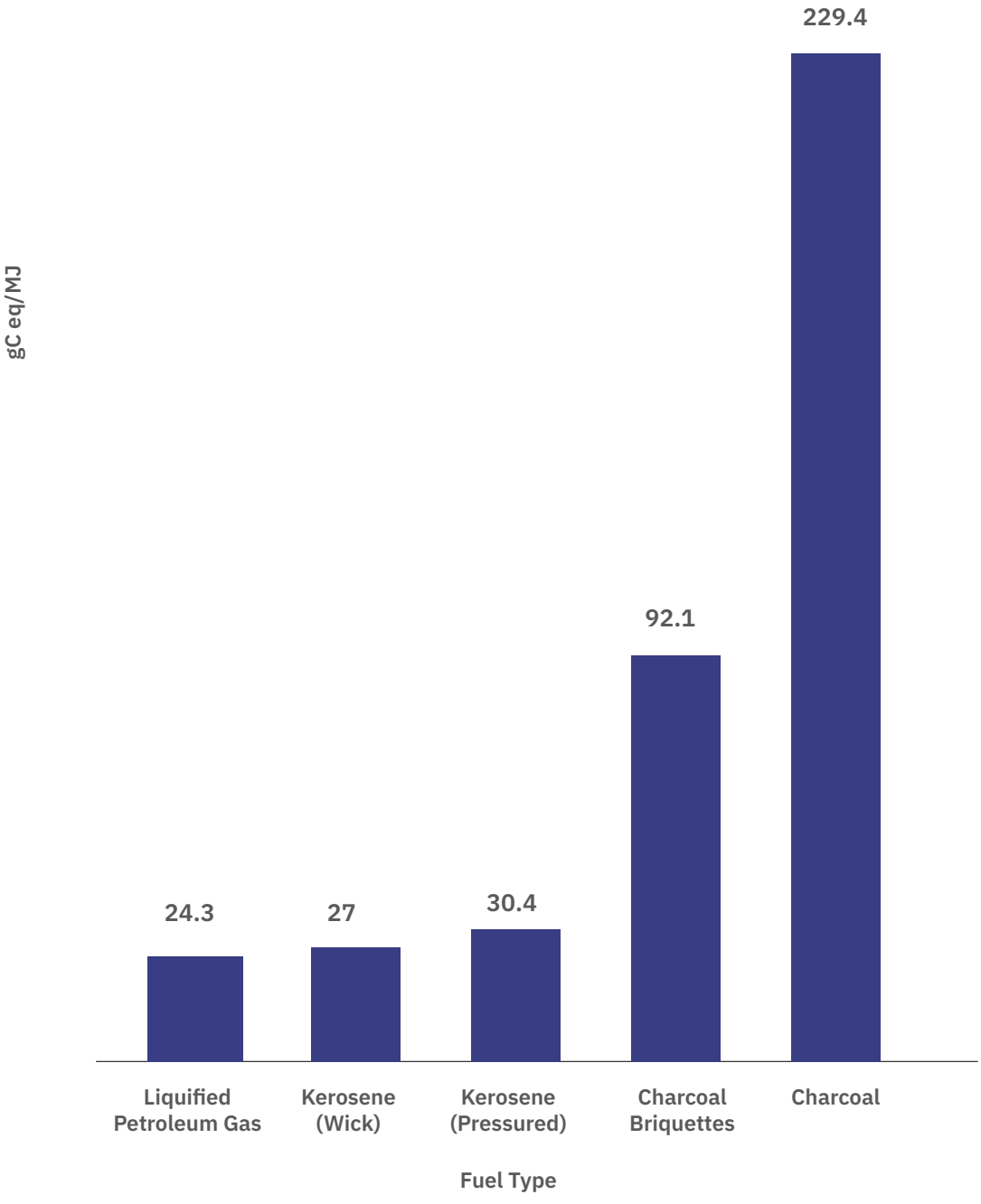
It will support the Government's aims under the Nationally Determined Contribution (NDC). At 24 gCeq/MJ (grams of carbon equivalent per unit of energy produced), cooking using charcoal and charcoal briquettes generates up to 9 and 4 times more CO2e emissions per unit of energy generated, respectively, compared to LPG, (Smith et al. 2000) as shown in Figure 24 below. This study is also supported by a recent study (2021) that confirms the same GHG abatement potential when households adopt LPG as a cooking fuel instead of charcoal (Champion et al. 2021).

Gas (including LPG) is also considered a practical transitional fuel and viable option for millions of households in Africa depending on traditional biomass for cooking.

At the just-concluded SEforALL forum in Kigali (April 2022), 10 Sub-Saharan African countries (DRC, Ghana, Kenya, Malawi, Morocco, Nigeria, Rwanda, Senegal, Uganda, and Zimbabwe) in a seven-point communique supported the deployment of gas as a transition fuel that would move people from traditional forms of cooking fuels reducing their exposure to associated negative impacts (Farand, 2022).

FIGURE 24

AVERAGE CARBON EMISSION PER MEGA JOULE (20-YEAR CUMULATIVE GWP)



Government support

The expanding economy and socio-economic development in recent years have contributed to an increase in demand for electricity. About 80% of Zambia's total installed generation capacity is hydro-based, vulnerable to weather and climatic changes, as demonstrated during the 2015-2019 energy crisis. The year 2020 reflects the deficit in supply relative to demand. Peak demand during this period was 2,310 MW against the installed capacity of 3,011 MW, compared to the lowest recorded effective capacity of 1,500 MW (Farand, 2022). A daily load profile that requires matching the peak demand with the base generation capacity would lead to a 35% deficit.

To balance the electricity supply and demand, ZESCO Limited – the national power utility company-, has been forced to undertake load management procedures. This includesnationwide load shedding schedules, some of which lasted up to 12 hours daily. In addition, the Government has been promoting alternative fuels such as LPG to address this shortfall. This informed the Government of the Republic of Zambia to undertake policy changes that will reduce the reliance on electricity for cooking in urban households from 35% to 20% while increasing the use of LPG from less than 1% to 40% by 2030 (Republic of Zambia, 2019).

Being aware that no single solution will solve the energy needs for cooking in Zambia, the government of Zambia is also open to other cleaner cooking technologies for urban areas, such as pellets and ethanol. There are ongoing efforts to develop ethanol standards.

Risk of duplication

Dependence on traditional forms of cooking has been highlighted as the leading cause of negative environmental, climate, health, and economic impacts. Access to clean cooking solutions is also low (about 16%) against the SDG 7 of universal access to modern, affordable, and sustainable energy by 2030. Due to this realization, several programs (as outlined in section 5.2) support solutions based on fuelwood, charcoal, biogas, pellets, and electric cooking, but none are focussed on supporting LPG. Table 17 below highlights key ongoing programs in the energy for cooking in Zambia that have recently been commissioned.

TABLE 17: SUMMARY OF ON-GOING INTERVENTIONS IN ZAMBIA

	Program details			Common types of program components Vs. components supported by a specific program			
#	Program name	Fund size/target area	Type of solution supported	Enterprise funding	Consumer Financing	Creation of awareness	Policy development
1	Modern Cooking Facility for Africa	• 13.8 million Euros • Urban and Peri-urban areas	• Electric, biogas, bioethanol, solar thermal stoves, briquettes, and pellets stoves*	• Catalytic grants and Result Based Financing	• None	• None	• None
2	Clean Flame Fund	• US$ 100,000 • Target area not specified	• Pellet gasifiers	• Grant financing	• None	• None	• None
3	A2C	• US$ 24.9 million in Urban areas	• Tier3+ solutions	• Grant financing	• None	• Creation of awareness of alternatives to charcoal	• Establishing and training a national Charcoal Taskforce • Setting the Energy Sector Advisory Group

*The Modern Cooking Facility for Africa excludes funding for LPG solutions

Therefore, the risk of duplicating or formulating conflicting efforts is minimal for any intervention supporting LPG. Such an initiative will also be wholly aligned with the upstream Government efforts to resolve supply challenges. It can also be argued that since pellets and bioethanol are at the nascent stage, concerted efforts are paramount to growing the industry.

Stoves performance

LPG and pellet stoves perform above the Tier 3 performance threshold. (Champion et al. 2021) compares emissions (carbon dioxide, carbon monoxide, total hydrocarbons, methane, nitrogen oxides, fine particulate matter (PM2.5), organic carbon, elemental carbon, and ultrafine particles) and efficiency data between the ISO IWA protocol and the Water Boiling Test (WBT)[15]. The study examines the performance of six stove/fuel combinations (liquefied petroleum gas (LPG), pellet, wood fan, wood rocket, three stone fire, and charcoal) tested in the same laboratory.

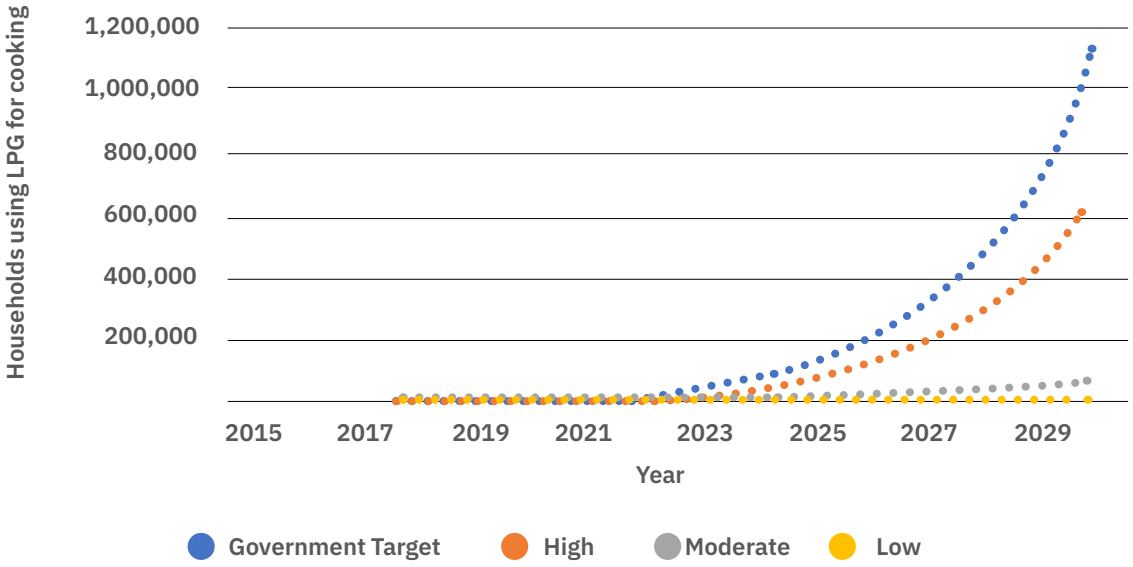
Further emissions data, including polycyclic aromatic hydrocarbons, are utilized to compare the ISO and Firepower Sweep Test (FST) protocols. The experiments place LPG under Tier 5 for both CO and $PM_{2.5}$ emissions while pellet stoves under Tier 5 and Tier 4 for CO_2 and $PM_{2.5}$ emissions, respectively.

6.1.2 Suitability and rationale for the intervention

The aggregate number of households using LPG has tripled between 2015 and 2017, starting with an ultra-low base of 1,296 households. As shown in Figure 25 below, achieving the national target by 2030 will require an average annualized increase of 56%. A 40% LPG use rate by 2030, as envisioned by the Government plan, translates to 0.47 million households and 1.1 million households using the solution by 2028 and 2030, respectively. This, in all assessments, appears to be highly ambitious. A low (12.5%), moderate (25%), and high growth (50%) average annualized growth rate tops attain an estimated 12,490, 39,802, and 443,603 households, respectively, using LPG by 2028. Population projections are based on data from the UN population division (Department of Social and Economic Affairs, 2018).

Without a deliberate and overarching strategy to increase LPG, the use rates will invariably remain low. Although pellets and ethanol are at their nascent stage, there are efforts to grow the uptake of these solutions. For instance, the government has been keen on developing ethanol standards. A pellet production factory with a capacity of 15,000 tonnes is now in operation after being dormant since 2013 due to a fire.

FIGURE 25:
PROJECTED LPG USE IN URBAN AREAS OF ZAMBIA



15 High-power represents boiling water or frying. Lower-power represents simmering water. Overall represents working all power levels

As explained in section 6.1, there are several barriers to the uptake of cleaner cooking solutions. There are two core barrier groups.

- The **first** is supply-side barriers associated with national production or sufficient importation of LPG at the upstream level. The Government is addressing these concerns in line with their plan to expand use. Additionally, there is limited suppliers of ethanol and pellet solutions. The second are barriers associated with access to finance, including capital to develop extensive last-mile distribution networks among suppliers and affordability of the appliances among low-income end-users.

- This program addresses the **second** group of barriers by providing concession financing, including grants and subsidies along the supply chain. It is envisioned that this intervention will unlock substantial private sector capital. Lack of awareness and misperception of LPG safety is a lesser barrier that can be addressed through various forms of technical assistance support.

Subsidies are market interventions used to circumvent market systems to improve welfare. In the energy sector, subsidies have been used to advance access to modern, clean, affordable, and sustainable energy (Sowa, Nii and Accra, 2007). Experts, governments, non-governmental organizations, and policymakers have been concerned about subsidies. While some view it as a critical safety net in the development process, others view it as an unsuitable tool that alters the market system and distorts government fiscal agendas (Sowa, Nii and Accra, 2007).

The effects of energy subsidies can be negative or positive depending on the implementation of the subsidy. Subsidies that target fuels rather than infrastructure result in energy market distortions. This has been the case in India, where the subsidy program targeted LPG fuel forcing all markets to price LPG at about 60% of the supply cost (UNEP, 2008). Subsidies that result in lower prices of energy infrastructure, such as cylinders and stoves, increase the consumption of respective fuels and, therefore, positively benefit suppliers of the fuels.

However, not subsidizing the fuel cost may also lead households to revert to traditional cooking forms (Troncoso et al. 2019). To ensure that subsidies effectively target the vulnerable, they need proper targeting (ensuring only those that deserve a subsidy receive it). There is evidence that subsidies can benefit middle to upper-class community members the most, as was the case with the India LPG subsidy program, where 76% of the subsidy was allocated to urban areas containing a quarter of the population. In the urban areas, over half of the subsidy benefited a quarter of the urban households who were higher income (UNEP, 2008). The proposed design of this facility takes note of these considerations.

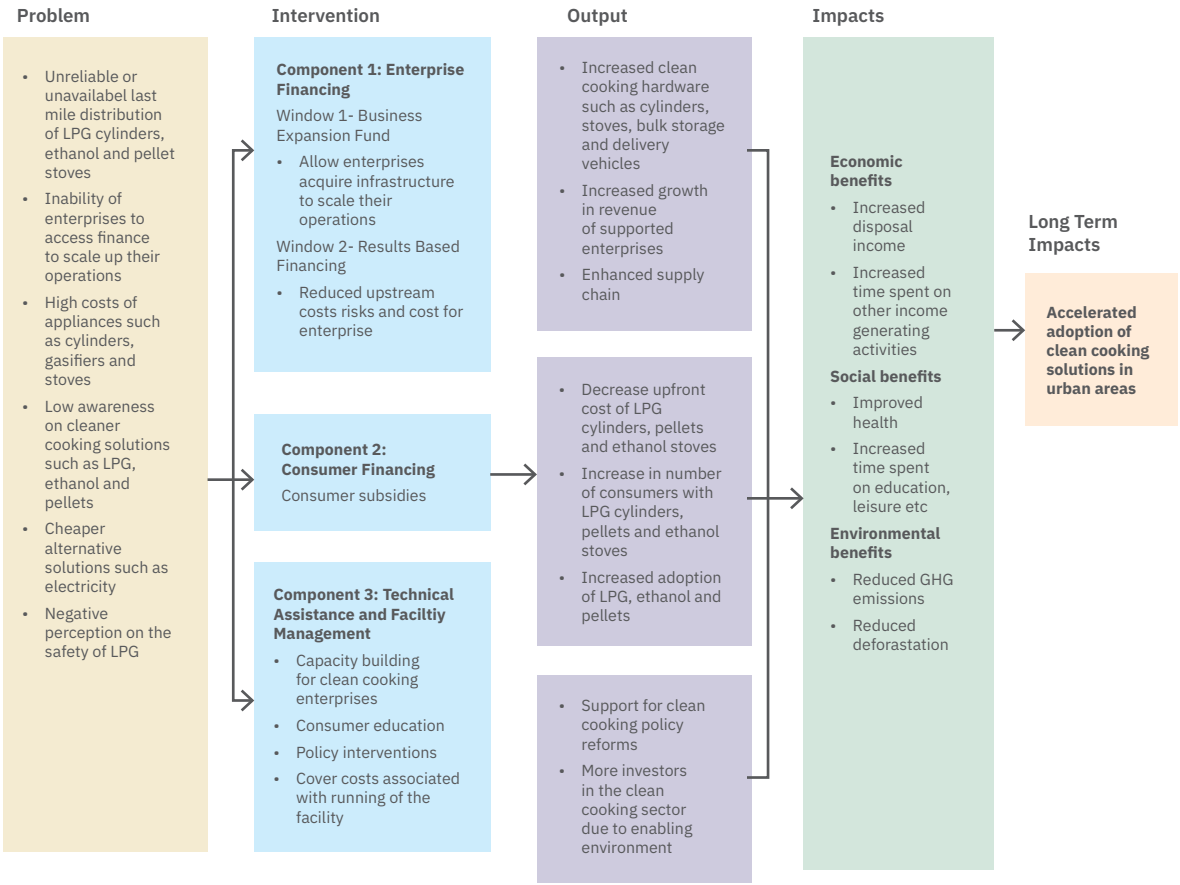
6.2 Theory of change

The theory of change explains the logic and assumptions linking the various barriers and interventions to clean cooking adoption. The available hardware, efficient distribution networks, innovative financing mechanisms, and a favourable policy environment are prerequisites for enhancing the adoption of clean cooking solutions. It also presents interventions and the impacts of clean cooking solutions, as summarised in Figure 26. A transition to cleaner and less polluting energy options has the great potential to mitigate anthropogenic climate change while delivering social, economic, commercial, and environmental benefits.

The core problems being addressed include unreliable and unavailable last-mile distribution options, limited access to finance, the high upfront cost of clean cooking appliances among low-income households, low awareness levels suppressing demand, cost-competitive alternative solutions, and negative perceptions of safety. The program will deliver change through three components:

- **enterprise finance,**
- **consumer finance, and**
- **technical assistance.**

FIGURE 26
THEORY OF CHANGE



6.3 Summary of the proposed design

The Government intends to stimulate the uptake of clean cooking solutions such as LPG, ethanol, and pellets and promote them as alternatives to charcoal and electricity for cooking through several policies and incentives, such as the national energy policy of 2008 and the removal of VAT from LPG and associated appliances (except for the cylinders).

Energy Regulatory Board (ERB) has approved a regulatory framework to monitor wholesale and retail prices for imported and locally sourced LPG. However, all the LPG is currently being imported. With more consumers expected to switch to LPG, regulating retail prices has become necessary to ensure consumers are not over-charged, thus preventing them from using LPG. In addition, ERB has introduced licenses for distribution, importation, and export of LPG, retail of LPG, and filling of cylinders with LPG16. For Ethanol, the National Energy Policy (2019) only covers biofuels for use in the transport sector; however, in May this year, the Zambia Bureau of Standard drafted Zambian Standards for bioethanol for cooking and their associated appliances.Ethanol and pellets usage for cooking, unlike LPG, is still at its nascent stage; therefore, there have been no significant statistics on usage rates.

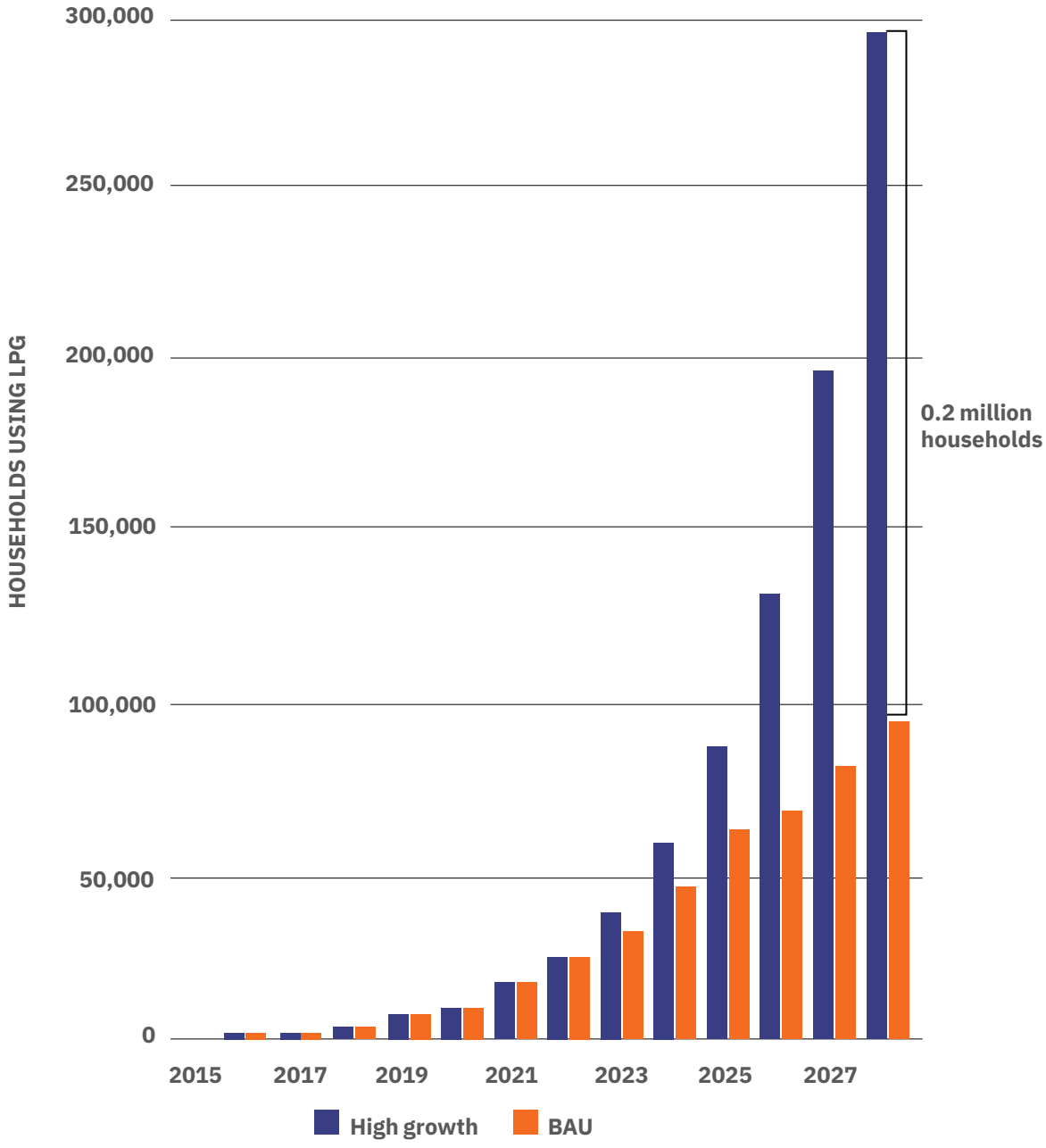
The last survey with a representative sample for urban areas was the 2017 MTF by the World Bank, which did not have penetration rates for these two cooking solutions due to the limited number of households using them (the use rate was insignificant to be captured in an urban representative sample).

Therefore, LPG use statistics were used to extrapolate the number of consumers expected to be using clean cooking solutions by 2028. The current annual increase in the number of households using LPG can be attributed to the changes in electricity supply (cost and quality) and has been organic without a deliberate overarching strategy. Inevitably, the number of households using LPG will continue to increase.

As illustrated in Figure 27, a high growth (annualized average increase of 50%) will enable about 0.3 million households to transition to using LPG by 2028. This growth rate will not be attained and sustained without deliberate efforts to address the core barriers to uptake. This program will be a 5-year scalable program (2023 – 2027) that will ensure an additional 0.1 million to 0.2 million households transition to cleaner cooking solutions (LPG, ethanol, and pellets) by 2028. The budget proposed is based on a target of 0.1 million households but can be expanded depending on the availability of funds.

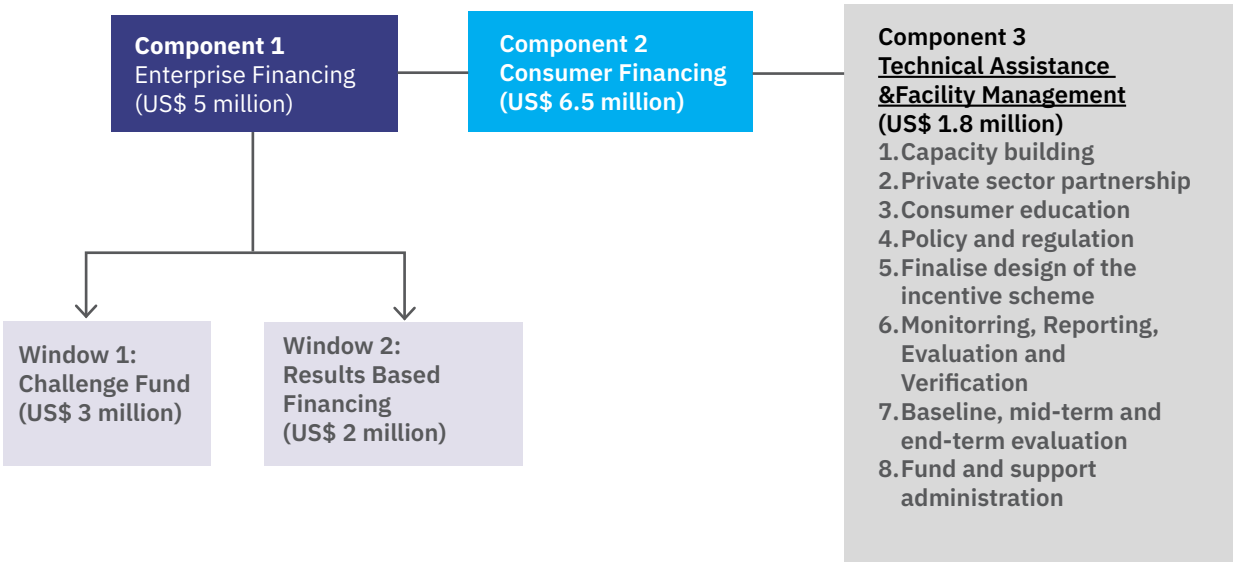
FIGURE 27

PROJECTION OF HOUSEHOLDS USING LPG 2015-2017 IN ZAMBIA



The proposed design will have three components, i.e., Consumer Financing (US$ 6.5 million), Enterprise Financing (US$ 5 million), and Technical Assistance & Facility Management (US$ 1.8 million), as indicated in Figure 28.

FIGURE 28
COMPONENTS OF THE FACILITY



6.3.1 Component 1: Enterprise financing

The supply-side incentives will reduce the risk or cost incurred by companies/enterprises in distributing LPG, pellets, and ethanol to end-users. The stimulus exist to cushion these companies and incentivise them to explore new territories and markets for their products. Reaching end-users through last-mile distribution, especially in areas where the distribution networks are not well established and functional, is costly to companies. This is due to the high investments required to lay the infrastructure. Enterprise financing will be implemented in two windows.

WINDOW 1: CHALLENGE FUND

A challenge fund is a financing mechanism that allocates funds using competition among organizations as the lead principle. It invites companies and institutions working in a targeted field to submit business proposals. For this program, the broader objective is to extend financial services to clean cooking companies involved in the manufacture/distribution of ethanol, pellets, and LPG for cooking to trigger investment in high-risk markets and stimulate innovation in the clean cooking sector. So as not to limit the innovative approaches by clean cooking enterprises, this program will be non-prescriptive in the innovation/approach taken by enterprises to increase the use of clean cooking products among consumers in urban Zambia.

The challenge fund awards grants to projects that best meet the fund's objectives and fulfill various pre-established eligibility criteria including a due diligence conducted by an investment committee (a body independent of the donor and fund managers responsible for project selection). Before a call for proposals is opened, a term sheet providing an overview of the program, objectives, and scope of the challenge fund, including funding ranges, financing and technical assistance offered, and selection criteria, is made public to inform prospective applicants in the preparation of the full application process. Standard minimum criteria for most challenge funds include that the enterprise has been in existence for a minimum of 2-3 years, it has audited accounts for that period; is not placed in bankruptcy; not engaged in activities such as arms production, and has a financial position which makes it likely to be able to sustain a project, etc.Such criterion is necessary to reduce risk of fraud and increase chances of selecting an enterprise that can flourish after the grant.[17]

Successful applicants must match a certain percentage of the grant with their financing and/or in-kind contributions. Matching funds guarantee an applicant's commitment and leverages donor funding. To avoid ambiguity in the application process, detailed information will be provided on eligible and ineligible costs and how they should be calculated for matching funds. To encourage women's participation and local companies, the required matching funds must be differentiated between women's and men-led businesses—for example, a 25% and 50% matching requirement for women-led and men-led enterprises, respectively.

Regarding the institutional structure, the Development Finance Institution (DFI) is – a specialized development organization usually majority-owned by national governments. In this case, the Development Bank of Zambia will be the fund manager responsible for disbursing funds once the program manager approves an enterprise/company to be awarded the grant.

The application process will be conducted online and in two phases. In phase 1, the applicants submit an expression of interest of one or two pages, pending an investment committee's shortlist. Successful applicants are invited for phase 2, where they submit a full proposal, usually in a business plan format. The investment committee then selects winners based on the criteria and completeness of the application. Common challenges with this process include unexpected volumes of proposals, proposals that may be developed by a consultant and therefore may not reflect the quality of an enterprise/proposed project, and the need to consider factors such as gender when selecting enterprises for support.

17 A guide based on Sida's and other actors work using challenge funds in development assistance/as a method of development

WINDOW 2: **RESULTS-BASED FINANCING (RBF)**

The Results-Based Financing (RBF) approach is a financing scheme that provides incentives to foster private sector investments in hard-to-reach, non-commercial, or underserved markets. These incentives can also enable product and service providers to extend additional services, such as after-sales support and warranties in these markets. For this program, the RBF will solely target LPG enterprises. As shown in Table 16, the LPG supply chain actors are not receiving any concessional financial support relative to other cooking solutions. This report has identified this as a critical gap. The Modern Cooking Facility for Africa, for example, does not directly support the uptake of LPG-based solutions. The RBF incentives are provided as ex-post payment to enterprises upon delivery and external verification of pre-agreed results.

The pre-agreed results are the number of LPG cylinders sold to low-income and low-income female-headed households above a pre-agreed baseline (based on historical sales performance). Only sales made above the pre-agreed baseline will be eligible for the determination/calculation An independent verification process of the sales reported by the enterprises will be undertaken by an independent verification agent contracted by the facility to ascertain the validity and accuracy of the information. Verification will trigger the disbursement of the next phase of the incentives. The enterprises must use the RBF incentives to cover consumer sensitisation, training, and education.

The BRILHO Market Development Fund in Mozambique, funded by by Foreign, Commonwealth & Development Office (FCDO), includes an RBF facility that provided an incentive of US$10 per LPG system and an additional US$10 if the sale is made in an underserved area (Energy4Impact, 2021). A similar incentive structure will be adopted for this program with the aim of encouraging companies to expand their sales and operations to densely populated low-income urban areas in Zambia. RBF project beneficiaries will be selected through a competitive approach. The eligibility criteria will include the applicant's legal status and compliance, demonstrated operational experience in urban areas, and manufacturing/ distribution of certified products. The application and payment process should be simple, transparent, and scalable to ensure the benefits of applying an RBF approach are maximized. The ability to confirm the result quickly and accurately will be key in ensuring the success of this program.

Based on the target of 100,000 households by 2028, this RBF component will require approximately US$ 2 million.

6.3.2 Component 2: Consumer financing

Cash transfers are a popular means of subsidizing LPG in developing countries. In 2005 and 2014, the Government of Indonesia applied an unconditional cash transfer initiative to protect poor households against fuel price rises (Savatic, 2016). In 2010, Iran enforced a uniform cash transfer to cushion low-income households from the increasing energy prices (Salehi-Isfahani, Wilson and Deutschmann, 2015).

Notably is the Government of India's Direct Benefit Transfer Scheme –*a conditional transfer scheme for LPG implemented in 2013*. Under this scheme, households bought LPG at the market rate and received a subsidy directly into their bank accounts.

Households were only allowed to purchase a maximum of 12 cylinders of 14.2kgs of gas per year (Sharma et al. 2019). This type of subsidy implementation encountered several challenges, among them being the complex documentation required, which most of the time made banks delay the verification process and reject many applications, thus affecting the effectiveness of the cash transfer process. This was attributed to unpreparedness by banks in the implementation of this scheme. The ripple effect was the delays in the subsidy being credited into the beneficiary's bank accounts, which left distributors with the burden of explaining subsidy-related questions without much information or capacity (Jain, Agrawal and Ganesan 2018).

For this program, the consumer subsidy will be in the form of an asset finance loan, where the customer receives the stove upfront after paying a deposit of 10% of the product cost. The customer will then be allowed to repay the loan upon an agreed period. The Micro Finance Institution (MFI) will have an existing agreement with a supplier of clean cooking products, e.g., pellet stove, ethanol stove, or LPG cylinder, from which the MFI will purchase the products before selling to consumers as a loan product.

During an interview with an MFI, they reported that lower loan ticket sizes {ZMW 5,000-20,000 (US$ 297.62-1,190.48), are risky due to high defaulting rates. As a result, they attract high-interest rates of up to 55-60% per annum and can go as high as 75% per annum. To minimize the risk associated with default in payment, the Development Bank of Zambia (a government-backed financial institution) will absorb credit risk resulting from default in payment by consumers, encouraging local MFIs to provide loans to consumers of clean cooking products. Consumer loans are advantageous in that they allow for flexibility in payment. However, they are expensive in the long run and might discourage consumers from taking them. To counter this, the government must negotiate with the MFIs for subsidized loan rates for consumers purchasing clean cooking products. The repayment period can range between three or six months, with favourable interest rates for shorter repayment periods. Examples of financial institutions that can be approached for this financing model include Entrepreneurs Financial Centre (EFC) and FINCA Zambia Limited.

The second approach in consumer financing would be a demand-side subsidy for households that would not have purchased the stove if the subsidy were not provided. Zambia has a Social Cash Transfer Programme (SCT), administered by the Ministry of Community Development and Social Services (MCDSS) through the Department of Social Welfare[18]. The program was formed to respond to the HIV/AIDS pandemic, leading to most households being left with no breadwinner. The following households are quality to be beneficiaries of the program.

- Female-headed households with three children or more.
- Child-headed households: This is a household that is headed by a child aged 18 years and below.
- Households with a person (s) who are chronically ill on palliative.
- Households with a person (s) with severe disability.
- Households with an elderly member aged 65 years and above.
- The household must be resident in the same locality for a continuous period of 6 months or more.

The program is in all districts in Zambia (116), with approximately one million registered beneficiaries. The beneficiaries receive bimonthly cash transfers of 180 ZMW (11 US$), and the people with disabilities receive 300 ZMW (18 US$). Suppliers can use this platform and delivery mechanism to identify households purchasing the stoves through a bi-monthly cash top-up, which the household may use to repay the product in six installments. The household will be expected to pay the registration fee (e.g., 1 US$) to foster commitment, and the program will send an extra amount to their usual cash transfer that they would then use to purchase the stove on a Pay-as –go model. Giving the household the cash to buy the stove improves ownership/appreciation of the stove instead of receiving the stove free. To encourage suppliers to join the program, non-repayments by the households, even after receiving the cash, will be fully compensated.

18 Ministry of Community Development and Social Services (MCDSS) through the Department of Social Welfare .https://www.mcdss.gov.zm/?page_id=2086

The program will target households in urban areas that use fuel that is not freely available (e.g., purchasing ethanol for their cooking needs). This will ensure they can still buy LPG or Ethanol in small quantities at a price comparable to the cost of charcoal. The first phase can target 1,000 households and scale in phase 2 depending on lessons learned from the first phase. This approach of delivering subsidies would limit leakages to non-deserving households.

As indicated earlier, ethanol and pellet cooking technologies are still at their nascent stage in Zambia. Therefore, there is no significant data to allow the projection of the estimated number of consumers to be targeted by 2028. The budget estimates for this component were calculated based on projections for LPG consumers by 2028.

However, the budget will cater to consumers willing to purchase pellet stoves, ethanol stoves and LPG cylinders. Based on the target of 100,000 households by 2028 and the average cost of 6kg cylinder, 9kg cylinder, pellet stove, and ethanol stove being US$ 65 (USAID Zambia, 2021), approximately US$ 6.5 million should be set aside for consumer financing.

6.3.3 Component 3: Technical assistance and Facility Management

A. Technical Assistance

The technical assistance component is non-financial assistance provided as value-add services to the enterprise. It is essential in helping applicants with their business plans, project proposals, and project implementation. It helps maximize the quality of project implementation outcomes, business sustainability, and impact. Applicants can benefit from technical assistance from the application process to the proposed implementation stage. Technical services include, but are not limited to:

1. Awareness campaigns/consumer education.

Among other factors, the slow growth in clean cooking usage in Zambia has been attributed to the Zambian population being unaware of alternative clean cooking solutions for domestic use and the myths surrounding the safety of LPG (UNCTAD, 2011). This program will undertake awareness campaigns on ethanol, LPG, and pellets, primarily targeting women since they are majorly involved in household cooking.

Educating them on the benefits of switching to cleaner cooking solutions is essential. This is expected to build consumer awareness of, trust in, and stimulate demand for cleaner cooking solutions, which are key enablers in establishing commercial markets. In addition, the program will work with health practitioners, women groups, and educators on the issues of household air pollution resulting from using traditional fuels and alternative cooking options. Gender-targeted messages will be developed, and clean cooking champions will be identified per each predetermined zones in the urban areas. Mass media, social media, and other innovative marketing options will be used to raise awareness of clean cooking solutions and, consequently, demand for clean cooking solutions. Youths and women will be used as clean energy marketers, which will be a source of income and a way to break social norms regarding clean cooking. If need be, a consultant may be contracted to lead this component. The program will also coordinate with other development agencies to ensure complementarity with other cooking initiatives and avoid duplication.

2. Capacity building.

In addition to awareness programs, capacity-building programs are essential in providing Government agencies and enterprises with the skills required to develop the clean cooking sector. Government agencies can benefit from information on clean cooking products and best practices for scaling the market to serve consumers commercially. Capacity building helps enterprises build their managerial, operational, financial, and capital-raising capabilities. To promote gender equity, the program will offer capacity building in the form of training workshops for entrepreneurs in the clean cooking sector. The workshops will seek to support meaningful involvement of decision makers who aspire to function in support of gender equity but are unaware of how to go about it. In addition, to promote women entrepreneur's economic empowerment, the program will offer workshops to equip women with skills to run their businesses effectively and profitably. These interventions set the foundation for a suitable clean cooking sector. This program will target youth and women as LPG, ethanol, and pellets marketers.

3. Policy and regulation advocacy.

Several national Government policies have been established in Zambia to address biomass energy use. For example, the 1994 National Energy Policy (revised 2008) aimed to reduce charcoal production by 400,000 tonnes by 2010 by encouraging more efficient production and promoting the use of alternative fuels (Atteridge et al. 2013). Similar goals are contained in the 2002 and 2006 poverty reduction strategy papers, Zambia SEforALL Action Agenda, and the vision 2030, all aiming at reducing fuelwood use to 40% by 2030 (Republic of Zambia, 2016). In addition, the current petroleum standards address the storage and distribution of petroleum products; electrical installations in the distribution and marketing sector; and the installation of underground storage tanks, pumps/dispensers, and pipework at service stations and consumer installations. This program will provide technical assistance in reviewing related policies and regulations and identifying areas for improvement to support market development. Among regulations that need to be addressed include:

i. **The cylinder exchange pool.** Currently, consumers can only exchange their cylinders with cylinders of the same brand (USAID Zambia, 2021). A change in this regulation will not only provide consumers with a broader choice of LPG brands but also increase the accessibility of LPG. However, this should be accompanied by enforcement of monitoring and inspection of LPG cylinders to ensure compliance with Zambian standards.

ii **.Tax exemption.** Value-added tax and import duties on LPG, ethanol, and pellets can significantly increase the cost of companies to import these fuels, which in turn increases the retail price customers pay. Currently, pellets are subjected to VAT in Zambia, making the cost of pellets higher and unaffordable to low-income households. For LPG, there is a waiver (until 30th September 2022) on imported petroleum products to avert the fuel price hike.[19] However, the reinstatement of taxes will likely push the cost of LPG, making it out of reach for low-income households. Additionally, LPG cylinders are subject to 15% import duty and 16% VAT making the cylinders unaffordable to low-income earners. On the other hand, cooking appliances for ethanol are currently zero-rated for import and VAT.

B. Facility Management

A common approach by most donor institutions is to subcontract the management of funds to external organizations due to the high administration costs. Subcontracting is undertaken through competitive bidding. Activities to be undertaken by the facility manager include but are not limited to:

1. **Fund administration,** including finalizing the program design.

2. **Monitoring.** Monitoring is essential for tracking progress against the agreed milestones. Therefore, day-to-day monitoring of the implementation progress will be done in-house under the lead of the project manager. This will inform any delays or difficulties faced during the implementation so that proper and timely support or corrective measures can be taken.

3. **Baseline, Mid-term, and End-term evaluation.** For the evaluations, this program will engage an independent verification agent to check the project documents submitted by the grantee against the results. Suppose the grantee retails the LPG cylinders with an in-built PAYG technology. In that case, data from the technology will be used for monitoring, reporting, and verification. A portfolio baseline study will be conducted 2-5 months after contracting. This will provide the basis for the World Bank to review the situation for grantees. In addition, it assists in comparing changes during mid-term review and final evaluation. The mid-term evaluation will aim to assess the continued relevance of the program and progress towards achieving laid-out impacts. It will take place at the implementation mid-point of the program, essentially after two and half years. The end-term assessment will focus on the program results and how they were achieved and will be vital in deciding whether to continue the program, improve it, scale it or replicate it elsewhere. Recognised evaluation criteria will guide both mid-term and end-term evaluations around relevance, efficiency, effectiveness, impact, and long-term sustainability.

19 LusakaTimes.com. "Zambia: Extension of waiving tax on imported fuel, while helping consumers will see Government lose Money." (2022).https://www.lusakatimes.com/2022/01/15/extension-of-waiving-tax-on-imported-fuel-while-helping-consumers-will-see-Government-lose-money/> [Accessed 13 June 2022].

6.4 Program budget

The breakdown of the proposed program budget is indicated in Table 18 below.

Table 18: PROGRAM BUDGET

#	Component	Unit cost (US$)	Quantities	Total costs (US$)	Comments
1.	Consumer financing				
	6kg,13kg LPG cylinders, ethanol stove, and pellet stove	65	100,000	6,500,000	The average cost of a 6kg cylinder, 13kg cylinder, ethanol stove, and pellet stove is US$ 65. Over the 5 years, the program targets 100,000 households.
2.	Enterprise financing				
a	Challenge fund	-	-	3,000,000	Enterprises will participate in a competition with the best business proposal, receiving grant funding.
b	Results Based Financing	20	100,000	2,000,000	Offer an incentive of US$10 per LPG unit sold and an additional US$ 10 for every sale in underserved areas.
3.	Technical Assistance & Facility Management				
	Capacity building	-	-	100,000	Hire a consulting firm to handle the component of capacity building. It will involve training enterprises on marketing, preparing project proposals, and pitching their business models.
	Consumer education	-	-	200,000	Hire a consulting firm to handle the awareness creation component that will apply the below-the-line (BTL) and above-the-line marketing (ATL) techniques.
	Policy and regulation	-	-	200,000	Conducting market assessment to support regulations in favor of the use of clean cooking solutions.
	Finalize the design of the program	1	100,000	100,000	Hire a consultant to finalize the design of the program.
	Monitoring, evaluation, verification, and reporting	4	50,000	200,000	Conduct baseline, midterm, and end-term evaluation, and verification, each at US$ 50,000.
	Support administration			1,000,000	10% of the total cost.
Total cost for the program				**13,300,000**	

6.5 Institutional arrangement

The success of previous programs was pegged on effective sector stakeholder consultations, which aim at gathering stakeholders' input for the program implementers to understand key concerns and address them adequately. Stakeholders' engagement will assist in getting buy-in from the political establishment. This will be crucial in implementing this program. This was evident in the India LPG subsidy reform program that received positive support from the Prime Minister and the Executive arm of the Government. This support ensured the scheme was implemented through the political and operational challenges (Mital, Mukherjee and Gelb, 2017). This analysis proposes a governance structure constituting a Steering Committee, Project Implementation Unit (PIU), Selection Panel, and Grant Recipients (enterprises and consumers).

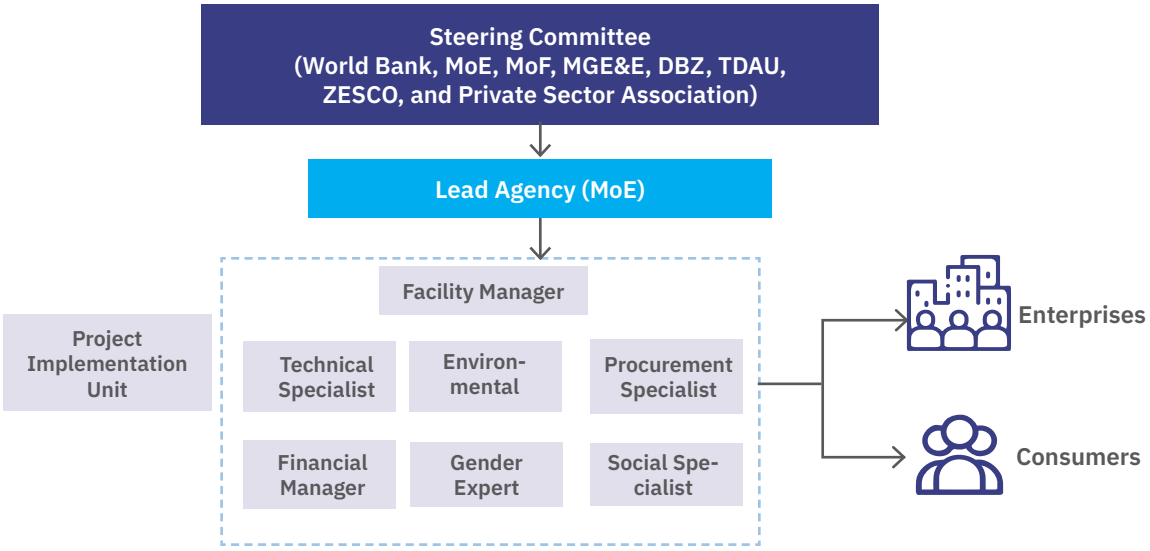
The Ministry of Energy Zambia will host the Steering Committee. Its composition should preferably include representatives from the Ministry of Energy, Development Bank of Zambia, Ministry of Finance, Ministry of Health, Ministry of Lands and Natural Resources, Ministry of Commerce, Trade and Industry, and the World Bank, Team. It will be responsible for providing strategic oversight, including approving any changes made to the scope or budget for this program. Development Bank of Zambia will be the fund manager since it is already trained in fund management and has developed operational manuals to enable it to undertake this role under the existing World Bank Project – Electricity Services Access Project hosted by the Development Bank of Zambia.

The project implementation unit will be composed of a project manager who will be responsible for the overall execution of the program and will work closely with the Technical Manager who will be responsible for administering activities stipulated under components 1 and 2, including ensuring gender integration within the program. The Financial Manager will be responsible for the management and rollout of the debt facility. Other specialists in the project implementation Unit include procurement, environmental, social, and gender experts. The Project Implementation Unit (PIU) will oversee the approving of enterprises/ MFIs to receive funding with DBZ making sure the approvals are consistent with the fund principles before disbursement of funds. The PIU will be responsible for progress and financial reports provided every six months.

The selection panel/investment panel will be responsible for reviewing and selecting enterprises to be funded under the program as per approved selection criteria. The panel will be independent and formed with representation from the Energy Regulations Board, Department of Energy, Central, and Project Implementation Unit.

Figure 29 shows the proposed institutional structure of this facility.

FIGURE 29
FACILITY INSTITUTIONAL STRUCTURE

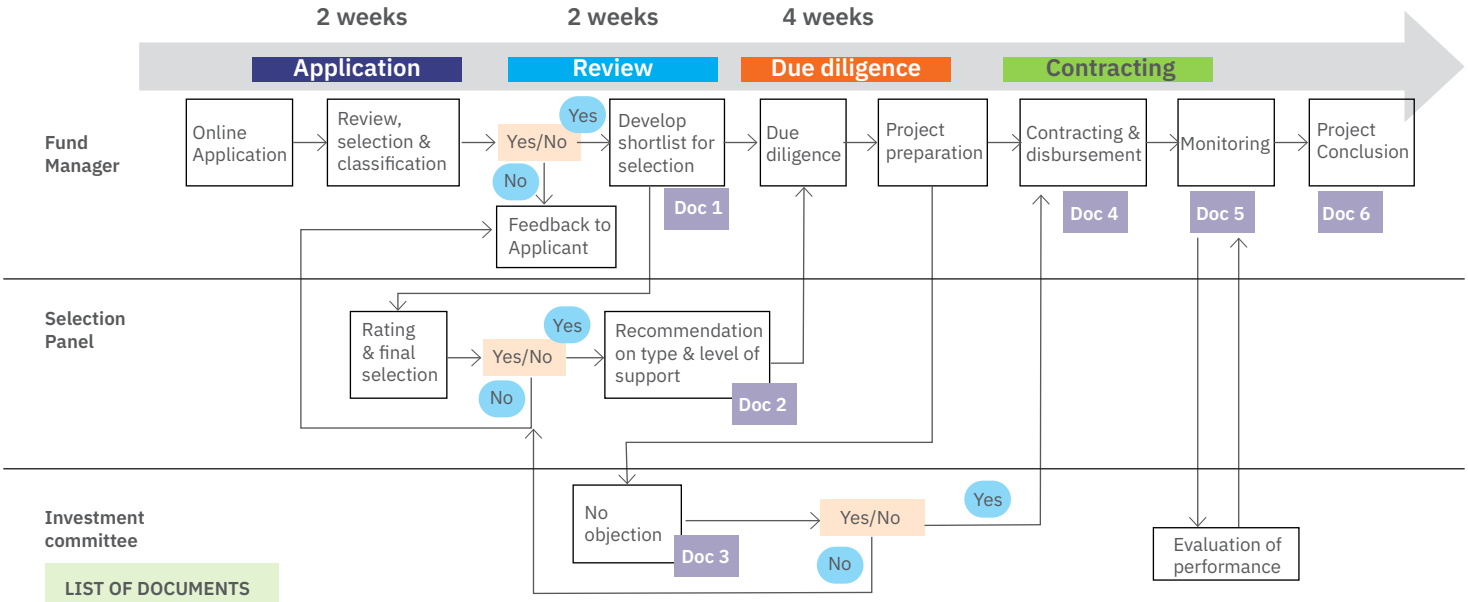


MoE - Ministry of Energy,MoF - Ministry of Finance,ZABS - Zambia Bureau of Standards,TDAU - Technology Development and Advisory Unit,
ZESCO - Zambia Electricity Supply Corporation,MGE&E - Ministry of Green Economy and Environment,DBZ - Development Bank of Zambia

6.6 Operational procedures

The operational procedures will be detailed in the operating manual, which will include, among other things, eligibility criteria, type of RBF beneficiaries, application processes, and verification procedures. Figure 30 below outlines the application steps for enterprises.

FIGURE 30
SUMMARY OF THE APPLICATION PROCESS FOR ENTERPRISES



LIST OF DOCUMENTS
1. Business proposals
2. Selected report
3. No objection letter
4. Contracts
5. Independent verifier reports
6. Final project report

6.7 Risks

The main risks are anticipated at three levels: supply side, demand side, and Government side. Table 19 explains the risks and possible mitigation measures.

TABLE 19: ANTICIPATED RISKS DURING PROGRAM IMPLEMENTATION

#	Risks identified	Likelihood	Mitigation measures
A	**Supply-side risks**		
1	Low interest among potential enterprises	Low	The calls for proposals will be widely circulated and engage local stakeholders to generate traction for the uptake of this funding opportunity.
2	Data risk: Inadequate clean cooking market intelligence to build an evidence-based business case	High	Collaborating with partners in the clean cooking space to share the relevant data.
3	Enterprises have weak systems and structures	Medium	The program will undertake a need assessment for all grantees and identify priority challenges that will need to be addressed (immediate, medium & long-term) through technical assistance during the program period.
4	Non-scalable business model	Medium	The program will develop criteria for assessing the business model's scalability and sustainability. If it is unsure or lacks a track record, the program will recommend the enterprise pilot model before replicating and scaling up. An example of such a business model is PAYG LPG.
5	Limited ability by enterprises to make a sound application	Medium	The application will be made in a stepwise approach from concept to business plan process. The program will provide a ready, well-detailed, and easy-to-follow template to ensure all the required information is captured.
6	Inadequate capacity to implement the project	Medium	The selection criterion and assessment of potential enterprises and business models will consider the technical capacity to deliver expected impacts.
7	Inability by enterprises to make sufficient installations	Medium	The program will develop a proactive monitoring system. In addition, technical support can be provided where appropriate.
8	Project failing to result in the expected gender benefits.	Medium	Evaluation and due diligence to cover potential gender benefits and incomes. Support will be consulted during project implementation to ensure gender benefits are achieved.
B	**Demand-side risks**		
1	Market risk: Low-income customers cannot afford or are not willing to pay for clean cooking solutions	High	The target market is urban and peri-urban communities with medium disposable income. The enterprise's business model will be assessed and allowed to develop innovative mechanisms to ensure the solutions offered are affordable to the end-users.
2	Awareness risk: Low awareness of the clean and alternative cooking solutions	High	The grantees will be allowed to undertake sensitization campaigns in their target market using the fund
3	Cultural & perception risk: Many people are bound to the traditional way of cooking. Some claim food cooked traditionally tastes better than on a modern stove	Medium	The grantees will be allowed to undertake consumer education and demonstrations for their target market through the fund to clear some of the misconceptions
C	**Government side risks**		
1	Lack of ownership from the Government	Low	Local institutions, relevant stakeholders, and Government agencies will be engaged throughout the project.
2	The regulatory environment associated with the program is underdeveloped	Low	Relevant stakeholders will be engaged and institutional support to address identified gaps harnessed.

07| Conclusions and Recommendations

7.1 Conclusions

Enabling Environment

Information gathered in this study identifies both enablers and barriers to the uptake of cleaner cooking solutions across the different actors in the cooking solution landscape in Zambia. Measures supporting the growth of the clean cooking sector by improving the enabling environment are already ongoing or in existence. Such efforts include: Suspending VAT on LPG fuel and cooking appliances and reducing excise duty on ethanol from 125% to 65%. In addition, the ethanol standards are being developed, and the existing LPG standards are being revised. Currently, the sale of LPG is restricted to petrol stations due to safety considerations. The revision process will allow other authorized outlets to also sell LPG and thus expanding the availability of these services. The lack of internationally recognized standards (e.g., biomass solutions standards) and limited testing capabilities of cookstoves in the country is a significant barrier to scaling up the adoption rates. However, the World Bank in collaboration with the Ministry of Energy is supporting a study assessing the feasibility of setting up a stove testing laboratory at the Technology Development Advisory Unit (TDAU) in the University of Zambia.

Several development agencies are supporting initiatives that promote the use of higher-tier cooking solutions such as ethanol, pellets, and LPG in Zambia. More than US$ 50 million in support will be delivered by USAID (A2C), SIDA (MCFA) and Heza (Clean Flame Fund) combined. Zambia has exceptionally high interest rates make credit inaccessible to many supply chain actors. This is one of the main barriers to access to finance. On average, the interest rates available to most supply chain actors is between 55% and 60% per annum. The interest rates available to micro-enterprises can go as high as 75% per annum. Although loans denominated in US dollars have lower interest rates ranging between 13% to 28% per annum, the currency of trade is Zambian Kwacha (ZMW) exposing the borrowers to foreign exchange risks. Even without the forex risk, these are still relatively high interest rates. Many financial institutions also require collateral in form of fixed assets (such as land or buildings) which excludes many businesses. However, there are loan products designed for women with flexible requirements where movable assets such as electronics can be leveraged as collateral. Due to a lack of affordable loans with flexible requirements for enterprises, small and medium enterprises, and new entrants to the market struggle to scale their business, develop their supply chains and conduct awareness creation campaigns to promote the uptake of clean cooking solutions.

Trends and Barriers in the Zambia cooking sector

Charcoal is the most common cooking solution in urban areas, with approximately 60% of all residential users which is approximately one million households using it as the primary fuel. It plays a dual role as a source of income for rural households and a source of affordable energy for urban users. Relative to most fuels, charcoal is affordable, available, and easily accessible. These characteristics guarantee a sustained demand for the product. Electricity,a clean fuel,is the second most used fuel in urban areas and is also supported by similar characteristics. Most higher tier solutions struggle to favorably compete with charcoal, even though they are associated with environmental, health, and climate benefits.

Data from Focus Group Discussions confirms that the level of awareness and exposure to improved cooking solutions such as bioethanol, pellets, and briquettes among households is low. Many of these solutions have limited last-mile distribution networks. The lack of awareness of these cleaner cooking solutions, their market sizes, and their risk profile limit financial institutions appetite to lend to the supply chain actors. As a result, these

financial institutions are unwilling or unable to offer the much-needed financial services.

Compounding these barriers is the affordability of the solution (upfront cost) and/or fuel (recurrent cost). Almost all higher tier stoves have a relatively high price compared to traditional solutions. The use of these solutions is therefore restricted to higher income households. Socio-cultural preferences and other factors beyond affordability also contributes to the current mix of cooking solutions. This analysis finds that 35% of households in the 5th wealth quintile (wealthiest households) still use charcoal while 4% use wood. Although affordability is an overarching barriers other factors such as convenience, cooking practices, lack of awareness, and consistent supply of alternative fuel contribute as well.

Based on Zambia Multi-Tier Framework (MTF) data analysis, 51% of households are willing to pay the total cost (ZMW 979.6) of an improved cookstove upfront (gasifier pellet stove). The willingness increased by 63% when the stove is presented at a discounted price of ZMW 646.5. The progressive reduction in price increases the willingness to pay as expected. There are several cleaner cooking solutions including the 6 kg LPG, ethanol solutions, and others ranging from ZMW 120 to 800 which theoretically means that targeted subsidies that discount the upfront cost could make many of these products within the reach of most households. Subsidies should be complemented by other measures e.g., extending the repayment period. Addressing affordability will increase uptake and use only if other barriers to uptake and use such as accessibility, availability, and awareness will be addressed. Awareness constitutes a lack of knowledge or exposure but in extreme cases, a misconceived aversion to using some solutions. LPG and ethanol are, for example, perceived to be unacceptably dangerous. Without a programmatic approach that systematically removes the barriers to uptake and use, singular or univariate approaches are bound to have a lopsided effect on the sector,and be insufficient in achieving the desired impact.

Gender and access to cleaner cooking solutions

There are more male-headed households in Zambia's urban areas (76%) than female-headed households (24%). According to the Multi-Tier Framework data, only male-headed households were using LPG solutions for cooking. This stem from the safety concerns associated with the solution but crucially, because LPG systems are more expensive relative to other solutions and women-led households have on average significantly less disposable income. Additionally, the Focus Group Discussions data indicates that men are more likely to have a steady income relative to women, thus, able to purchase and use fuels that have relatively higher recurrent costs. This demonstrated the need to create awareness not only among the women, who mainly carry out the food preparation activities, but also among men as they could influence the purchasing choices. The provision of such information will make them more agreeable to setting aside funds for purchasing cleaner stoves and recurrent costs of the fuels. Female-headed households are more likely to be using a biomass stove (charcoal and wood) at 69.9% compared to male-headed households at 65.4%. 83% of male-headed households were willing to pay the total price (ZMW 979, or about US$ 58) upfront for an ICS stove compared to 17% of female-headed households. This observation shows the need to have programs for cleaner cooking solutions that target female-headed houses to bridge the accessibility gap.

Program Design

This market assessment forms the basis for a demand-driven intervention that removes the critical barriers to limiting the uptake and use of cleaner solutions. The proposed US$ 13.3 million program aims to directly facilitate the transition to cleaner cooking solutions among 100,000 households and will indirectly stimulate further promotion across the market by demonstrating the viability of these solutions among underserved urban areas. A program that cuts across multiple solutions is preferred instead of a one-solution approach. The cooking solution must have Green House Gases (GHG) abatement potential, government support, fit the urban context, and record a stove performance (thermal efficiency, emissions, safety, and durability) of tier 3 and above. The program aims to systematically address barriers to access to finance, lack of adequate last-mile distribution networks among suppliers, and affordability of the appliances among low-income end-users. The program will achieve its goals by providing concession financing, including grants and subsidies along the supply chain, while supporting awareness creation initiatives (impacts of cooking with dirty fuels, safety concerns, types of cleaner cooking solutions, etc.).

Enterprise financing will be through Result-based financing (RBF) and other types of grants, while consumer financing will consist of loans at lower rates and demand-side subsidies. The RBF component is structured to encourage the sale of cleaner solutions in low-income areas while targeting female-headed households. To minimize the potential leakage of demand-side subsidies, the Social Cash Transfer Programme (SCT), administered by the Ministry of Community Development and Social Services (MCDSS) through the Department of Social Welfare, will be used as the delivery channel to target deserving households. The program will be coordinated under the Ministry of Energy. Other key stakeholders will include the Development Bank of Zambia, Ministry of Finance, Ministry of Health, Ministry of Lands and Natural Resources, Ministry of Commerce, Trade and Industry, and the World Bank Team.

7.2 Recommendations

Strengthen policy, standards, and institution framework

The Energy Policy (2019) highlights strategies for promoting improved cookstoves, and recommends that an implementation plan for the proposed strategy, and a regulatory framework for the cookstoves be developed to guide the realization of the goals. In 2016, the government set an ambitious goal of

- 20% Electricity:
- 40% LPG:
- 20% Charcoal:
- 20% Firewood

to promote cleaner cooking technologies for urban households.

These targets are set from the baseline of

- 35% Electricity:
- 0.1% LPG:
- 60% Charcoal:
- 6% Firewood.

It is also unclear why the government intends to increase the use of firewood (dirty fuel) to 20% from a baseline of 6%. There is a need to revise these targets and include other cleaner technologies, such as bioethanol and pellets, which are excluded from this goal. There is also a need to address supply-side barriers associated with national production or sufficient importation (e.g., expanding storage, zero rating imports of cylinders) of LPG at the upstream level if the uptake of this solution is to grow by almost 40%.

There is still a long way to go before biomass solutions (e.g., pellets, charcoal, wood stoves, among others) are eradicated from Zambia's energy mix for cooking. Therefore, internationally recognized standards need to be developed and effectively implemented. Revision of the LPG standards and formulation of ethanol standards by the government is a step in the right direction as it will assist in product differentiation, diversity of solutions, and development of supply chains in the case of LPG. A testing centre for cookstoves in the country must be set up to contribute to quality products in the market, spur innovation, and significantly contribute to scaling up the adoption rates.

Strengthen sectoral coordination

Although there is awareness among the cooking sector players on the ongoing initiatives, there is still room for better coordination that facilitates a structured and continuous collaboration towards achieving the clean cooking goals by 2030. Once there is a clear plan agreed upon by all relevant stakeholders, including the public sector, development agencies, private sector, academia, and civil society, then the industry must transition from planning to implementing the plans. For instance, the private sector, civil society, and development agencies could coordinate promotional and educational campaigns to improve awareness of the benefits of improved cookstoves solutions. Like any new products, the benefits of these solutions should be well marketed to increase their appeal. On the other hand, academia and private institutions could be involved in research and development. Efficiency,time and fuel-save improvements are primary in stove design because they improve economics in terms of fuel cost and the time spent cooking.

Public institutions can play a role in contributing to policy development as well as subsequent implementation. Coordination across sectors and institutions to take advantage of complementariness and provision of appropriate interventions to promote clean cooking in Zambia is essential to achieving maximum benefits and avoiding duplication of efforts.

Provision of market intelligence and continuous tracking

Understanding consumer needs and wants are critical to success in the clean cooking sector. Benefits associated with clean cooking cannot be achieved unless consumers see cooking technologies and fuels as advantageous products that provide an improved cooking experience and add value to their lifestyle.

Also, consumers, especially those at the base of the pyramid, are not a uniform market. Instead, they consist of varied market segments with distinct needs, motivations, and perceptions. Market research can be used to uncover and better understand these segments. These insights could attract and guide private sector investments including willingness among financial institutions to provide much-needed capital for this sector. Identifying perceptions from end users will lead to marketing interventions that better address their needs and preferences. Knowledge about markets is critical for overcoming supply-side barriers and spurring the adoption of clean cooking solutions and fuels. Some clean cooking fuels such as ethanol, pellets and LPG are nascent in Zambia but with insufficient data on cooking habits, purchasing trends, financial needs, fuel costs, cultural barriers, and communication strategies. Robust market intelligence reports provide the needs, wants and aspirations of consumers. Insights gained from market assessments can be incorporated into the design and execution of market strategies. This leads to a thriving market for clean cooking solutions, which attracts investors into the sector.

Enhance access to finance and fiscal incentives

The cost of clean cooking fuels and technologies is one of the primary factors that deter households from adopting clean cooking solutions in Zambia. Critical stakeholders in the clean cooking sector, such as government agencies, have a duty to provide a favourable environment that promotes clean cooking by addressing documented financial barriers. The assistance should

- **target upstream players**, including manufacturers and importers of fuels and appliances;
- **midstream players**, including the distributors with working capital support;
- **downstream players**, including last mile distributors; and consumer finance.

Measures such as tax exemptions, reduced import duties and subsidies on imported appliances and clean fuels are one of the many solutions that can be considered. Another measure that can be considered is the investment in local manufacturing of clean cooking appliances to minimise the cost of importation, which will lower the price. For instance, the manufacturers of Mbaula charcoal stoves could be trained on how to produce improved charcoal stoves. The use of local raw materials would significantly reduce the cost of production. Offering affordable cooking fuels to households will encourage the adoption of clean cooking solutions.

Financial institutions should leverage green finance to caution their risk of lending to producers and consumers in the sector. While there are interventions that provide financial assistance to producers of clean cooking solutions, the funds remain inaccessible to informal cooking sector entrepreneurs for various reasons, key among them being the strict funding requirements. Though sector entrepreneurs need to strengthen their capacity to access such funds, the requirements should be designed to accommodate the limitations present in Zambia's informal cooking sector and women-led enterprises. Establishing feasible conditions without weakening the aim of these interventions will be essential in bridging the gap between the funds and the informal entrepreneurs.

However, to ensure the sustainability of clean cooking enterprises beyond donor funding, clean cooking enterprises should be trained on alternative sources of finance like carbon financing. This will be necessary to continue market expansion and to help scale business operations. Likewise, end user finance options also need to be promoted.

An example of such financial support includes a government-backed credit guarantee fund from which local enterprises can draw from to expand their businesses. In the meantime, donor funding can be used to kick-start clean cooking solutions by lowering the initial costs of operations and that of clean cooking appliances.

Awareness creation

Awareness creation in the clean cooking sector in Zambia should happen at two levels:

1. Among consumers on the benefits and usage of clean cooking products and
2. Among manufacturers, distributors, and implementers of programs on standards and regulations within the sector.

A consumer education program would need to be developed with a clear strategy for reaching the various types of end users.

The education program objectives would be to:

- create awareness of the different types of clean cooking solutions as alternatives to traditional fuels or supplement electricity use for cooking;
- highlight the benefits of clean cooking solutions relative to other cooking solutions and demonstrate how these technologies are best used.

The rolling out of awareness creation is determined by the target group. For example, in urban areas, television and billboards would be effective. In rural areas, awareness among Community-Based Organisations, women groups, and youth groups would be successful. It is also essential for different stakeholders in the supply chain to ensure that they are aware of the various standards in the sector. Product standardization ensures cost reduction, production efficiency and convenience to consumers. For maximum market transformation, awareness creation needs to be complemented by other measures such as quality, affordability, and availability of products to the consumers. Financial institutions also need to be exposed to the investment potential within the cleaner cooking solutions markets. This will stimulate lending appetite and guide their pricing based on the associated risk of lending to supply chain actors.

Mainstreaming gender in energy policies and interventions

The baseline data affirms that gender-neutral general interventions will not be sufficient to ensure access to universal access to clean and improved energy solutions by 2030. This conclusion is grounded in the realization that the barriers and opportunities are structured differently across female and male-headed households. While some of these barriers and opportunities are distributed evenly across households, a few are specific and require targeted interventions. Barriers such as affordability, for example, disproportionately affect female-headed households. The disadvantage of having gender-neutral energy policies is that it aggravates the disadvantages that female-led enterprises and households must contend with. The inclusion of gender in energy policies requires acknowledging women's contribution as agents and not only as beneficiaries of clean cooking products. To ensure gender-sensitive energy policies are formulated, there is a need to first conduct a gender analysis of the existing energy policies. This would seek to understand how current policies and practices within the sector address gender inequalities and stereotypes and what can be done to enable gender equality. The analysis would also provide information on critical gender gaps in existing energy policy formulation and implementation, allowing for the development of a more gender-aware policy.

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No	Organization
1.	Entrepreneurs Financial Centre (EFC) Zambia
2.	Development Bank of Zambia
3.	Afrox
4.	Supamoto
5.	VITALITE
6.	Dama Gas (Refilling and home deliverables)
7.	UpEnergy Zambia
8.	Kainos Green Energy
9.	Energy Regulations Board
10.	MoE- Department of Energy
11.	Technology Development Advisory Unit (TDAU)
12.	COMACO
13.	A2C
14.	SNV
15.	SIDA
16.	Bio-Carbon Partners
17.	Biofuels Association of Zambia
18.	Clean Cooking sub-Committee (ESAG)
19.	ZESCO Limited
20.	Greenbelt Energy Limited (GBEC)