BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF SAFETY HEALTH AND ENVIRONMENTAL MANAGEMENT



Framework for the transition to clean household cooking energy in rural communities under low- and middle-income settings.

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE BACHELOR OF SCIENCE HONORS DEGREE IN SAFETY HEALTH AND ENVIRONMENTAL MANAGEMENT.

May 30, 2026

ABSTRACT

Rural households in Zimbabwe and other low- and middle-income countries continue to rely heavily on traditional biomass fuels such as firewood and charcoal for household cooking. This continued dependence contributes significantly to household air pollution, environmental degradation, and adverse health outcomes, particularly among women and children who are most exposed to indoor smoke. Although clean cooking technologies such as liquefied petroleum gas (LPG), electricity, biogas, and improved cookstoves have been introduced, adoption in rural communities remains low and inconsistent due to socio-economic, infrastructural, institutional, cultural, and gender-related barriers. This study examined the development of a context-appropriate framework for clean household cooking energy transition in rural communities of Zimbabwe. The main objective was to identify the key drivers and barriers influencing clean cooking adoption and to propose an integrated framework that supports sustainable energy transitions. A mixed-methods research design was adopted, incorporating both quantitative and qualitative approaches. Data were collected using structured household questionnaires, key informant interviews, focus group discussions, participant observations, and document analysis. The study targeted rural households and institutional stakeholders involved in energy policy and service delivery. Findings revealed that clean cooking adoption is strongly influenced by household income, education levels, infrastructure availability, cultural cooking practices, gender roles, and institutional awareness. Results further showed that limited access to LPG distribution networks, unreliable electricity supply, and weak policy implementation significantly constrain energy transitions. The study concludes that clean cooking transitions require integrated, multi-dimensional interventions rather than isolated technological solutions. It recommends strengthened rural energy infrastructure, targeted subsidies, improved policy implementation, and community-based awareness programs to accelerate adoption of clean cooking technologies in rural Zimbabwe.

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Degree Title: Bachelor of Science Honours Degree in Environmental Health / Safety, Health and Environmental Management

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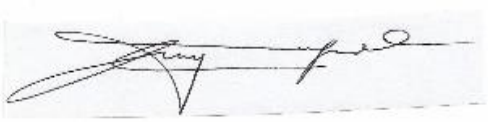
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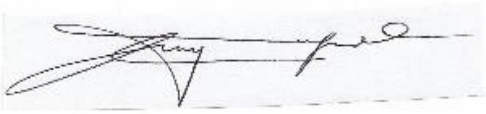
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DECLARATION

I RUTENDO BHERO, declare that this dissertation titled Framework for the transition to clean household cooking energy in rural communities under low- and middle-income settings. is entirely my own original work. All sources used have been properly acknowledged and referenced. This work has not been submitted for any other academic qualification at any institution.

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DEDICATION

I dedicate this research project to my family for their unwavering love, support, and encouragement throughout my academic journey. Their continuous motivation and belief in my abilities have been a source of strength from the beginning of this study to its completion. My two friends Gamu and Chido who became sisters during this academic journey we had together.

ACKNOWLEDGEMENTS

First and foremost, I extend my gratitude to God for His guidance, protection, and strength throughout this academic journey. I would also like to sincerely thank my supervisor for his/her continuous guidance, constructive criticism, and academic support throughout the development of this research. His/her mentorship played a significant role in shaping the quality and direction of this dissertation. I further extend my appreciation to my family and friends for their emotional support, encouragement, and motivation during both challenging and successful phases of this academic journey. Finally, I acknowledge all individuals, institutions, and participants who contributed directly or indirectly to the successful completion of this study. Their support is highly appreciated and will always be remembered.

TABLE OF CONTENTS

Abstract□□□□□□□□□□□□□□□□□□□□...□□□□□□…□□□□□□□.□.i

Approval form……..ii

Declaration……..…iii

Acknowledgements……..…….iv

CHAPTER I: INTRODUCTION□□□□□□□□□□□□□□□□□□□□□□□□…….....1

1.1 Background of the study ……..1

1.2 Statement of the study ……...2

1.3 Aim of the study ……2

1.4 Objectives of the study ……...…2

1.5 Research questions ……..…….3

1.6 Significance of the study ……...…3

1.7 Assumptions of the study ……..3

1.8 Limitations of the study ……4

1.9 Delimitations of the study ……4

CHAPTER 2: LITERRATURE REVIEW……..5

2.1 Concept of clean house hold cooking energy ……...5

2.1.1 Definition and meaning of clean house hold cooking energy……5

2.1.2 Traditional house hold cooking fuels and practices ……...5

2.1.3 Clean cooking fuels and technologies □□□□□□□□□□□□□□□□□□□□□…6

2.1.4 Characteristics of a clean cooking system ……7

2.1.5 Clean cooking energy as a development and policy issue ……7

2.2 Global and regional status of clean cooking in LMI settings ……..8

2.2.1 Global access to clean house hold cooking energy ……8

2.2.2 Regional trends with emphasis on Sub Saharian Africa……9

2.2.3 Rural urban disparities in clean cooking access ……9

2.2.4 Clean cooking and sustainable development goal 7……10

2.3 Theoretical and conceptional framework for clean cooking transition…..……11

2.3.1 Theoretical framework ……11

2.3.2 Conceptional framework……..12

2.4 Health impacts of traditional house hold cooking fuel ……..13

2.4.1 Indoor air pollution from transitional cooking fuels……14

2.4.2 Respiratory and cardiovascular health effects ……14

2.4.3 Impacts on women, children and other vulnerable groups……..15

2.4.4 Eye, skin and other non-respiratory healthy effects ……15

2.4.5 Public health implications of continued use of traditional cooking fuels ……16

2.5 Environmental and climate change implications of traditional cooking practices ……16

2.5.1 Deforestation and forest degradation……16

2.5.2 Land degradation and ecosystem impacts……17

2.5.3 Greenhouse gas and black carbon emissions …..……17

2.5.4 Contribution to climate vulnerability in rural communities ……18

2.5.5 Environmental benefits of transitioning to clean energy……..18

2.6 Socio economic and gender dimensions of house hold cooking energy ……19

2.6.1 Socio economic determinants of house hold cooking choices ……19

2.6.2 Time, poverty and opportunity costs ……..20

2.6.3 Gender roles and house hold decision making ……20

2.6.4 Health education and livelihood implications ……..21

2.6.5 Equity considerations in clean cooking interventions ……21

2.7 Barries to the adoption of clean house hold cooking energy……...21

2.7.1 Economic and affordability barriers ……22

2.7.2 Infrastructure and access constraints……22

2.7.3 Cultural and behavioral barriers ……..23

2.7.4 Gender and intra household decision making barriers ……23

2.7.5 Institutional and policy barriers……23

2.7.6 Interaction of barriers and implications for transition……..24

2.8 Enablers and successful clean cooking interventions ……25

2.8.1 Policy and regulatory support ……..25

2.8.2 Financial mechanisms and affordability interventions ……25

2.8.3 Role of non-governmental organisations and development partners……26

2.8.4 Private sector and market-based approaches ……...26

2.8.5 Community engagement and social acceptance ……..27

2.8.6 Health environmental and climate co benefits as adoption drivers ……27

2.8.7 Lessons from successful clean cooking intervention ……..27

CHAPTER 3: METHODOLOGY……29

3.1 Description of study area……29

3.2 Research designs……..29

3.3 Target population ……29

3.4 Sample size and sampling procedures ……30

3.5 Research instruments……..…30

3.6 Data collection methods ……..31

3.6.1 House hold questionnaire survey……..31

3.6.2 Focus group discussions……..31

3.6.3 Key informant interviews……31

3.6.4 Participant observation ……31

3.6.5 Checklist and systematic review of relevant frameworks……31

3.7 Data analysis……32

3.7.1 Quantitative data analysis……32

3.7.2 Qualitative data analysis……..33

3.8 Development of conceptional framework……33

3.9 Ethical considerations……..33

CHAPTER 4: RESULTS AND DISCUSION……..34

4.1 Introduction ……34

4.2 Response rate and data reliability……34

4.3 Demographic characteristics of respondents□□□□□□□□□□□□□□□□...…□35

4.3.1 Gender distribution……...…35

4.3.2 Age distribution □□□□□□□□□□□□□□□□□□□□□□□□□□□□.…□..36

4.4 House hold cooking energy usage……...…37

4.4.1 Primary cooking energy usage……37

4.4.2 Secondary cooking energy usage……37

4.5 Socio economic factors affecting clean cooking adoption……..38

4.5.1House hold income and clean cooking adoption□□□□□□□□□□□□□□□□...…38

4.5.2 Educational level and adoption……39

4.6 Infrastructure and accessibility outcomes……...39

4.6.1 Access to energy infrastructure……39

4.7 Institutional and policy support□□□□□□□□□□□□□□□□□□□□□□□□□□...…40

4.7.1 Awareness of clean cooking programs□□□□□□□□□□□□□□□□□□□□□.…40

4.8 Cultural and gender outcomes……41

4.8.1 Cultural influence on energy sources……41

4.9 Inferential analysis□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□...…41

4.9.1 Chi square tests: income level versus clean cooking adoption……41

4.9.2 Regression analysis: predictors of clean cooking adoption……42

4.10 Development and validation of proposed framework……43

4.11 Chapter summary□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□...…44

CHAPTER 5 DISCUSION OF RESULTS……45

5.1 Introduction……45

5.2 House hold cooking usage in rural areas……45

5.3 Socio economic factors influencing clean cooking adoption……46

5.4 Infrastructure and accessibility on clean cooking transitions……47

5.5 Institutional and policy support for cooking transition……47

5.6 Cultural and gender considerations in house hold energy choices……47

5.7 Relationship between socio economic factors and clean cooking adoptions……48

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS……50

6.1 Introduction……50

6.2 Conclusions ……50

6.2.1 House hold cooking energy usage……50

6.2.2 Socio economic factors……51

6.2.3 Infrastructure and accessibility……51

6.2.4 Institutional and policy support……52

6.2.5 Cultural and gender factors……52

6.2.6 Framework development and validation……53

6.3 Recommendations……54

6.3.1 Recommendations to the government of Zimbabwe……54

6.3.2 Recommendations to the ministry of energy and power development ……54

6.3.3 Recommendations to development partners and Non-governmental Organisation……54

6.3.4 Recommendations to rural communities……54

6.3.5 Recommendations for future researchers……55

6.4 Chapter summary……56

References……57

Appendix……60

CHAPTER 1: INTRODUCTION

1.Background of the Study

Rural households in many low and middle-income countries continue to rely on traditional biomass fuels such as firewood and charcoal for cooking because of affordability, accessibility, and cultural familiarity. However, research shows that smoke from solid fuels is a leading contributor to household air pollution, which is linked to respiratory infections, chronic lung diseases, and cardiovascular conditions (World Health Organization, 2023). According to Lewis and Pattanayak (2020), income levels, education, and market access significantly influence the adoption of clean cooking technologies. Despite increased policy attention, clean cooking transitions remain slow in rural regions due to persistent structural barriers (International Energy Agency, 2023).

Energy transition in rural settings is shaped by interrelated socio-economic and infrastructural factors. Low household incomes, high upfront costs of LPG and improved stoves, weak distribution networks, and unreliable electricity supply limit sustained adoption (Pachauri et al., 2021). Furthermore, cultural cooking practices and taste preferences often reinforce attachment to traditional fuels. The World Bank (2022) notes that without supportive financing mechanisms and infrastructure development, rural energy transitions remain fragmented and inequitable. These realities demonstrate that clean cooking adoption cannot be addressed through supply-side solutions alone.

Environmental sustainability and gender equity are also central to the clean cooking discourse. Unsustainable harvesting of firewood contributes to deforestation and land degradation, undermining rural livelihoods and ecosystem stability. Women and girls, who are primarily responsible for cooking and fuel collection in many rural communities, face time poverty and health risks due to prolonged exposure to smoke (United Nations Development Program, 2021). Recent studies emphasize that successful energy transitions require integrated frameworks that address health, environmental, economic, and social dimensions simultaneously (Gill-Wiehl et al., 2021).

1.2 Statement of the Problem

Despite clear evidence of the health, environmental, and socio-economic harms associated with traditional biomass fuels, most rural households in low- and middle-income settings continue to depend on firewood and charcoal for cooking. Household air pollution remains a significant public health concern, contributing to preventable illnesses and premature deaths (World Health Organization, 2019). Studies show that adoption of clean cooking technologies is constrained by income limitations, weak infrastructure, limited policy coordination, and cultural preferences (Lewis & Pattanayak, 2020; World Bank, 2021). The persistence of these barriers highlights the absence of a comprehensive and context-sensitive framework to guide effective transition strategies in rural low- and middle-income communities.

1.3 Aim of the Study

The study seeks to develop a context-appropriate framework that supports the transition to clean household cooking energy in rural communities under low- and middle-income settings.

1.4 Objectives of the Study

The objectives of this study are to:

1. Evaluate cooking energy usage in rural communities.

2. Analyze socio-economic factors affecting adoption of clean cooking fuels for household energy.

3. Identify the influence of infrastructure and accessibility on the adoption of clean cooking energy.

4. Examine institutional and policy support for transition to clean energy for household cooking.

5. Investigate cultural and gender considerations related to energy consumption for cooking in households.

1.5 Research Questions

The study seeks to answer the following questions:

1.Which energy sources are used for cooking by rural households?

2. What role do socio-economic variables play in the use of clean household cooking energy?

3. How significant are infrastructure and accessibility in influencing the use of clean cooking energy?

4. What is the involvement of institutions and policies in promoting clean cooking energy?

5. What is the relationship between cultural practices and household energy choices?

6. What are the barriers and facilitators of the transition to clean fuels for household cooking in rural areas?

1.6 Significance of the Study

This study is significant because it provides evidence-based insights that can guide policymakers, development practitioners, and energy planners in designing practical strategies for accelerating clean cooking transitions in rural low- and middle-income communities. By integrating socio-economic, infrastructural, cultural, and institutional perspectives, the proposed framework contributes to improved public health outcomes, environmental sustainability, and gender equity while strengthening the academic discourse on household energy transitions.

1.7 Assumptions of the Study

- Rural households are aware of at least one clean cooking energy alternative.
- Socio-economic conditions significantly influence household energy choices.
- Institutional and infrastructural support affects adoption of clean cooking technologies.
- Respondents will provide reliable and truthful information during data collection.

1.8 Limitations of the Study

- The study focuses on selected rural communities, which may limit generalization to all settings.
- Financial and time constraints may restrict the sample size.
- Some respondents may provide socially desirable responses.

- Rapid economic or policy changes during the study period may influence household decisions.

1.9 Delimitations of the Study

- The study concentrates only on household cooking energy and excludes lighting or industrial energy use.
- The research focuses on rural communities within low- and middle-income settings.
- The study examines household-level energy decisions rather than national energy supply systems.
- The proposed framework is tailored to rural contexts and may require adaptation for urban settings.

CHAPTER TWO: LITERATURE REVIEW

2.1 Concept of Clean Household Cooking Energy

2.1.1 Definition and Meaning of Clean Household Cooking Energy

Clean household cooking energy refers to cooking fuels and technologies that enable food preparation with minimal emission of harmful pollutants, high combustion efficiency, improved safety, and reduced environmental impact when compared to traditional biomass-based cooking systems. Clean cooking energy is increasingly recognized as a critical component of sustainable development, public health improvement, and environmental protection, particularly in low- and middle-income countries (LMICs) where reliance on traditional cooking fuels remains widespread (World Health Organization, 2022).

The concept of clean cooking extends beyond the type of fuel used to include the entire cooking system, encompassing the fuel source, stove technology, ventilation, and user practices. A cooking system may only be considered clean if it significantly reduces household exposure to smoke and toxic emissions while remaining affordable, accessible, and culturally acceptable to users. Consequently, clean cooking energy is increasingly framed as a public health and development intervention, rather than solely an energy-sector concern.

In LMIC contexts, clean cooking energy is essential for addressing persistent challenges such as indoor air pollution, deforestation, climate change, and gender inequality. The adoption of clean cooking solutions is therefore closely linked to broader development outcomes, including improved health, enhanced productivity, and sustainable natural resource management.

2.1.2 Traditional Household Cooking Fuels and Practices

Traditional household cooking fuels commonly used in LMICs include firewood, charcoal, crop residues, and animal dung. These fuels are typically burned in open fires or simple stoves constructed from clay, metal, or stones. Such cooking systems are characterized by incomplete combustion, low thermal efficiency, and high emissions of smoke and particulate matter. Cooking is often carried out in enclosed or poorly ventilated spaces, increasing exposure to harmful pollutants.

Traditional cooking practices persist largely because biomass fuels are perceived as readily available and low-cost, particularly in rural areas where households collect firewood from surrounding environments. However, the apparent affordability of these fuels masks significant hidden costs, including health impacts, environmental degradation, and the time burden associated with fuel collection. Studies have consistently shown that reliance on traditional cooking fuels is strongly associated with poverty, limited access to infrastructure, and weak institutional support for alternative energy sources (IEA, 2023).

The continued use of traditional cooking fuels reflects not only economic constraints but also deeply embedded cultural practices. In many rural communities, cooking methods are closely tied to food preferences, social norms, and household roles, making transition to alternative systems more complex than simple fuel substitution.

2.1.3 Clean Cooking Fuels and Technologies

Clean cooking fuels and technologies are designed to address the limitations of traditional systems by improving combustion efficiency and reducing emissions. Common clean cooking fuels include liquefied petroleum gas (LPG), electricity, biogas, ethanol, and solar energy. These fuels are typically used with purpose-designed stoves that allow for controlled combustion and improved heat transfer.

LPG is widely promoted as a clean cooking fuel due to its high energy density, rapid cooking time, and low emissions at the point of use. Electricity provides one of the cleanest cooking options, producing no indoor emissions; however, its use in rural LMICs is often constrained by unreliable supply, high tariffs, and limited grid coverage. Biogas offers a renewable alternative suitable for rural households with access to livestock and water, although initial installation costs can be prohibitive.

Improved biomass cookstoves occupy an important position within the clean cooking spectrum, particularly in rural areas where complete fuel switching is not immediately feasible. These stoves aim to reduce fuel consumption and emissions while allowing households to continue using familiar biomass fuels. Solar cookers represent an environmentally sustainable option but face challenges related to weather dependency, cooking speed, and cultural acceptability.

2.1.4 Characteristics of a Clean Cooking System

A clean cooking system is defined by several interrelated characteristics that determine its effectiveness and sustainability. Energy efficiency is a critical attribute, as efficient systems require less fuel to achieve the same cooking output, reducing costs and pressure on natural resources. Low emissions are essential for minimizing health risks associated with indoor air pollution. Systems that fail to significantly reduce emissions may not deliver meaningful health benefits. Affordability and accessibility are equally important. Even the cleanest technologies will experience low adoption if households cannot afford upfront costs or recurring fuel expenses. Accessibility includes physical availability of fuels and spare parts, as well as reliability of supply. Safety is another defining characteristic, particularly in households with children, where risks of burns or explosions can deter adoption. Finally, cultural compatibility plays a decisive role in determining sustained use. Cooking systems must accommodate local food types, cooking methods, and household preferences. Technologies that conflict with established cooking practices often experience low acceptance or abandonment after initial adoption.

2.1.5 Clean Cooking Energy as a Development and Policy Issue

Clean household cooking energy is increasingly recognized as a cross-cutting development issue that intersects with health, environment, gender, and economic policy domains. International development agendas have elevated clean cooking as a priority intervention for reducing preventable disease and environmental degradation. The integration of clean cooking into national energy and health policies reflects growing recognition of its broader societal benefits.

In rural LMIC settings, clean cooking energy contributes to improved health outcomes by reducing exposure to indoor air pollution, particularly among women and children. It also supports environmental sustainability by reducing deforestation and greenhouse gas emissions. From a socio-economic perspective, clean cooking systems reduce time spent on fuel collection, enabling greater participation in education and income-generating activities. However, the effectiveness of clean cooking interventions depends on how well technologies and policies are aligned with local contexts. Clean cooking energy must therefore be approached as a socio-

technical system, requiring coordinated action across energy, health, environment, and social sectors.

2.2 Global and Regional Status of Clean Cooking in Low- and Middle-Income Settings

2.2.1 Global Access to Clean Household Cooking Energy

Globally, access to clean household cooking energy remains a major development challenge, particularly in low- and middle-income countries (LMICs). Despite significant progress in expanding access to electricity over the past two decades, improvements in clean cooking have been comparatively slow. A substantial proportion of the global population continues to rely on traditional biomass fuels such as firewood, charcoal, and agricultural residues for daily cooking. This persistent reliance highlights structural inequalities in energy access and underscores the marginalization of clean cooking within broader energy transition agendas (International Energy Agency, 2023).

The global clean cooking gap is largely concentrated in LMICs, where poverty, rapid population growth, and limited infrastructure constrain the adoption of modern cooking fuels. While clean fuels such as LPG and electricity are technically available in many countries, their affordability and accessibility remain significant barriers for low-income households. As a result, many households continue to use traditional fuels despite being aware of the associated health and environmental risks. This situation demonstrates that awareness alone is insufficient to drive large-scale transitions to clean cooking energy.

Globally, the pace of progress in clean cooking is not aligned with international development targets. Current projections indicate that without accelerated and targeted interventions, a large proportion of the global population will continue to rely on polluting cooking fuels well beyond 2030. This slow progress has significant implications for public health, environmental sustainability, and climate change mitigation efforts.

2.2.2 Regional Trends with Emphasis on Sub-Saharan Africa

Sub-Saharan Africa exhibits the lowest levels of clean cooking access worldwide and has experienced the slowest rate of progress over time. Unlike other regions where economic growth

has facilitated gradual transitions to modern cooking fuels, many countries in Sub-Saharan Africa face persistent economic constraints that limit household purchasing power. Consequently, the number of people relying on traditional cooking fuels in the region has continued to increase due to population growth, despite modest gains in clean cooking adoption (IEA, 2023).

The regions heavy dependence on biomass fuels is closely linked to widespread rural poverty, limited energy infrastructure, and weak market penetration of clean cooking technologies. Firewood remains the dominant cooking fuel in rural areas, while charcoal is more common in urban and peri-urban settings. Clean fuels such as LPG and electricity are predominantly used by higher-income households and are concentrated in major urban centers.

In addition, energy policy in many Sub-Saharan African countries has historically prioritized electricity generation and access, often overlooking household cooking energy needs. This imbalance has resulted in substantial investments in electrification without corresponding improvements in clean cooking access. As a result, many households with access to electricity continue to rely on biomass fuels for cooking due to high electricity tariffs and unreliable supply.

2.2.3 Rural Urban Disparities in Clean Cooking Access

Rural urban disparities in clean cooking access are a defining feature of LMIC energy systems. Urban households generally have better access to clean cooking fuels due to proximity to markets, higher income levels, and more developed infrastructure. In contrast, rural households face multiple disadvantages, including long distances to fuel suppliers, poor transport networks, and limited availability of clean cooking technologies.

In rural areas, traditional biomass fuels are often freely collected from surrounding environments, reinforcing the perception that they are costless. This perception significantly reduces incentives to adopt clean cooking alternatives, even when the long-term health and environmental costs are substantial. Furthermore, rural households often lack access to credit or financing mechanisms that could support the purchase of clean cooking technologies.

Institutional factors also contribute to rural urban disparities. Energy distribution systems and private sector investments tend to favor urban markets where demand density and profitability are higher. Rural clean cooking programs, where they exist, are often implemented as short-term

projects rather than sustained, large-scale interventions. This uneven distribution of resources has entrenched energy inequalities between rural and urban populations.

2.2.4 Clean Cooking and Sustainable Development Goal 7

Clean household cooking energy is a central component of Sustainable Development Goal 7, which aims to ensure access to affordable, reliable, sustainable, and modern energy for all. Clean cooking is explicitly recognized as essential for achieving universal energy access and for supporting progress in health, gender equality, and environmental sustainability. However, global progress toward the clean cooking component of SDG 7 has been insufficient, particularly in LMICs (United Nations, 2022).

The slow pace of clean cooking transition threatens the achievement of multiple interrelated development goals. Continued reliance on traditional cooking fuels undermines efforts to reduce preventable diseases, limit deforestation, and mitigate climate change. In rural LMIC settings, failure to address clean cooking needs perpetuates cycles of poverty and environmental degradation.

Achieving SDG 7 therefore requires a renewed focus on clean cooking energy, particularly in rural areas. This includes integrating clean cooking into national energy strategies, strengthening institutional coordination, and developing context-specific approaches that address the economic and cultural realities of rural households. Without such targeted efforts, clean cooking will remain one of the most neglected dimensions of sustainable energy development.

2.3 Theoretical and Conceptual Framework for Clean Cooking Transition

The transition from traditional to clean household cooking energy in low- and middle-income settings is a complex process influenced by economic, social, institutional, and behavioural factors. To understand this transition, this study is grounded in relevant theories that explain technology adoption, energy system change, and household decision-making. These theories inform the development of a conceptual framework that guides the study variables, data collection, and analysis.

2.3.1 Theoretical Framework

Energy Transition Theory

Energy Transition Theory explains changes in energy systems as gradual shifts from traditional, inefficient energy sources to modern, efficient, and cleaner alternatives. These transitions are influenced by economic development, technological innovation, policy support, and institutional capacity. In high-income countries, energy transitions have historically followed linear pathways characterized by increasing income levels and expanding infrastructure. However, in low- and middle-income settings, particularly rural areas, energy transitions are often slow, uneven, and non-linear (Savacool, 2016).

In the context of household cooking energy, Energy Transition Theory highlights that adoption of clean cooking technologies is not solely determined by availability but by a combination of affordability, reliability, and policy support. In many rural settings, households experience energy stacking, where clean and traditional fuels are used simultaneously rather than complete substitution. This theory therefore helps explain why clean cooking adoption does not automatically occur even when modern fuels are introduced.

Diffusion of Innovations Theory

Diffusion of Innovations Theory provides insight into how new technologies spread within social systems over time. According to this theory, adoption is influenced by five key attributes: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003). In the case of clean cooking technologies, households assess whether new cooking systems offer clear advantages over traditional methods, such as reduced smoke, faster cooking, or fuel savings.

Compatibility with existing cooking practices is particularly important in rural communities where food preparation methods are culturally embedded. Technologies perceived as complex or difficult to maintain are less likely to be adopted, especially where technical support is limited. Observability and peer influence also play a crucial role, as households are more likely to adopt clean cooking technologies when they observe successful use by neighbors or community members. This theory is therefore useful in explaining community-level variation in clean cooking adoption.

Sustainable Livelihoods Framework

The Sustainable Livelihoods Framework situates household energy decisions within broader livelihood systems. It emphasizes the role of five types of capital financial, human, physical, social, and natural in shaping household choices and resilience. Access to clean cooking energy is closely linked to these livelihood assets. For example, households with higher financial capital are better able to afford clean cooking technologies, while those with stronger human capital may have greater awareness of health and environmental risks associated with traditional fuels (DFID, 1999).

In rural low-income settings, households often face constraints across multiple livelihood dimensions, limiting their capacity to adopt and sustain clean cooking technologies. The Sustainable Livelihoods Framework therefore highlights that clean cooking adoption is not simply a matter of individual preference but is shaped by structural livelihood conditions. This perspective is particularly relevant for understanding energy poverty in rural communities.

Behavior Change and Technology Adoption Models

Behavior changes models further contribute to understanding household cooking energy choices by emphasizing the role of attitudes, social norms, and perceived behavioural control. These models suggest that awareness of clean cooking benefits alone is insufficient to drive adoption without supportive social and economic conditions. Factors such as perceived cost, social acceptance, and trust in technology providers strongly influence adoption decisions.

In rural contexts, behavioural factors interact with economic and cultural constraints to shape energy choices. Behavior changes models therefore complement energy and diffusion theories by highlighting the psychological and social dimensions of clean cooking adoption.

2.3.2 Conceptual Framework

The conceptual framework for this study was developed through a synthesis of the theoretical perspectives discussed above and empirical literature on household energy use in low- and middle-income settings. The framework illustrates the assumed relationships between key determinants of clean household cooking energy adoption and the outcomes of such adoption.

The framework identifies socio-economic factors including household income, education level, and employment status as key independent variables influencing clean cooking adoption. These factors affect a household' s ability to afford clean cooking technologies and understand their potential benefits. Institutional and policy factors, such as government energy policies, subsidies, and non-governmental interventions, also play a critical role by shaping the availability and affordability of clean cooking options.

Infrastructure and access factors including availability, accessibility, and reliability of clean cooking fuels and technologies directly influence household energy choices. Even when households are willing to adopt clean cooking solutions, limited infrastructure can constrain actual adoption. Cultural norms and gender roles act as intervening variables, influencing household decision-making processes and shaping preferences for certain cooking methods.

The dependent variable in the framework is the adoption of clean household cooking energy, measured by the type of fuel and cooking technology used by households. Adoption is expected to lead to positive outcomes, including improved health, reduced environmental degradation, time savings, and enhanced livelihoods.

This conceptual framework provides a logical structure for the study by guiding the formulation of research objectives, the design of data collection instruments, and the selection of appropriate data analysis techniques. It ensures coherence between theory, empirical investigation, and interpretation of findings.

2.4 Health Impacts of Traditional Household Cooking Fuels

The continued reliance on traditional household cooking fuels is widely recognized as a major public health concern in low- and middle-income countries (LMICs). Traditional cooking practices, particularly the use of firewood, charcoal, crop residues, and animal dung, expose households to high levels of indoor air pollution. These exposures have significant short-term and long-term health consequences, disproportionately affecting rural populations, women, children, and other vulnerable groups. The health burden associated with traditional cooking fuels has elevated clean cooking energy to a critical public health priority (World Health Organization, 2022).

2.4.1 Indoor Air Pollution from Traditional Cooking Fuels

Indoor air pollution generated from the combustion of traditional biomass fuels is one of the leading environmental health risks in LMICs. Biomass combustion in open fires or inefficient stoves releases a complex mixture of harmful pollutants, including fine particulate matter (PM2.5), carbon monoxide, nitrogen oxides, and polycyclic aromatic hydrocarbons. These pollutants accumulate rapidly in enclosed or poorly ventilated cooking spaces, which are common in rural households.

Exposure to indoor air pollution is often prolonged, as cooking activities occur daily and may last several hours. In many rural settings, kitchens are located within living spaces or poorly separated from sleeping areas, further increasing exposure levels. Studies consistently show that pollutant concentrations in households using traditional fuels often exceed international air quality guidelines by several multiples, posing serious health risks to occupants (WHO, 2022).

Indoor air pollution from traditional cooking fuels is therefore not a sporadic exposure but a chronic environmental hazard that affects household members throughout their lifetime.

2.4.2 Respiratory and Cardiovascular Health Effects

One of the most well-documented health impacts of traditional cooking fuels is their association with respiratory diseases. Exposure to biomass smoke has been strongly linked to acute respiratory infections in children, particularly pneumonia, which remains a leading cause of child mortality in LMICs. Repeated exposure during early childhood can impair lung development and increase susceptibility to respiratory illnesses later in life.

Among adults, prolonged exposure to indoor air pollution is associated with chronic obstructive pulmonary disease (COPD), chronic bronchitis, asthma, and reduced lung function. Women, who are typically responsible for cooking, experience higher exposure levels and consequently bear a disproportionate burden of respiratory disease. In addition to respiratory effects, emerging evidence links biomass smoke exposure to cardiovascular conditions, including hypertension and ischemic heart disease, due to systemic inflammation caused by inhaled pollutants.

These health outcomes contribute significantly to morbidity and premature mortality in rural communities, reducing life expectancy and increasing healthcare costs for households and health systems.

2.4.3 Impacts on Women, Children, and Other Vulnerable Groups

Women and children are the most vulnerable to the health impacts of traditional household cooking fuels due to gendered household roles and behavioural patterns. In many rural LMIC contexts, women spend extended periods cooking and caring for children, resulting in prolonged exposure to smoke. Infants and young children are often carried on the caregivers back or remain close to the cooking area, increasing their inhalation of pollutants during critical stages of development.

Pregnant women exposed to indoor air pollution face increased risks of adverse pregnancy outcomes, including low birth weight, stillbirth, and complications during childbirth. Children exposed to biomass smoke may experience impaired cognitive development, frequent illness, and reduced school attendance due to poor health. Elderly household members and individuals with pre-existing health conditions are also particularly susceptible to the adverse effects of indoor air pollution.

The unequal distribution of health risks within households underscores the gender and social dimensions of traditional cooking practices and highlights the need for targeted interventions that prioritizes vulnerable populations.

2.4.4 Eye, Skin, and Other Non-Respiratory Health Effects

In addition to respiratory and cardiovascular impacts, traditional cooking fuels are associated with a range of non-respiratory health problems. Prolonged exposure to smoke irritates the eyes, leading to conjunctivitis, eye infections, and increased risk of cataracts. Eye-related conditions are common complaints among women who cook regularly using traditional fuels.

Skin irritation and burns are also frequent, particularly among children who play near open fires. The absence of proper stove enclosures and safety features increases the risk of accidental burns

and injuries. Carbon monoxide poisoning, although less visible, represents another serious risk, particularly in poorly ventilated indoor spaces.

These additional health effects further illustrate that the burden of traditional cooking fuels extends beyond respiratory disease and affects overall household safety and well-being.

2.4.5 Public Health Implications of Continued Use of Traditional Cooking Fuels

The widespread use of traditional cooking fuels has significant implications for public health systems in LMICs. High rates of respiratory and cardiovascular disease linked to indoor air pollution increase demand for healthcare services, strain limited medical resources, and contribute to preventable healthcare expenditure. In rural areas with limited access to health facilities, these impacts are particularly severe.

From a preventive health perspective, transitioning to clean household cooking energy represents one of the most cost-effective interventions for reducing disease burden associated with environmental exposures. Clean cooking solutions reduce exposure to harmful pollutants at the source, offering sustained health benefits over time.

Addressing the health impacts of traditional cooking fuels therefore requires integrated approaches that combine energy policy, public health planning, and community-level interventions. Without significant progress in clean cooking adoption, the health burden associated with traditional fuels is likely to persist, undermining broader development and health objectives in rural LMIC settings.

2.5 Environmental and Climate Change Implications of Traditional Cooking Practices

Traditional household cooking practices have far-reaching environmental and climate change implications, particularly in low- and middle-income countries (LMICs) where biomass fuels remain the dominant source of household energy. The widespread use of firewood, charcoal, and other biomass fuels contributes directly to deforestation, ecosystem degradation, and greenhouse gas emissions. These impacts are most pronounced in rural areas, where natural resources form the foundation of household livelihoods and environmental sustainability.

2.5.1 Deforestation and Forest Degradation

One of the most visible environmental consequences of traditional cooking practices is deforestation. The demand for firewood and charcoal places significant pressure on forest resources, particularly in rural areas where fuelwood is harvested directly from surrounding woodlands. In many LMICs, fuelwood collection is largely unregulated, leading to unsustainable extraction rates that exceed natural regeneration capacity.

Deforestation driven by household energy demand contributes to forest degradation, loss of biodiversity, and disruption of ecosystem services. Forests play a critical role in regulating local climates, conserving soil moisture, and supporting agricultural productivity. As forest cover declines, rural communities become increasingly vulnerable to soil erosion, declining soil fertility, and reduced availability of non-timber forest products that support livelihoods.

Charcoal production further exacerbates forest degradation. The conversion of wood into charcoal is highly inefficient, requiring large quantities of wood to produce small amounts of fuel. This process accelerates tree loss and contributes to land degradation, particularly in areas supplying charcoal to urban markets (FAO, 2020).

2.5.2 Land Degradation and Ecosystem Impacts

The environmental impacts of traditional cooking fuels extend beyond deforestation to include broader land and ecosystem degradation. Continuous removal of biomass reduces vegetation cover, exposing soil to erosion by wind and water. Soil erosion diminishes agricultural productivity, which is particularly detrimental in rural economies that depend heavily on subsistence farming. Loss of vegetation also affects water cycles by reducing infiltration and increasing surface runoff. This can lead to reduced groundwater recharge, drying of local water sources, and increased vulnerability to droughts. In rural LMIC settings, where climate variability is already a challenge, environmental degradation linked to traditional cooking practices further undermines household resilience. Ecosystem degradation resulting from biomass harvesting threatens biodiversity by destroying habitats and reducing species richness. The loss of biodiversity has long-term implications for ecosystem stability and the sustainability of rural livelihoods.

2.5.3 Greenhouse Gas and Black Carbon Emissions

Traditional cooking practices contribute significantly to climate change through the emission of greenhouse gases and short-lived climate pollutants. Biomass combustion releases carbon dioxide, methane, and nitrous oxide, all of which contribute to global warming. While biomass is sometimes considered carbon-neutral, unsustainable harvesting and inefficient combustion negate this assumption, resulting in net carbon emissions. Of particular concern is the emission of black carbon, a component of particulate matter produced during incomplete combustion of biomass fuels. Black carbon has a strong warming effect on the climate and contributes to regional atmospheric changes. Household cooking is a major source of black carbon emissions in LMICs, especially in rural areas where traditional stoves are widely used (World Health Organization, 2022). Black carbon also affects local air quality and accelerates glacial melting when deposited on snow and ice, further linking household cooking practices to broader climate change processes.

2.5.4 Contribution to Climate Vulnerability in Rural Communities

The environmental degradation associated with traditional cooking practices increases climate vulnerability in rural communities. Deforestation and land degradation reduce the capacity of ecosystems to buffer climate shocks such as floods, droughts, and heatwaves. As a result, rural households become more exposed to climate risks that threaten food security and livelihoods. Climate change, in turn, exacerbates dependence on biomass fuels by reducing agricultural productivity and limiting income opportunities. This creates a vicious cycle in which poverty, environmental degradation, and reliance on traditional cooking fuels reinforce one another. Without intervention, this cycle undermines both environmental sustainability and long-term development prospects.

2.5.5 Environmental Benefits of Transitioning to Clean Cooking Energy

Transitioning to clean household cooking energy offers substantial environmental and climate benefits. Clean cooking technologies reduce demand for firewood and charcoal, thereby alleviating pressure on forest resources. Reduced biomass harvesting supports forest regeneration, biodiversity conservation, and ecosystem stability. Clean cooking systems also lower greenhouse gas and black carbon emissions by improving combustion efficiency or eliminating combustion

altogether in the case of electricity and solar cooking. These reductions contribute to climate change mitigation and improved air quality at both local and regional levels (IEA, 2023). From an environmental sustainability perspective, clean cooking energy is a critical intervention for protecting natural resources, enhancing climate resilience, and supporting sustainable rural development. Integrating clean cooking into environmental and climate policies can therefore generate co-benefits that extend beyond household energy use.

2.6 Socio-Economic and Gender Dimensions of Household Cooking Energy

Household cooking energy choices are deeply embedded within broader socio-economic and gender structures, particularly in low- and middle-income countries (LMICs). The reliance on traditional cooking fuels is not merely a technical issue but reflects inequalities in income, access to resources, education, and decision-making power within households and communities. Understanding the socio-economic and gender dimensions of household cooking energy is therefore critical for designing effective clean cooking interventions that are equitable and sustainable.

2.6.1 Socio-Economic Determinants of Household Cooking Energy Choices

Socio-economic status plays a central role in determining household cooking energy choices. Income level is one of the most influential factors, as clean cooking technologies often require higher upfront investment and recurring fuel costs compared to traditional biomass fuels. In low-income households, particularly in rural areas, limited financial resources constrain the ability to purchase clean cooking stoves or fuels, even when households are aware of their benefits (IEA, 2023). Education level also influences cooking energy choices by shaping awareness of health, environmental, and safety risks associated with traditional fuels. Households with higher levels of education are more likely to adopt clean cooking technologies due to greater access to information and increased capacity to evaluate long-term benefits. Employment status and livelihood stability further affect energy choices, as households with irregular income streams may prioritize immediate affordability over long-term gains. Asset ownership and access to credit are additional socio-economic factors that shape clean cooking adoption. Households with access to financial services or community savings schemes are better positioned to overcome

upfront cost barriers. In contrast, households lacking such support mechanisms remain trapped in cycles of energy poverty, relying on traditional fuels despite their negative consequences.

2.6.2 Time Poverty and Opportunity Costs

Time poverty is a significant but often overlooked dimension of household cooking energy use. In many rural LMIC contexts, households particularly women and girls spend several hours each day collecting firewood, preparing fuel, and tending open fires. This time burden represents a substantial opportunity cost, limiting participation in education, income-generating activities, and community engagement. The opportunity costs associated with traditional cooking practices reinforce socio-economic inequalities. Time spent collecting fuel reduces labor availability for agricultural production and other livelihood activities, constraining household income potential. Children, especially girls, may miss school or experience reduced academic performance due to household energy-related responsibilities. Clean cooking technologies have the potential to reduce time poverty by eliminating or significantly reducing fuel collection and cooking time. However, the extent to which these benefits are realized depends on sustained adoption and reliable access to clean fuels.

2.6.3 Gender Roles and Household Decision-Making

Gender roles strongly shape household cooking energy practices. In many LMIC settings, cooking is socially constructed as a female responsibility, resulting in women bearing the primary burden of exposure to indoor air pollution and fuel collection. Despite this, women often have limited decision-making power over household expenditures and energy choices, which are frequently controlled by male household heads. This mismatch between responsibility and authority poses a significant barrier to clean cooking adoption. Even when women recognize the benefits of clean cooking technologies, they may be unable to influence purchasing decisions due to financial dependence or cultural norms. Gendered power dynamics therefore play a critical role in shaping household energy transitions. Empirical studies have shown that clean cooking interventions are more successful when women are actively involved in decision-making processes, training programmes, and technology dissemination. Empowering women through

targeted financing, education, and leadership opportunities can enhance adoption and sustained use of clean cooking technologies.

2.6.4 Health, Education, and Livelihood Implications

The socio-economic and gender dimensions of household cooking energy have far-reaching implications for health, education, and livelihoods. Prolonged exposure to indoor air pollution disproportionately affects women and children, contributing to poor health outcomes that reduce productivity and increase healthcare costs. These health burdens further entrench poverty by limiting households' ability to engage in income-generating activities. Education outcomes are also influenced by household energy practices. Time spent on fuel-related tasks reduces study time for children, while health-related absenteeism further undermines educational attainment. Improved access to clean cooking energy can therefore contribute indirectly to improved education outcomes by reducing time and health constraints. From a livelihood' s perspective, clean cooking adoption can free up time and resources for productive activities, enhance household resilience, and support poverty reduction. However, these benefits are contingent on equitable access to clean cooking technologies and supportive socio-economic conditions.

2.6.5 Equity Considerations in Clean Cooking Interventions

Equity is a critical consideration in clean cooking transitions. Without deliberate efforts to address socio-economic and gender inequalities, clean cooking interventions risk disproportionately benefiting higher-income or urban households, leaving the poorest and most vulnerable behind. Rural households, female-headed households, and marginalized groups often face compounded barriers to adoption. Inclusive clean cooking strategies must therefore integrate social protection mechanisms, gender-sensitive design, and community participation. Subsidies, targeted financing, and inclusive policy frameworks can help ensure that clean cooking interventions reach those most in need. Addressing socio-economic and gender dimensions is essential for achieving universal and equitable access to clean household cooking energy.

2.7 Barriers to the Adoption of Clean Household Cooking Energy

Despite growing recognition of the benefits of clean household cooking energy, adoption rates in low- and middle-income countries (LMICs) remain low, particularly in rural communities. The

transition from traditional to clean cooking energy is constrained by a range of interrelated barriers that operate at household, community, market, and institutional levels. Understanding these barriers is essential for designing effective interventions that address the realities faced by rural households.

2.7.1 Economic and Affordability Barriers

Economic constraints represent one of the most significant barriers to the adoption of clean cooking energy. Clean cooking technologies such as LPG stoves, electric cookers, and biogas systems often require high upfront investment compared to traditional cooking methods. For low-income rural households, these initial costs are prohibitive, particularly in contexts characterized by unstable or seasonal incomes (IEA, 2023). In addition to upfront costs, recurring expenses associated with clean fuels such as refilling LPG cylinders or paying electricity tariffs pose ongoing affordability challenges. Many households prioritize short-term survival needs over long-term health and environmental benefits, leading them to continue using freely collected firewood or low-cost charcoal. The absence of affordable financing mechanisms, subsidies, or credit facilities further limits the ability of rural households to invest in clean cooking technologies. Economic barriers are often compounded by broader structural poverty, making clean cooking adoption difficult even when households are aware of its benefits.

2.7.2 Infrastructure and Access Constraints

Limited infrastructure and poor access to clean cooking fuels and technologies constitute another major barrier. In many rural areas, clean cooking fuels such as LPG and electricity are either unavailable or unreliable. Long distances to fuel suppliers, poor road networks, and inadequate distribution systems increase the cost and inconvenience of accessing clean fuels, discouraging adoption. Electricity access, where available, is often unreliable, characterized by frequent outages and voltage fluctuations. These reliability issues undermine confidence in electricity as a primary cooking energy source. Similarly, maintenance and repair services for clean cooking technologies are scarce in rural areas, increasing the risk of technology failure and abandonment. Infrastructure constraints therefore limit not only initial adoption but also sustained use of clean cooking technologies, reinforcing continued reliance on traditional fuels.

2.7.3 Cultural and Behavioural Barriers

Cultural norms and behavioural practices play a critical role in shaping household cooking energy choices. Cooking practices are deeply embedded in social traditions, food preferences, and cultural identities. In many rural communities, traditional cooking methods are preferred because they are perceived to enhance taste, accommodate large pots, or suit specific food types. Resistance to change is often reinforced by familiarity and trust in traditional methods. Clean cooking technologies may be perceived as incompatible with local cooking practices or inadequate for meeting household needs. Behavioural barriers are further strengthened by limited exposure to successful clean cooking adoption within communities, reducing confidence in new technologies. Energy stacking the simultaneous use of multiple fuels reflects behavioural adaptation rather than full transition. While households may adopt clean cooking technologies for certain tasks, they often continue using traditional fuels due to habit, convenience, or cultural preference.

2.7.4 Gender and Intra-Household Decision-Making Barriers

Gender dynamics within households significantly influence clean cooking adoption. Although women are typically responsible for cooking and fuel collection, they often lack decision-making power over household expenditures and technology choices. Financial decisions are frequently controlled by male household heads, limiting women' s ability to adopt clean cooking technologies even when they recognize their benefits. This disconnects between responsibility and authority creates a structural barrier to clean cooking adoption. Women may prioritize health, safety, and time savings, while male decision-makers may prioritize cost considerations. Gender norms that limit women' s access to income, credit, and education further constrain adoption potential. Addressing gender-related barriers requires inclusive approaches that empower women through participation, access to finance, and involvement in clean cooking initiatives.

2.7.5 Institutional and Policy Barriers

Weak institutional support and policy implementation gaps also hinder the adoption of clean household cooking energy. In many LMICs, energy policies have historically focused on electricity generation and industrial energy needs, with limited attention to household cooking

energy. As a result, clean cooking initiatives are often fragmented, underfunded, or implemented as short-term projects. Lack of coordination among government agencies, non-governmental organisations, and the private sector reduces the effectiveness of clean cooking programmes. Inadequate monitoring and evaluation frameworks further limit the ability to assess programme impact and sustainability. Policy inconsistency and uncertainty can also discourage private sector investment in clean cooking markets, reducing availability and affordability of technologies. Without strong institutional frameworks, clean cooking interventions struggle to achieve scale and long-term impact. 2.7.6 Information and Awareness Barriers

Although awareness of the health risks associated with traditional cooking fuels is increasing, information gaps remain a barrier to adoption. In some rural communities, households lack accurate information about the benefits, costs, and safe use of clean cooking technologies. Misinformation or lack of trust in new technologies can discourage uptake. Awareness campaigns that fail to consider local contexts and literacy levels may have limited impact. Without sustained engagement and practical demonstrations, information alone is unlikely to translate into behavioural change.

2.7.7 Interaction of Barriers and Implications for Transition

The barriers to clean cooking adoption rarely operate in isolation. Economic constraints interact with infrastructure deficits, cultural norms, gender dynamics, and institutional weaknesses to create complex barriers that are difficult to overcome through single-sector interventions. This interaction explains why clean cooking adoption remains low despite growing global attention. Effective transition to clean household cooking energy therefore requires integrated strategies that simultaneously address affordability, access, cultural acceptance, gender equity, and institutional support. Understanding these barriers provides a foundation for identifying targeted enablers and designing context-specific transition frameworks.

2.8 Enablers and Successful Clean Cooking Interventions

The transition to clean household cooking energy in low- and middle-income countries (LMICs) is achievable when enabling conditions are deliberately created to address the economic, institutional, infrastructural, and socio-cultural barriers facing households. Evidence from

successful clean cooking initiatives demonstrates that no single intervention is sufficient; rather, progress depends on coordinated, multi-sectoral strategies that respond to local contexts. Enablers of clean cooking adoption therefore encompass policy support, financing mechanisms, community engagement, market development, and behavioural change interventions.

2.8.1 Policy and Regulatory Support

Strong policy and regulatory frameworks are critical enablers of clean cooking transitions. Governments play a central role in setting national priorities, allocating resources, and creating enabling environments for clean cooking markets. Countries that have integrated clean cooking into national energy, health, and environmental policies tend to achieve higher adoption rates than those that treat clean cooking as a peripheral issue. Policy instruments such as fuel subsidies, tax exemptions for clean cooking technologies, and standards for stove performance can significantly lower adoption barriers. Clear regulatory frameworks also encourage private sector participation by reducing uncertainty and investment risk. Conversely, inconsistent policies or frequent changes in energy pricing undermine household confidence in clean cooking solutions. Successful clean cooking programmes often align national energy policy with public health and climate strategies, recognizing the multiple co-benefits of clean cooking adoption. This integrated approach enhances institutional coordination and improves the sustainability of interventions.

2.8.2 Financial Mechanisms and Affordability Interventions

Affordability remains one of the most decisive factors influencing clean cooking adoption. Successful interventions therefore prioritize financial mechanisms that reduce upfront and recurring costs for households. These mechanisms include direct subsidies, results-based financing, micro-credit schemes, pay-as-you-go models, and revolving community funds. Subsidies targeted at low-income and rural households have been shown to significantly increase adoption rates when well designed and transparently administered. However, poorly targeted subsidies can distort markets and benefit higher-income households disproportionately. Effective financial interventions balance affordability with market sustainability. Innovative financing approaches such as pay-as-you-go LPG and cookstove financing enable households to spread

costs over time, making clean cooking technologies more accessible. Community-based savings groups and cooperatives also play a role in enabling households to mobilize resources collectively. Evidence suggests that combining financial support with awareness and training enhances sustained adoption (IEA, 2023).

2.8.3 Role of Non-Governmental Organisations and Development Partners

Non-governmental organisations (NGOs) and development partners have played a pivotal role in advancing clean cooking transitions, particularly in rural and marginalized communities. These actors often fill gaps left by limited state capacity, providing technical assistance, funding, and community-level engagement. NGO-led interventions frequently emphasize participatory approaches that involve communities in technology selection, training, and monitoring. Such approaches enhance trust, cultural compatibility, and ownership, increasing the likelihood of sustained use. NGOs also contribute to capacity building by training local artisans, technicians, and entrepreneurs, thereby strengthening local supply chains. Development partners support clean cooking initiatives through pilot projects, research, and policy advocacy. While pilot projects can demonstrate feasibility, evidence indicates that scaling up successful interventions requires integration into national systems rather than prolonged project-based implementation.

2.8.4 Private Sector and Market-Based Approaches

The private sector is a key enabler of clean cooking transitions through the production, distribution, and servicing of clean cooking technologies. Market-based approaches enhance sustainability by reducing dependence on donor funding and fostering innovation. Successful clean cooking markets are characterized by reliable supply chains, after-sales services, and consumer trust. Public private partnerships have been particularly effective in expanding access to clean cooking technologies. Governments can support private sector engagement by providing incentives, reducing import duties, and investing in enabling infrastructure. Market development initiatives that support local entrepreneurs also enhance rural access by decentralizing distribution networks. However, purely market-driven approaches may exclude the poorest households unless complemented by social protection measures. Evidence suggests that hybrid models combining market mechanisms with targeted subsidies achieve more inclusive outcomes.

2.8.5 Community Engagement and Social Acceptance

Community engagement is a critical enabler of clean cooking adoption, particularly in rural contexts where social norms strongly influence behavior. Successful interventions actively involve community leaders, women' s groups, and local institutions in program design and implementation. This participatory approach enhances legitimacy, trust, and social acceptance of new technologies. Demonstration projects and peer-to-peer learning play an important role in increasing observability and reducing uncertainty. Households are more likely to adopt clean cooking technologies when they observe successful use by neighbors and receive practical guidance. Behavior changes communication strategies that are culturally sensitive and delivered in local languages further support adoption. Gender-responsive approaches that empower women as users, decision-makers, and entrepreneurs have been shown to enhance both adoption and sustained use. Engaging men in awareness programs also helps address intra-household decision-making dynamics.

2.8.6 Health, Environmental, and Climate Co-Benefits as Adoption Drivers

The multiple co-benefits of clean cooking energy serve as important enablers when effectively communicated and realized. Reduced exposure to indoor air pollution improves health outcomes, lowers healthcare costs, and enhances productivity. Environmental benefits include reduced deforestation and improved ecosystem sustainability, while climate benefits arise from lower greenhouse gas and black carbon emissions (World Health Organization, 2022). Successful interventions often frame clean cooking as a solution that delivers immediate household-level benefits alongside long-term environmental gains. Emphasizing time savings, convenience, and safety alongside health and environmental outcomes resonates strongly with households and increases acceptance.

2.8.7 Lessons from Successful Clean Cooking Interventions

Evidence from successful clean cooking initiatives highlights several key lessons. First, integrated approaches that address affordability, access, and behavior simultaneously are more effective than single-focus interventions. Second, sustained adoption depends on reliable supply chains, after-sales support, and continued engagement rather than one-off technology distribution.

Third, context specificity is essential. Technologies and strategies must be adapted to local cooking practices, income levels, and institutional capacities. Finally, monitoring and evaluation systems are necessary to assess impact, identify challenges, and support continuous improvement. These lessons underscore that clean cooking transitions are complex socio-technical processes that require long-term commitment, coordination, and adaptive learning.

CHAPTER THREE: METHODOLOGY

3.1 Description of the Study Area

The study was conducted in selected rural communities of Zimbabwe, which are representative of low- and middle-income rural settings characterized by widespread dependence on traditional biomass fuels for household cooking. These areas experience limited access to modern energy services, unreliable electricity supply, low household income levels, and weak energy infrastructure. Firewood and charcoal remain the dominant cooking fuels due to their perceived affordability, accessibility, and compatibility with traditional cooking practices.

Rural Zimbabwe also presents significant environmental, social, and institutional challenges relevant to clean cooking transitions. Extensive fuelwood harvesting contributes to deforestation and land degradation, while women and girls bear a disproportionate burden of fuel collection and exposure to household air pollution. At the same time, policy efforts to promote liquefied petroleum gas (LPG), improved cookstoves, electricity, and biogas have faced implementation constraints. These characteristics make rural Zimbabwe an appropriate and relevant context for examining household cooking energy transitions and developing a framework applicable to similar low- and middle-income rural settings.

3. 2 Research Design

The study adopted a mixed methods research design, integrating quantitative and qualitative approaches. This design was chosen to capture both measurable patterns of household cooking energy use and in-depth contextual factors influencing adoption, including socio-economic conditions, infrastructure, institutional support, cultural practices, and gender dynamics.

A cross-sectional design was employed for primary data collection, allowing data to be gathered from households and key stakeholders at a single point in time. The mixed methods approach facilitated triangulation of findings, enhanced validity, and supported the synthesis of empirical evidence into a comprehensive clean cooking transition framework.

3.3 Target Population

The target population comprised rural households in the selected study areas and key institutional stakeholders involved in household energy provision, policy, and community development. At the household level, respondents included adult household members (18 years and above) responsible for cooking and household energy decision-making. Institutional stakeholders included representatives from government departments, local authorities, non-governmental organizations, community leaders, and energy service providers.

3.4 Sample Size and Sampling Procedures

A multistage sampling technique was employed. In the first stage, rural districts were purposively selected based on high reliance on biomass fuels and limited clean cooking energy access. In the second stage, wards and villages were randomly selected to ensure representativeness. In the final stage, households were selected using systematic random sampling. The household sample size was determined using standard social science sample size determination methods, considering population size, confidence level, and margin of error. This ensured that the sample was sufficiently large to allow meaningful statistical analysis. Purposive sampling was used to select key informants with relevant expertise and experience in household energy, environmental health, and rural development.

3.5 Research Instruments

The study utilized multiple research instruments to capture diverse data:

Structured household questionnaire

Focus group discussion guide

Key informant interview guide

Participant observation checklist

Document review checklist for policy and framework analysis

The use of multiple instruments enhanced data triangulation and strengthened the reliability and validity of findings.

3.6 Data Collection Methods

3.6.1 Household Questionnaire Survey

Structured questionnaires were administered through face-to-face interviews to collect quantitative data on household cooking energy sources, socio-economic characteristics, accessibility of clean cooking fuels, affordability, and perceptions of clean cooking technologies. This method was appropriate for rural contexts with varying literacy levels.

3.6.2 Focus Group Discussions

Focus group discussions (FGDs) were conducted with community members, with particular emphasis on women, who are the primary users of household cooking energy. FGDs explored cultural practices, gender roles, decision-making dynamics, perceptions of clean cooking technologies, and community-level barriers and facilitators to adoption.

3.6.3 Key Informant Interviews

Semi-structured key informant interviews were conducted with government officials, local leaders, health workers, non-governmental organizations, and energy service providers. These interviews provided insights into institutional arrangements, policy frameworks, market structures, and implementation challenges related to clean cooking energy promotion.

3.6.4 Participant Observation

Participant observation was used to capture real-life cooking practices, stove types, fuel storage methods, and kitchen conditions. Observations helped validate self-reported data and provided contextual understanding of household energy behaviors.

3.6.5 Checklist and Systematic Review of Relevant Frameworks

A document review checklist was used to conduct a systematic review of existing clean cooking and energy transition frameworks, policies, and strategies at global, regional, and national levels. The review focused on identifying key components, success factors, gaps, and applicability to rural low- and middle-income settings.

3.7 Data Analysis

3.7.1 Quantitative Data Analysis

Quantitative data from household questionnaires were coded and analyzed using statistical software. Descriptive statistics (frequencies, percentages, means, and charts) were used to summarize household cooking energy sources and characteristics.

Objective 1 (Assess cooking energy sources): Achieved through descriptive statistics showing primary and secondary cooking fuels.

Objective 2 (Socio-economic factors): Achieved using cross-tabulations and chi-square tests to examine relationships between income, education, household size, and clean cooking adoption.

Objective 3 (Infrastructure and accessibility): Analyzed through descriptive and inferential statistics linking distance to fuel sources, electricity access, and fuel availability to adoption patterns.

3.7.2 Qualitative Data Analysis

Qualitative data from FGDs, interviews, and observations were analyzed using thematic analysis.

Objective 4 (Institutional and policy support): Addressed by analyzing themes related to policy implementation, institutional coordination, and program effectiveness.

Objective 5 (Cultural and gender factors): Achieved by identifying recurring themes on traditions, cooking preferences, and gendered decision-making roles.

Objective 6 (Barriers and facilitators): Addressed through integrated analysis of household and stakeholder perspectives.

3.8 Development of the Conceptual Framework

Findings from quantitative analysis, qualitative themes, and the systematic review of existing frameworks were synthesized to develop a context-appropriate conceptual framework for clean cooking energy transition. The framework integrates socio-economic, infrastructural,

institutional, cultural, gender, and environmental dimensions, illustrating pathways and interactions influencing household energy transitions in rural low- and middle-income settings.

Evaluation of the Framework

The proposed framework was evaluated through expert review and stakeholder validation, involving selected key informants and practitioners. Feedback focused on relevance, feasibility, clarity, and applicability to rural contexts. Suggestions were incorporated to refine the framework and enhance its practical utility.

3.9 Ethical Considerations

Ethical principles were strictly adhered to throughout the study. Informed consent was obtained from all participants, participation was voluntary, and respondents were informed of their right to withdraw at any stage. Confidentiality and anonymity were ensured by excluding personal identifiers from data records. Permission to conduct the study was obtained from relevant authorities and community leadership structures.

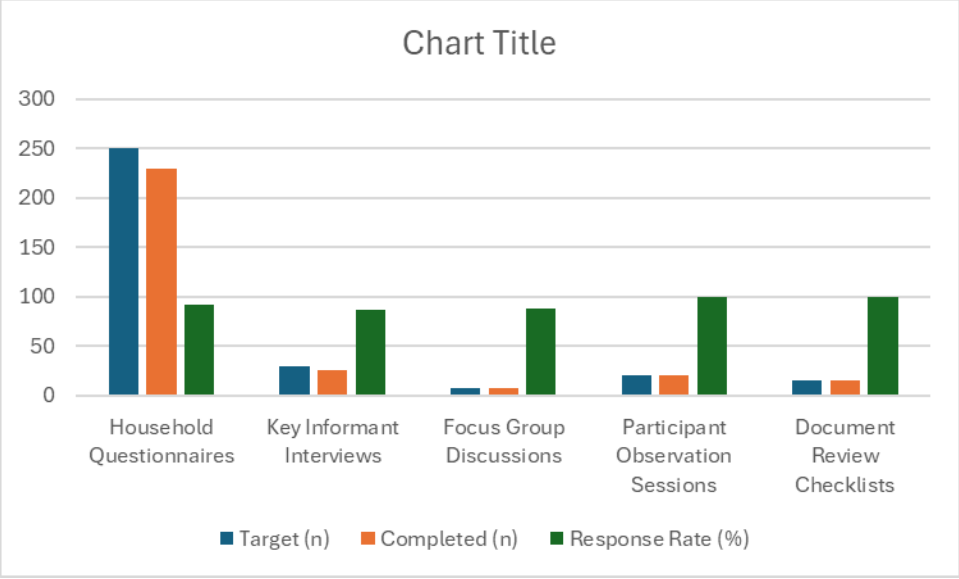
CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents, analyses, and interprets the empirical findings of the study on the development of a context-appropriate framework for the transition to clean household cooking energy in selected rural communities of Zimbabwe. The analysis integrates descriptive statistics, cross-tabulations, thematic analysis, and framework synthesis generated from household questionnaires, focus group discussions, key informant interviews, participant observations, and document reviews. The presentation follows a structured academic format using well-labelled tables and clearly specified figures (graphs), followed by detailed interpretation of both quantitative and qualitative findings. Emphasis is placed not only on reporting household cooking energy patterns but also on explaining their implications within public health, environmental sustainability, rural development, and gender equity frameworks.

4.2 Response Rate and Data Reliability

Figure 4.1: Response Rate by Data Collection Method

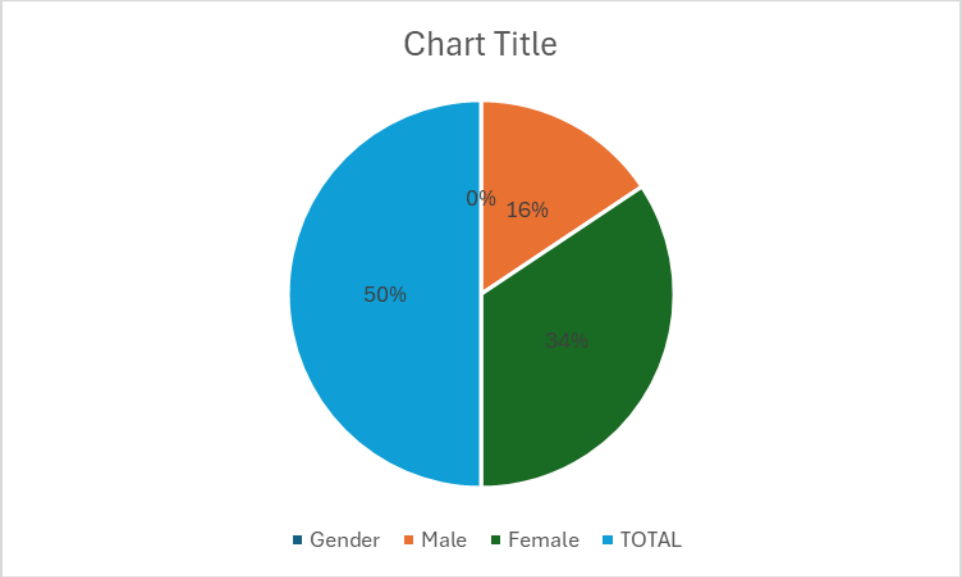


The response rate achieved in this study is highly satisfactory for both quantitative and qualitative components. The household questionnaire response rate of 92% is significantly above the commonly accepted threshold for social science research, indicating strong participant engagement and community willingness to contribute to discussions surrounding household energy transitions. The response rates for key informant interviews (86.7%) and focus group discussions (87.5%) are equally robust, suggesting that institutional stakeholders and community members recognized the relevance of clean cooking issues within rural development contexts. The complete response rates achieved in participant observation and document review further strengthen methodological triangulation. Overall, the consistency of high response rates across all research instruments enhances data credibility, minimizes non-response bias, and strengthens the reliability of the findings.

4.3 Demographic Characteristics of Respondents

4.3.1 Gender Distribution

Figure 4.2: Gender Distribution of Respondents



The gender distribution reveals a female-dominated sample, with women constituting 68.7% of respondents. This distribution is methodologically appropriate given that in most rural households in Zimbabwe, women are the primary users and managers of household cooking energy. Their dominant representation provides direct insight into everyday cooking practices, fuel preferences, health exposures, and household energy decision-making processes. The inclusion of male respondents remains equally important, as men often influence household financial decisions related to energy investments such as liquefied petroleum gas (LPG) and improved cookstoves. Therefore, the gender composition enhances analytical depth by capturing both operational and strategic dimensions of household energy transitions.

4.3.2 Age Distribution

Age Group	Frequency	Percentage (%)
18-30	48	20.9
31-40	76	33.0
41-50	61	26.5
51+	45	19.6

Table 4.3: Age Distribution of Respondents

The dominance of respondents within the 31– 40 age category indicates that the study largely captures economically active household members who are directly involved in cooking energy acquisition and decision-making. This age group represents families with high energy demand due to childcare responsibilities and larger household sizes. The inclusion of older respondents

further strengthens the dataset by incorporating historical perspectives on energy transitions, allowing comparison between traditional fuel dependence and emerging clean cooking technologies.

4.4 Household Cooking Energy Usage

4.4.1 Primary Cooking Energy Sources

Table 4.4: Primary Household Cooking Energy Sources

Energy Source	Frequency	Percentage (%)
Firewood	124	53.9
Charcoal	46	20.0
LPG	28	12.2
Electricity	18	7.8
Biogas	14	6.1

The results indicate that firewood remains the dominant cooking fuel among rural households, accounting for 53.9% of respondents. This confirms continued dependence on traditional biomass despite increasing policy attention toward clean energy transitions. Charcoal, which accounts for 20%, represents a secondary biomass option commonly used where firewood availability is declining. Modern energy alternatives such as LPG, electricity, and biogas collectively account for less than one-third of household energy use, indicating limited penetration of clean cooking technologies. The findings suggest that affordability, accessibility, and cultural familiarity continue to reinforce biomass dependence.

4.4.2 Secondary Cooking Fuel Usage

Table 4.5: Secondary Household Energy Sources

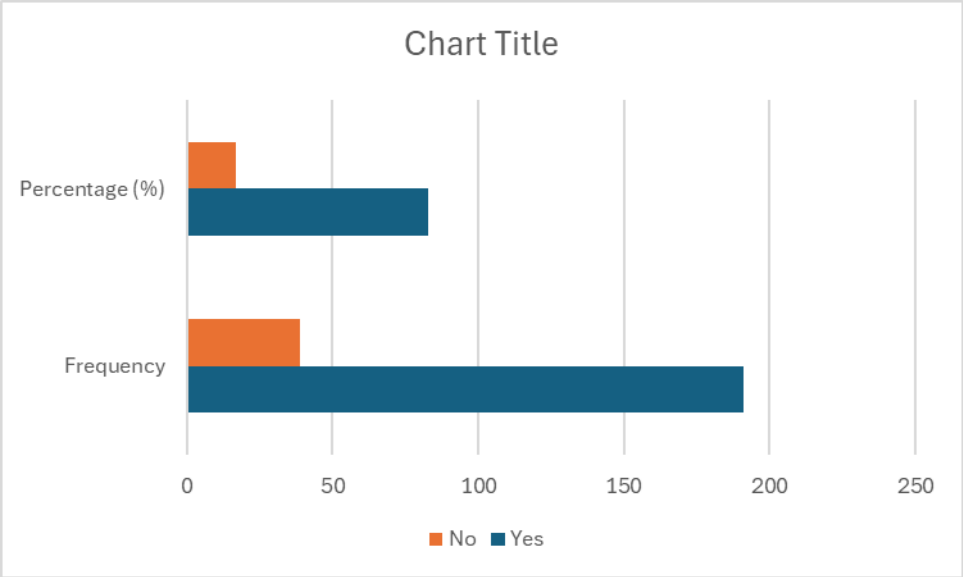
Fuel Type	Frequency	Percentage (%)
Firewood	64	27.8
Charcoal	52	22.6
LPG	56	24.3
Electricity	34	14.8
None	24	10.5

The findings indicate that many households' practice energy stacking rather than complete energy switching. Households often combine traditional biomass with modern fuels depending on fuel availability, meal type, seasonal conditions, and household income. This pattern suggests that clean cooking transitions in rural communities are gradual and multidimensional rather than linear.

4.5 Socio-Economic Factors Affecting Clean Cooking Adoption

4.5.1 Household Income and Clean Cooking Adoption

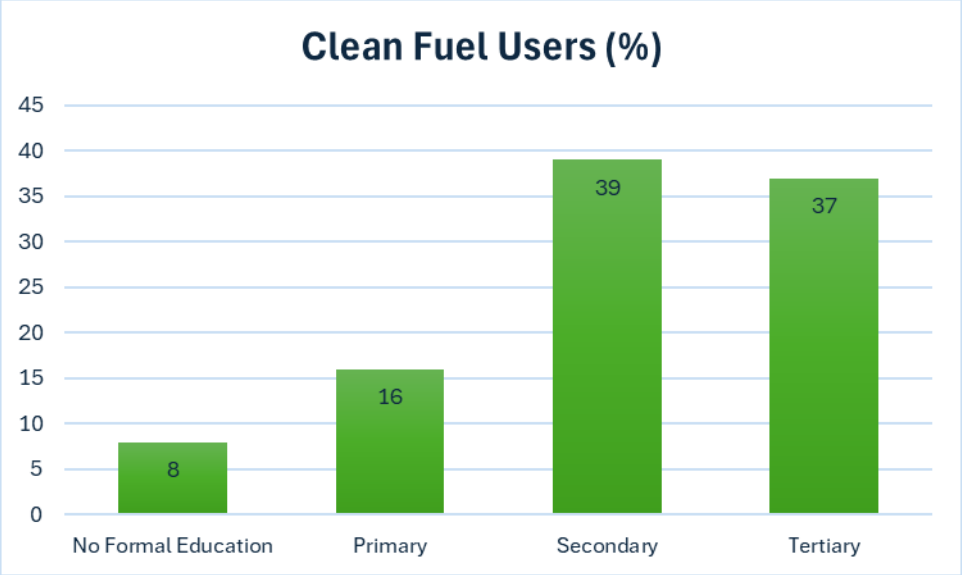
Figure 4.6: Income Influence on Adoption



The findings clearly demonstrate that household income is the most significant socio-economic determinant of clean cooking adoption. A substantial majority of respondents (83%) indicated that income directly affects their ability to purchase LPG cylinders, refill gas, or acquire improved cookstoves. This suggests that clean cooking adoption remains highly sensitive to purchasing power. Lower-income households continue to depend on freely collected biomass fuels, reinforcing energy poverty.

4.5.2 Educational Level and Adoption

Figure 4.7: Education and Clean Fuel Adoption



The findings indicate a positive relationship between educational attainment and clean cooking adoption. Households headed by respondents with secondary and tertiary education demonstrate higher adoption levels of LPG and electricity compared to households with lower educational

attainment. Education appears to influence awareness of health risks associated with biomass smoke as well as willingness to invest in cleaner technologies.

4.6 Infrastructure and Accessibility Outcomes

4.6.1 Access to Energy Infrastructure

Table 4.8: Infrastructure Constraints

Variable	Frequency	Percentage (%)
Limited LPG Access	88	38.3
Unreliable Electricity	74	32.2
Long Travel Distance	42	18.3
High Transport Costs	26	11.2

Infrastructure-related barriers emerge as significant constraints to clean cooking transitions. Limited LPG distribution networks, unreliable electricity supply, and poor road accessibility continue to undermine sustained adoption of clean cooking technologies. These findings suggest that energy transitions require simultaneous investment in both households purchasing power and rural infrastructure development.

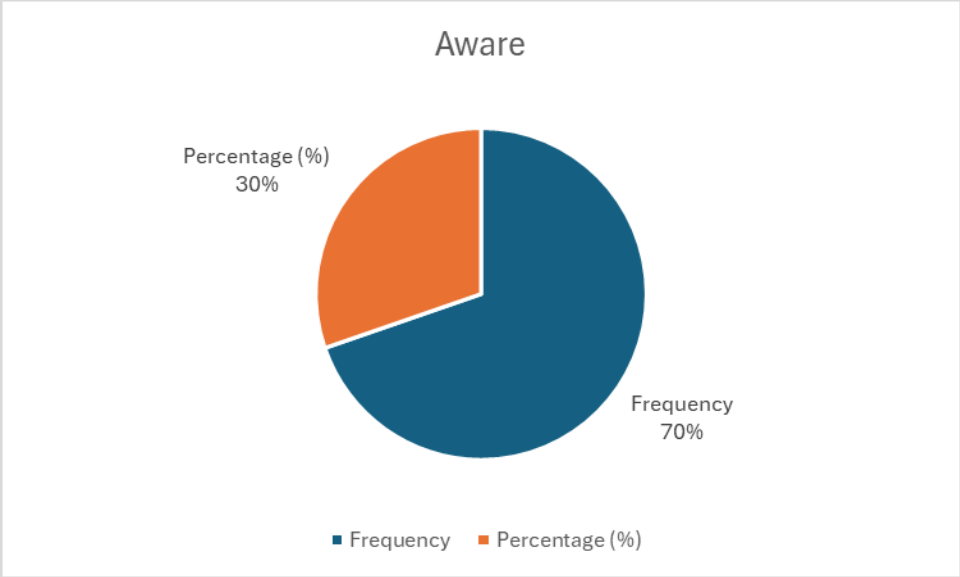
4.7 Institutional and Policy Support

4.7.1 Awareness of Clean Cooking Programs

Table 4.9: Awareness of Institutional Support Programs

Response	Frequency	Percentage (%)
Aware	64	27.8
Not Aware	166	72.2

Figure 4.9: Awareness of Energy Programs



The findings reveal low awareness of government and institutional clean cooking programs among rural households. More than two-thirds of respondents reported no awareness of clean energy promotion initiatives. This suggests weak policy outreach and limited rural penetration of energy awareness campaigns. Stakeholders from Ministry of Energy and Power Development and community development agencies acknowledged funding limitations and logistical challenges in rural implementation.

4.8 Cultural and Gender Outcomes

4.8.1 Cultural Influence on Energy Choices

Table 4.10: Cultural Influence on Fuel Choice

Response	Frequency	Percentage (%)

Yes	176	76.5
No	54	23.5

The findings confirm that cultural practices significantly influence household energy choices. Most respondents reported that traditional foods such as sadza are perceived to taste better when cooked using firewood. Cultural attachment to traditional cooking methods therefore acts as both a social identity marker and a barrier to complete transition toward clean fuels.

4.9 Inferential Analysis

4.9.1 Chi-Square Test: Income Level versus Clean Cooking Adoption

Table 4.11: Chi-Square Test of Association

Variable Relationship	Value	df	p-value
Income vs Clean Fuel Adoption	21.638	3	0.000

The Chi-square test results indicate a statistically significant association between household income and clean cooking adoption ($\chi^2 = 21.638$, $p < 0.001$). This confirms that clean fuel adoption is not randomly distributed across households but varies systematically according to income levels. Households with higher disposable income demonstrate greater adoption of LPG, electricity, and improved cookstoves, while lower-income households remain heavily dependent on biomass fuels. This finding confirms that economic empowerment is central to successful energy transitions.

4.9.2 Regression Analysis: Predictors of Clean Cooking Adoption

Table 4.12: Model Summary

Model	R	R Square	Adjusted R Square

1	0.714	0.510	0.498

Table 4.13: Coefficients Table

Predictor	B	Beta	T	Sig.
Constant	1.087	—	—	—
Household Income	0.592	0.614	5.216	0.000
Infrastructure Access	0.438	0.472	4.382	0.000
Policy Support	0.316	0.338	3.774	0.001

Regression Equation

$Y = 1.087 + 0.592X_1 + 0.438X_2 + 0.316X_3$

Where:

Y = Clean Cooking Adoption Index

X_1 = Household Income

X_2 = Infrastructure Access

X_3 = Policy Support

The regression analysis confirms a strong, positive, and statistically significant relationship between socio-economic conditions, infrastructure availability, institutional support, and clean cooking adoption among rural households. The coefficient of determination ($R^2 = 0.510$) shows that 51% of variation in clean cooking adoption is explained by these predictors. This represents

a substantial explanatory contribution within household energy research. The findings confirm that clean cooking transitions are multidimensional and depend on both household-level capacity and broader structural support systems.

4.10 Development and Validation of the Proposed Framework

The integrated findings from household surveys, qualitative interviews, participant observations, and policy reviews were synthesized to develop a context-appropriate clean cooking transition framework. The framework was subsequently validated by experts from community development agencies, public health institutions, and energy practitioners.

Table 4.14: Framework Validation Results

Criterion	Positive Responses (%)
Relevance	94
Feasibility	89
Clarity	91
Applicability	88

The validation results demonstrate strong stakeholder acceptance of the proposed framework, indicating its practical relevance for rural low- and middle-income settings.

4.11 Chapter Summary

This chapter has presented detailed descriptive, thematic, and inferential findings on household cooking energy transitions in rural communities of Zimbabwe. The results demonstrate statistically significant relationships between household income, infrastructure access, institutional support, cultural norms, and clean cooking adoption. Although policy initiatives promoting clean energy exist, practical adoption remains constrained by economic limitations, infrastructural deficits, and deeply rooted cultural practices. The findings further confirm that successful clean cooking transitions require integrated interventions that simultaneously address

economic empowerment, infrastructure expansion, policy implementation, gender inclusion, and environmental sustainability.

CHAPTER 5: DISCUSSION OF RESULTS

5.1 Introduction

This chapter discusses the major findings of the study on the development of a context-appropriate framework for the transition to clean household cooking energy in selected rural communities of Zimbabwe. The discussion is guided by the study objectives and integrates the empirical findings presented in Chapter Four with existing scholarly literature on household energy transitions, rural energy poverty, environmental sustainability, public health, and gender-inclusive development. Particular attention is given to the extent to which socio-economic conditions, infrastructure availability, institutional support, cultural practices, and gender dynamics influence household adoption of clean cooking technologies. Where appropriate, the findings of this study are compared with previous studies conducted in Zimbabwe and other developing economies in order to establish areas of convergence, divergence, and new contextual insights.

5.2 Household Cooking Energy Usage in Rural Communities

The findings of this study revealed that traditional biomass fuels, particularly firewood and charcoal, remain the dominant household cooking energy sources in rural communities. More than half of the respondents reported firewood as their primary cooking fuel, while only a small proportion of households reported using modern energy alternatives such as liquefied petroleum gas (LPG), electricity, and biogas. These findings are consistent with studies conducted by World Health Organization, which found that rural households in low- and middle-income countries continue to depend heavily on biomass fuels due to affordability, accessibility, and long-established cultural familiarity. Similarly, research by Lewis and Pattanayak found that biomass dependence remains high in resource-constrained communities where energy markets are underdeveloped and household incomes remain unstable.

The current findings also support observations made by Pachauri and colleagues, who found that energy transitions in developing economies are often characterized by energy stacking rather than complete energy switching. Households tend to combine traditional and modern fuels depending on income fluctuations, seasonal fuel availability, and specific cooking requirements. However, the findings differ from studies conducted in parts of Asia where accelerated rural electrification and subsidy programs have significantly reduced biomass dependence. The variation suggests that rural communities in Zimbabwe continue to face structural barriers that slow down complete clean energy transitions despite growing policy awareness.

5.3 Socio-Economic Factors Influencing Clean Cooking Adoption

The findings of this study established that household income is one of the most significant determinants of clean cooking adoption. A substantial majority of respondents indicated that income directly influences their ability to purchase clean cooking appliances, refill LPG cylinders, and sustain modern energy use. These findings are consistent with research by Lewis and Pattanayak, who found that income remains one of the strongest predictors of household energy transition in developing economies. Similar findings were reported by World Bank, which observed that lower-income households often remain trapped in biomass dependence because traditional fuels can be collected freely or purchased at relatively low immediate cost.

The findings further revealed that educational attainment positively influences clean cooking adoption. Households headed by respondents with secondary and tertiary education demonstrated higher adoption rates of LPG and electricity compared to households with lower educational levels. These findings support the work of Barnes, who found that education increases awareness of the health risks associated with indoor air pollution and improves willingness to invest in safer technologies. However, the findings differ from studies conducted in some urban African settings where income appears to outweigh education as the dominant determinant of fuel choice. This suggests that in rural Zimbabwe, education and income interact as complementary drivers of household energy decisions.

5.4 Infrastructure and Accessibility in Clean Cooking Transitions

The study established that infrastructure and accessibility significantly influence household adoption of clean cooking energy. Respondents identified unreliable electricity supply, limited LPG distribution networks, poor road infrastructure, and high transport costs as major barriers to sustained use of clean cooking technologies. These findings are consistent with studies by the International Energy Agency, which found that weak energy infrastructure remains one of the primary barriers to clean cooking transitions in rural communities across sub-Saharan Africa. Similar observations were made by Pachauri and Rao, who found that energy poverty is not solely determined by household income but also by physical access to energy services.

However, the current findings differ from studies conducted in countries such as India, where large-scale LPG distribution programs have significantly improved rural access to clean cooking fuels. The discrepancy may be explained by differences in infrastructure investment, rural market penetration, and policy implementation mechanisms. In Zimbabwean rural contexts, limited energy distribution networks and unreliable electricity supply continue to undermine household confidence in modern cooking technologies. This suggests that clean cooking transitions require not only household-level economic empowerment but also broader infrastructure development.

5.5 Institutional and Policy Support for Clean Cooking Transition

The findings of this study revealed low awareness of institutional and government programs promoting clean cooking technologies among rural households. More than two-thirds of

respondents indicated that they were not aware of existing energy promotion initiatives, suggesting weak policy visibility and limited rural outreach. These findings are consistent with reports by the United Nations Development Programme, which found that many rural energy interventions in developing countries fail to achieve large-scale adoption because of poor communication, fragmented implementation, and limited stakeholder engagement.

Similarly, studies conducted by the World Bank found that policy effectiveness in rural energy transitions depends heavily on institutional coordination, financing mechanisms, and community-based implementation. However, the findings of this study provide new contextual evidence by showing that policy existence alone does not guarantee household awareness or participation in clean cooking programs. This suggests that institutional support must extend beyond policy formulation to include active community sensitization, financial incentives, and localized implementation structures.

5.6 Cultural and Gender Considerations in Household Energy Choices

The findings of this study established that cultural beliefs and gender roles significantly influence household cooking energy choices. A substantial majority of respondents indicated that traditional foods are perceived to taste better when prepared using firewood, and many households associate biomass cooking with cultural identity and social continuity. These findings are consistent with research by Gill-Wiehl and colleagues, who found that cultural attachment to traditional cooking practices often slows adoption of modern energy technologies even where alternatives are physically available.

The findings further revealed that women remain the primary users and managers of household cooking energy, while men often control financial decisions related to major household investments. These findings support reports by the United Nations Development Program, which found that women and girls in rural communities carry a disproportionate burden of fuel collection, smoke exposure, and time poverty. However, studies conducted in some Latin American contexts have shown more gender-inclusive household energy decision-making. The variation suggests that clean cooking transitions in rural Zimbabwe must deliberately integrate gender empowerment strategies to ensure equitable adoption.

5.7 Relationship Between Socio-Economic Factors and Clean Cooking Adoption

The Chi-square analysis demonstrated a statistically significant relationship between household income and clean cooking adoption, confirming that clean fuel use varies systematically according to economic status. Households with higher incomes demonstrated significantly greater adoption of LPG, electricity, and improved cookstoves compared to lower-income households. These findings are consistent with studies by Barnes and Floor, who found that household energy transitions are strongly influenced by purchasing power and economic stability.

The findings further suggest that clean cooking technologies should not be viewed solely as technical solutions but as socio-economic interventions whose adoption depends on household financial capacity. This supports studies by Amartya Sen, who argued that development outcomes are closely linked to access to economic opportunities and resource capabilities. In the context of rural Zimbabwe, poverty remains a critical structural barrier to clean energy adoption, suggesting that subsidy mechanisms and microfinance programs may be necessary to accelerate household transitions.

5.8 Predictors of Clean Cooking Adoption

The regression analysis revealed a strong positive and statistically significant relationship between household income, infrastructure availability, policy support, and clean cooking adoption. The explanatory power of the regression model indicates that these variables account for a substantial proportion of variation in household energy choices. These findings are consistent with research by the International Energy Agency, which found that successful clean cooking transitions require integrated interventions that simultaneously address affordability, accessibility, and institutional support.

However, the unexplained variation in the regression model suggests that additional structural and behavioural factors continue to influence household energy decisions beyond the variables captured in the model. These may include cultural identity, risk perception, market volatility, household size, and seasonal fuel availability. The findings therefore contribute new contextual evidence that clean cooking transitions operate within a complex socio-technical ecosystem, where economic, infrastructural, social, and institutional variables interact dynamically.

5.9 Chapter Summary

This chapter discussed the findings of the study in relation to existing empirical and theoretical literature on household energy transitions, environmental sustainability, and rural development. The discussion established that household income, education, infrastructure access, institutional support, cultural practices, and gender dynamics significantly influence clean cooking adoption in rural communities. Although policy initiatives promoting clean energy exist, practical adoption remains constrained by poverty, weak infrastructure, limited institutional outreach, and deeply embedded cultural preferences. The chapter therefore confirms that successful clean cooking transitions require integrated, context-sensitive interventions that simultaneously address economic empowerment, infrastructure development, policy implementation, cultural acceptance, and gender inclusion.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the conclusions and recommendations of the study on the development of a context-appropriate framework for clean household cooking energy transition in rural communities of Zimbabwe. The conclusions presented in this chapter are drawn from the empirical findings presented in Chapter Four and the detailed discussion of results provided in Chapter Five. The chapter synthesizes the major findings according to the objectives of the study and provides a comprehensive interpretation of what the findings mean within the broader context of rural energy transitions, environmental sustainability, public health improvement, gender equity, and socio-economic development. Furthermore, this chapter provides practical recommendations directed toward policymakers, government institutions, development partners, community structures, researchers, and energy service providers whose roles are critical in

accelerating the transition from traditional biomass fuels to clean and sustainable household cooking energy systems in rural low- and middle-income settings.

6.2 Conclusions

Based on the findings of the study, the following conclusions were made:

6.2.1 Household Cooking Energy Usage

The study established that traditional biomass fuels, particularly firewood and charcoal, remain the dominant cooking energy sources among rural households in Zimbabwe despite growing national and international advocacy for clean cooking technologies. The findings demonstrated that a substantial proportion of rural households continue to rely on biomass fuels because these energy sources are perceived to be more accessible, relatively affordable in the short term, and deeply embedded within local cooking traditions and everyday household practices. Although some households reported awareness and occasional use of cleaner alternatives such as liquefied petroleum gas, electricity, and biogas, adoption levels remain considerably low and inconsistent across communities. The findings therefore indicate that household energy transitions in rural settings remain incomplete and largely characterized by energy stacking, where households combine traditional and modern fuels depending on financial circumstances, seasonal availability, and specific cooking requirements. This suggests that the transition toward clean cooking energy is not a simple technological shift, but a gradual socio-economic and behavioural process influenced by multiple contextual factors.

6.2.2 Socio-Economic Factors

The study found that socio-economic conditions, particularly household income, employment stability, and educational attainment, significantly influence the adoption of clean cooking technologies among rural households. Households with higher income levels and better educational backgrounds demonstrated greater capacity and willingness to adopt modern cooking technologies such as LPG, electricity, and improved cookstoves compared to households with lower income and limited educational exposure. The findings further showed that poverty remains one of the strongest structural barriers to clean cooking adoption, as many households prioritize immediate survival needs over long-term energy investments. In addition, limited

educational exposure was found to reduce awareness of the health risks associated with household air pollution and the potential long-term benefits of clean energy technologies. The study therefore concludes that successful clean cooking transitions cannot be achieved without simultaneously addressing rural poverty, income generation, educational empowerment, and financial inclusion within vulnerable communities.

6.2.3 Infrastructure and Accessibility

The study established that infrastructure availability and accessibility significantly affect household adoption and sustained use of clean cooking technologies in rural communities. Limited distribution networks for LPG, unreliable electricity supply, poor transport systems, long distances to energy suppliers, and high transportation costs were identified as major barriers preventing households from consistently accessing modern cooking fuels. Even among households willing to adopt clean cooking technologies, infrastructural limitations often forced them to revert to traditional biomass fuels due to supply interruptions and market inaccessibility. The findings therefore indicate that rural energy poverty is not only an issue of affordability but also one of physical access to reliable energy services. The study concludes that clean cooking transitions require substantial public and private investment in rural energy infrastructure, transport systems, supply chains, and decentralized energy distribution mechanisms to ensure sustained adoption and long-term energy security.

6.2.4 Institutional and Policy Support

The study found that awareness of institutional and government clean cooking initiatives remains relatively low among rural households despite the existence of policy frameworks promoting sustainable energy access. A significant proportion of respondents reported limited knowledge of government programs, subsidies, demonstration projects, or community energy initiatives aimed at promoting clean household cooking. This suggests that existing policies and programs have not yet achieved sufficient penetration, visibility, or practical impact at community level. The findings further indicate that policy implementation remains constrained by weak rural outreach, inadequate financial resources, fragmented institutional coordination, and limited monitoring of community-level outcomes. The study therefore concludes that policy formulation alone is

insufficient to drive household energy transitions unless accompanied by effective implementation mechanisms, stakeholder collaboration, community engagement, and continuous institutional support.

6.2.5 Cultural and Gender Factors

The study established that cultural beliefs, traditional cooking preferences, and gender roles significantly shape household energy choices in rural communities. Many households continue to associate firewood cooking with food quality, cultural identity, and traditional family practices, making complete transition to modern fuels socially complex even where alternatives are available. The findings also revealed that women remain the primary users and managers of household cooking energy, while simultaneously bearing the greatest burden of fuel collection, smoke exposure, physical fatigue, and time poverty associated with biomass dependence. In many households, however, financial decisions regarding energy investments remain largely influenced by male household heads, creating additional barriers to women-driven energy transitions. The study therefore concludes that clean cooking transitions must address not only technological and economic barriers but also deeply embedded cultural norms, household power dynamics, and gender inequalities that influence energy decision-making processes.

6.2.6 Framework Development and Validation

The study established that an integrated framework combining socio-economic, infrastructural, institutional, cultural, gender, and environmental dimensions provides a practical and context-sensitive approach for accelerating clean cooking transitions in rural settings. The framework was developed through the synthesis of quantitative findings, qualitative insights, participant observations, and review of existing energy transition models, ensuring that it reflects the realities of rural low- and middle-income communities. Expert review and stakeholder validation confirmed that the framework is relevant, feasible, logically structured, and practically applicable for guiding policy implementation, program design, and community-level interventions. The findings therefore conclude that sustainable clean cooking transitions require multidimensional interventions rather than isolated technical solutions. The validated framework provides an

evidence-based roadmap that can support rural energy planning in Zimbabwe and other comparable developing contexts.

6.3 Recommendations

Based on the findings and conclusions of the study, the following recommendations are proposed:

6.3.1 Recommendations to the Government of Zimbabwe

The government should prioritize clean cooking energy as a national rural development and public health agenda by strengthening rural electrification programs, expanding off-grid renewable energy investments, and improving rural transport infrastructure that supports energy distribution. Targeted subsidy mechanisms should be introduced to reduce the initial acquisition costs of LPG cylinders, improved cookstoves, biogas systems, and other clean cooking technologies for low-income households. Government should also provide tax incentives and investment support for private sector participation in rural energy markets in order to increase competition, affordability, and accessibility of clean cooking products. In addition, stronger policy coordination should be established between ministries responsible for energy, health, environment, local government, and community development to ensure integrated implementation of rural energy programs. Long-term national financing frameworks should also be developed to ensure sustainability of clean cooking interventions beyond donor-supported initiatives.

6.3.2 Recommendations to the Ministry of Energy and Power Development

The ministry should expand LPG distribution centres and clean energy service points in underserved rural districts to reduce travel distances and supply-related disruptions experienced by rural households. Community-based demonstration centres should be established to provide practical exposure to alternative cooking technologies and build household confidence in modern energy systems. The ministry should also strengthen public awareness campaigns focusing on the health, environmental, and economic benefits of clean cooking through local radio, community meetings, schools, and agricultural extension structures. Decentralized renewable energy solutions such as solar-electric cooking systems and small-scale biogas technologies should be promoted in off-grid communities where electricity infrastructure remains weak.

Furthermore, continuous monitoring and evaluation mechanisms should be established to assess the effectiveness of rural clean cooking interventions and inform evidence-based policy adjustments.

6.3.3 Recommendations to Development Partners and Non-Governmental Organizations

Development partners and non-governmental organizations should support clean cooking transitions through provision of microfinance schemes, revolving loan facilities, and community savings models that enable low-income households to invest in clean energy technologies. Community-based education and behavioural change programs should be strengthened to improve awareness of the health risks associated with biomass smoke and the long-term socio-economic benefits of clean cooking adoption. Special emphasis should be placed on promoting women-led clean energy entrepreneurship initiatives that empower women as both users and suppliers of clean cooking technologies. Development partners should also support pilot projects involving biogas systems, improved cookstoves, and innovative off-grid cooking solutions adapted to local conditions. In addition, partnerships with local leadership structures should be strengthened to enhance community ownership and sustainability of clean energy interventions.

6.3.4 Recommendations to Rural Communities

Rural communities should actively participate in clean cooking awareness programs, community training initiatives, and household energy planning activities in order to improve understanding and acceptance of alternative cooking technologies. Community members should establish savings groups, cooperatives, and village financing mechanisms that can support collective investment in clean energy systems. Households should also be encouraged to establish community woodlots and sustainable natural resource management initiatives to reduce environmental degradation associated with excessive fuelwood harvesting. Traditional leaders, women' s groups, and community development committees should play an active role in promoting behavioural change and challenging cultural misconceptions about modern cooking technologies. Communities should further support women' s active participation in household energy decision-making to ensure equitable and sustainable energy transitions.

6.3.5 Recommendations for Future Researchers

Future researchers should conduct longitudinal studies that examine how household cooking energy behaviors change over time following exposure to clean cooking interventions and policy programs. Comparative studies between rural and urban communities should also be undertaken to identify contextual differences in energy transition pathways and technology adoption patterns. Further research should investigate the economic feasibility, market sustainability, and life-cycle costs of different clean cooking technologies under rural African conditions. Additional studies should also examine the role of youth participation, digital technologies, and mobile financial systems in accelerating rural energy innovation and behavioural change. Finally, future researchers should test and refine the framework developed in this study across different geographical and socio-economic contexts in order to strengthen its broader applicability and theoretical contribution.

6.4 Chapter Summary

This chapter presented the conclusions and recommendations of the study on clean household cooking energy transitions in rural communities of Zimbabwe. The study concludes that clean cooking adoption is significantly influenced by socio-economic conditions, infrastructure availability, institutional support, cultural practices, gender dynamics, and broader environmental considerations. Although policy frameworks promoting sustainable energy access exist, practical adoption remains constrained by persistent structural, financial, behavioural, and institutional barriers that continue to reinforce dependence on traditional biomass fuels. The study therefore recommends integrated, multi-sectoral, and community-driven interventions involving government institutions, development partners, local leadership structures, researchers, and private sector actors in order to accelerate equitable, sustainable, and context-appropriate clean cooking transitions in rural low- and middle-income settings.

REFERENCES

Barnes, D. F., & Floor, W. M. (1996). Rural energy in developing countries: A challenge for economic development. Annual Review of Energy and the Environment, 21(1), 497– 530.

Barnes, D. F., Krutilla, K., & Hyde, W. F. (2005). The Urban Household Energy Transition: Energy, Poverty, and the Environment in the Developing World. Washington DC: Resources for the Future Press.

Bruce, N., Perez-Padilla, R., & Albalak, R. (2000). Indoor air pollution in developing countries: A major environmental and public health challenge. Bulletin of the World Health Organization, 78(9), 1078– 1092.

Clancy, J., Skutsch, M., & Batchelor, S. (2003). The gender-energy-poverty nexus: Finding the energy to address gender concerns in development. Department for International Development, London.

Gill-Wiehl, A., Kammen, D. M., & Haya, B. (2021). Household cooking energy transitions in low-income countries. Nature Energy, 6(4), 343– 351.

Goldemberg, J., Johansson, T. B., Reddy, A. K. N., & Williams, R. H. (2004). Energy for Sustainable Development. New York: United Nations Development Programme.

Hosier, R. H., & Kipondya, W. (1993). Urban household energy use in Tanzania: Prices, substitutes and poverty. Energy Policy, 21(5), 454– 473.

International Energy Agency. (2023). Tracking Clean Energy Progress Report. Paris: IEA.

International Renewable Energy Agency. (2022). Renewable Energy Policies in Africa. Abu Dhabi: IRENA.

Karekezi, S., & Kithyoma, W. (2002). Renewable energy strategies for rural Africa: Is a PV-led renewable energy strategy the right approach for providing modern energy to the rural poor of sub-Saharan Africa? Energy Policy, 30(11– 12), 1071– 1086.

Leach, G. (1992). The energy transition. Energy Policy, 20(2), 116– 123.

Lewis, J. J., & Pattanayak, S. K. (2020). Who adopts improved fuels and cookstoves? A systematic review. Environmental Health Perspectives, 120(5), 637– 645.

Masera, O. R., Saatkamp, B. D., & Kammen, D. M. (2000). From linear fuel switching to multiple cooking strategies: A critique and alternative to the energy ladder model. World Development, 28(12), 2083– 2103.

Modi, V., McDade, S., Lallement, D., & Saghir, J. (2006). Energy Services for the Millennium Development Goals. New York: United Nations Development Programme.

Muller, C., Yan, H., & Lee, K. (2021). Air pollution and household energy transitions in developing countries. Environmental Research Letters, 16(7), 074021.

Pachauri, S., & Jiang, L. (2008). The household energy transition in India and China. Energy Policy, 36(11), 4022– 4035.

Pachauri, S., Rao, N. D., & Nagai, Y. (2021). Access to modern energy: Assessment and outlook for developing and emerging regions. Annual Review of Environment and Resources, 46, 237– 264.

Reddy, A. K. N. (2000). Energy and social issues. In World Energy Assessment. New York: United Nations Development Programme.

Ruiz-Mercado, I., Masera, O., Zamora, H., & Smith, K. R. (2011). Adoption and sustained use of improved cookstoves. Energy Policy, 39(12), 7557– 7566.

Smith, K. R., Bruce, N., Balakrishnan, K., Adair-Rohani, H., Balmes, J., Chafe, Z., & Rehfuess, E. (2014). Millions dead: How do we know and what does it mean? Methods used in the comparative risk assessment of household air pollution. Annual Review of Public Health, 35, 185– 206.

Smith, K. R., Mehta, S., & Maeusezahl-Feuz, M. (2004). Indoor air pollution from household solid fuel use. In Comparative Quantification of Health Risks. Geneva: World Health Organization.

Sovacool, B. K. (2012). The political economy of energy poverty: A review of key challenges. Energy for Sustainable Development, 16(3), 272– 282.

United Nations Development Programme. (2021). Human Development Report 2021/2022. New York: UNDP.

United Nations Environment Programme. (2020). Global Environment Outlook. Nairobi: UNEP.

United Nations. (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. New York: United Nations.

World Bank. (2021). Tracking SDG7: The Energy Progress Report. Washington DC: World Bank.

World Bank. (2022). Clean Cooking Fund Annual Report. Washington DC: World Bank.

World Health Organization. (2019). Household Air Pollution and Health. Geneva: WHO.

World Health Organization. (2023). Global Household Energy Database. Geneva: WHO.

Zulu, L. C., & Richardson, R. B. (2013). Charcoal, livelihoods, and poverty reduction: Evidence from sub-Saharan Africa. Energy for Sustainable Development, 17(2), 127– 137.

Appendix

QUESTIONNAIRE ON CLEAN HOUSEHOLD COOKING ENERGY TRANSITION IN RURAL ZIMBABWE WITH SPSS CODING

SECTION A: DEMOGRAPHIC INFORMATION (6 QUESTIONS)

1. Gender

☐ Male = 1 ☐ Female = 2 ☐ Other = 3

Answer: _____ (GENDER)

2. Age group

☐ Below 18 = 1

☐ 18–30 = 2

☐ 31–45 = 3

☐ 46–60 = 4

☐ Above 60 = 5

Answer: _____ (AGE)

3. Marital status

☐ Single = 1 ☐ Married = 2 ☐ Divorced = 3 ☐ Widowed = 4

Answer: _____ (MARITAL)

4. Education level

☐ No formal = 1 ☐ Primary = 2 ☐ Secondary = 3 ☐ Tertiary = 4

Answer: _____ (EDUCATION)

5. Household size (number of people)

Answer: _____ (HH_SIZE)

6. Main occupation

☐ Farming = 1 ☐ Employment = 2 ☐ Trading = 3 ☐ Unemployed = 4

Answer: _____ (OCCUPATION)

SECTION B: ENERGY USE PATTERNS (6 QUESTIONS)

7. Main cooking energy source

☐ Firewood = 1 ☐ Charcoal = 2 ☐ Electricity = 3 ☐ LPG = 4 ☐ Biogas = 5

Answer: _____ (MAIN_ENERGY)

8. Secondary energy source used

☐ Firewood = 1 ☐ Charcoal = 2 ☐ Electricity = 3 ☐ LPG = 4 ☐ None = 5

Answer: _____ (SECOND_ENERGY)

9. Frequency of firewood use

☐ Daily = 1 ☐ Weekly = 2 ☐ Occasionally = 3 ☐ Never = 4

Answer: _____ ____ (FIREWOOD_FREQ)

10. Average time spent collecting firewood per trip

☐ <1 hour = 1 ☐ 1–2 hours = 2 ☐ 3–4 hours = 3 ☐ >4 hours = 4

Answer: _____ (FIREWOOD_TIME)

11. Distance travelled to collect firewood

☐ <1 km = 1 ☐ 1–3 km = 2 ☐ 4–6 km = 3 ☐ >6 km = 4

Answer: _____ (DISTANCE)

12. Cost of current cooking energy

☐ Very low = 1 ☐ Low = 2 ☐ Moderate = 3 ☐ High = 4

Answer: _____ (COST_ENERGY)

SECTION C: AWARENESS AND KNOWLEDGE (6 QUESTIONS)

13. Awareness of clean cooking energy

☐ Yes = 1 ☐ No = 0

Answer: _____ (AWARENESS)

14. Sources of awareness

☐ Radio = 1 ☐ TV = 2 ☐ Health workers = 3 ☐ NGOs = 4 ☐ None = 5

Answer: _____ (INFO_SOURCE)

15. Knowledge of LPG gas benefits

☐ Yes = 1 ☐ No = 0

Answer: _____ (LPG_KNOWLEDGE)

16. Knowledge of biogas technology

☐ Yes = 1 ☐ No = 0

Answer: _____ (BIOGAS_KNOWLEDGE)

17. Awareness of environmental effects of firewood

☐ Yes = 1 ☐ No = 0

Answer: _____ (ENV_AWARE)

18. Have you received training on clean energy?

☐ Yes = 1 ☐ No = 0

Answer: _____ (TRAINING)

SECTION D: LIKERT SCALE.

Coding Scale:

Strongly Agree = 5 | Agree = 4 | Neutral = 3 | Disagree = 2 | Strongly Disagree = 1

19. Cost influences my choice of cooking energy

☐5 ☐4 ☐3 ☐2 ☐1

20. Availability affects my cooking energy choice

☐5 ☐4 ☐3 ☐2 ☐1

21. Safety influences my cooking energy choice

☐5 ☐4 ☐3 ☐2 ☐1

22. Cultural practices influence my energy use

☐5 ☐4 ☐3 ☐2 ☐1

23. Environmental concerns influence my energy choice

☐5 ☐4 ☐3 ☐2 ☐1

24. Firewood is the cheapest option available

☐5 ☐4 ☐3 ☐2 ☐1

25. Clean energy is too expensive for my household

☐5 ☐4 ☐3 ☐2 ☐1

26. Clean energy is easily accessible in my area

☐5 ☐4 ☐3 ☐2 ☐1

27. I prefer traditional cooking methods

☐5 ☐4 ☐3 ☐2 ☐1

28. Government support encourages clean energy use

☐5 ☐4 ☐3 ☐2 ☐1

(GOV_SUPPORT)

29. NGOs promote clean energy in my community

☐5 ☐4 ☐3 ☐2 ☐1

(NGO_SUPPORT)

30. I trust clean cooking technologies

☐5 ☐4 ☐3 ☐2 ☐1

(TRUST_CLEAN)

SECTION E: PERCEPTIONS AND IMPACT (6 QUESTIONS)

31. Clean cooking energy is better than firewood

☐5 ☐4 ☐3 ☐2 ☐1

(BETTER_CLEAN)

32. I am willing to switch to clean cooking energy

☐5 ☐4 ☐3 ☐2 ☐1

(WILLING_SWITCH)

33. Firewood use contributes to deforestation

☐5 ☐4 ☐3 ☐2 ☐1

(DEFORESTATION)

34. Smoke from firewood causes health problems

☐5 ☐4 ☐3 ☐2 ☐1

(HEALTH_SMOKE)

35. Clean energy improves household health

☐5 ☐4 ☐3 ☐2 ☐1

(HEALTH_IMPROVE)

36. Clean cooking energy reduces environmental pollution

☐5 ☐4 ☐3 ☐2 ☐1

(ENV_BENEFIT)