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LIQUEFIED PETROLEUM GAS UTILISATION IN GHANA: A COMPARATIVE STUDY OF AGONA NKWANTA AND SEKONDI IN THE WESTERN REGION

BY

NANA AKOSUA ACHIAA ADU

2022

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NANA AKOSUA ACHIAA ADU

Thesis submitted to the Institute for Oil and Gas Studies of the Faculty of Social Sciences, College of Humanities and Legal Studies, University of Cape Coast, in partial fulfilment of the requirements for the award of Master of Philosophy degree in Oil and Gas Resource Management.

SEPTEMBER 2022

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature: …… Date: …….....

Name: Nana Akosua Achiaa Adu

Supervisors' Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Supervisor's Signature: …… Date: ……...

Name: Prof. Joseph Aggrey- Fynn

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ABSTRACT

The study examined LPG utilisation by conducting a comparative study between two distinct study areas, namely Agona Nkwanta and Sekondi in the Western Region of Ghana. It delved deeper into the stages of utilisation (i.e. adoption and sustained usage), challenges affecting them and determining factors to scale- up. The mixed method approach was employed with a descriptive research design. Questionnaires were administered to 379 households using simple random sampling and 6 people were interviewed as organisational facilitators using the homogenous purposive and convenience sampling. The quantitative data was then analysed with SPSS using the descriptive statistics and independent t-test, whilst the thematic analysis was used for the qualitative data. The study revealed low levels of LPG adoption and sustained usage amidst high fuel stacking amongst the two study areas, with Sekondi having a much higher level of sustained usage than Agona Nkwanta. The most pressing challenges found in both study areas include: high cost of refilling gas cylinders, inadequate gas filling stations, fear associated with gas usage, lack of funds for the initial purchase of gas and its equipment, preference for biomass, and long distance of gas filling stations. It was also revealed that regulators and LPG Marketing Companies have a role to play in scaling up LPG utilization in terms of safety, education, work ethics and monitoring. Per the findings, the study concluded that the proposed Cylinder Recirculation Model will help provide solutions to most of the pressing challenges with LPG usage. The study recommends it be set in-motion and Organisational Facilitators sit up in their roles towards LPG usage.

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KEY WORDS

Households

Utilisation

Organisational facilitators

Adoption

Sustained usage

Biomass

Regulators

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DEDICATION

To my late boss Dr. Otuo Serebour Agyemang and my family

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TABLE OF CONTENTS

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Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

Digitized by Sam Jonah Library

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Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

LIST OF TABLES

Digitized by Sam Jonah Library

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Digitized by Sam Jonah Library

© University of Cape Coast https://ir.ucc.edu.gh/xmlui

LIST OF FIGURES

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LIST OF ACRONYMS

SSA	Sub-Saharan Africa
EC	Energy Commission
NPA	National Petroleum Authority
HAP	Household Air Pollution
WHO	World Health Organisation
LPG	Liquefied Petroleum Gas
GACC	Global Alliance for Clean Cookstoves
UNFCCC	United Nations Framework Convention on Climate Change

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CHAPTER ONE

Introduction

Energy is seemingly one of the major problems the world faces today, affecting all. Lots of the world's population continue to struggle to consistently get access to clean and affordable modern energy (WHO, 2018). In order to tackle this problem, it is essential to comprehend the factors driving its uptake especially in developing countries like Ghana, where the problem is prevalent (Ghana Energy Commission, 2012; Essandoh, Adam & Brew-Hammond, 2013). Since the world became conscious of sustainable development, Liquefied Petroleum Gas (LPG) has gained popularity as a desirable fuel for industrial, commercial and domestic purposes. This has resulted in a gradual increase in LPG consumption in households by an average of 80% since the 1990s (Ahunu, 2015), though it hasn't gained much dominance yet. Despite efforts made to promote its usage, there is still a long way to go as traditional fuels (biomass) such as fire wood and charcoal continues to be the major wellsprings of fuel in Ghana. Biomass fuels, despite their numerous adverse effects still constitute about 73.9% of total fuel used (Broni-bediako & Dankwa, 2013) and remain widely used in both rural and urban areas. This work seeks to investigate the driving forces behind the slow progress of LPG utilisation through a comparative study between two distinct areas, namely Agona Nkwanta and Sekondi, in the Western region of Ghana.

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Background to the Study

Globally, 41% of households, over 2.8 billion people depend on solid fuels (coal and biomass) for domestic activities such as cooking and heating (Amegah & Jaakkola, 2016). This widespread use of solid fuels seem to be in developing countries (low income and middle income), where intervention efforts to provide clean household energy solutions are not achieving desired goals. CITAC (2020) discloses that per the 2019 revision of the United Nations World Population Prospects, nearly half of the estimated population increment which is 1.6 billion in the next 20 years will be in Africa, where energy poverty persist and if not addressed it can lead to serious repercussions.

The opposition of the widely used Biomass (charcoal and wood) fuels is because of their adverse effects on both the environment and individuals at large. Biomass fuels have been the major cause of household air pollution (HAP), one of the "world's biggest killers." Amegah and Jaakkola (2016) reported that in 2010, household air pollution was estimated to have caused 3.5 million premature deaths worldwide and also contributed to outdoor air pollution, causing an additional 370,000 deaths. In addition to causing major environmental burdens (Climate Change), it impedes the empowerment of women and girls (Rosenthal, Quinn, Grieshop, Pillarisetti, & Glass, 2017), and leads to retarding economic development. In 2009, the contribution of charcoal production to deforestation in tropical countries with the highest rates of deforestation was estimated at less than 7% (Chidumayo & Gumbo, 2013). Again, emissions of greenhouse gases from charcoal production in tropical ecosystems in 2009 were estimated at 71.2 million

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tons of carbon dioxide and 1.3 million tons of methane, contributing to global warming (Rosenthal et al., 2017).

Looking at the impacts of biomass usage, a shift to a safer alternative was needed. This has driven many countries, especially in Sub-Saharan Africa (SSA), to also take this action to promote clean and affordable cooking technology through the use of LPG (UNDP, 2014). LPG is now being projected as the centrepiece of household energy consumption for energy sustainability (UNFCC, 2014). Despite its origin from the burning of fossil fuel, LPG is safer and more convenient, and in addition, burns clean without producing smoke and with low pollutant emissions (Sepp, 2014).

The energy sustainability campaign is aimed not only at eradicating the use of biomass fuels and their adverse effects but also at mitigating global climate change towards the achievement of sustainable development goals. The World Health Organisation (WHO), United Nations Framework Convention on Climate Change (UNFCCC), and the United Nation's General Assembly have championed this action in South Asia (SA) and Sub-Saharan Africa (SSA) where this threat persists through awareness campaigns, carbon financing for cook stoves (UNFCCC, 2014), and Sustainable Development Goals (SDGs) to address challenges such as poverty reduction, gender equality, education, health and environmental sustainability, which seem to be connected to energy sustainability. Since 2010, the Global Alliance for Clean Cook stoves (GACC), which is now the Clean Cooking Alliance (CCA) has also captained global efforts through the involvement of stakeholder groups including government ministries and agencies,

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producers, distributors and users with a goal of switching over 100 million households to clean cook stoves using LPG by 2020 (Amegah & Jaakkola, 2016).

Countries in this campaign such as Nigeria, Sudan, Kenya, and Ghana among others, have taken numerous approaches to foster their LPG markets including awareness programs, subsidies, appliance promotions, and educating the masses on the efficiency, cleanliness, environmental and health benefits of using LPG instead of expedients such as biomass fuels (CITAC, 2020). Although adoption has been relatively steady around the world with recorded improvements over the years, much work remains to be done. Sub-Saharan Africa has the highest proportion of households using biomass fuels, and it is the only region globally where traditional biomass usage is still growing alongside the population (Carrion, Prah, Tawiah, Agyei, Twumasi, Mujtaba, Jack & Asante, 2018).

Ghana, a low middle-income country with a population of about 28 million as of 2016, has about 50% of its population living in rural areas and about 35.7% of its dwellings in urbanized regions (WHO, 2018). Fuel wood and charcoal are the main sources of energy for an average of 70% of households in Ghana, with the excuse of households either lacking access to or being unable to afford LPG. Accessibility to LPG remains an integral part of the development agenda of the country. The Government of Ghana, as part of its effort to improve sustainable energy for all (SEA4all), launched the National LPG promotion program and the Rural LPG promotion program with the long term goal of ensuring that households adapt to clean energy for economic development (Ahunu, 2015). This national action plan aimed to expand Liquefied Petroleum

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Gas (LPG) access to 50% of the country's population by 2020, promoting LPG in rural areas that host half of Ghana's population and where the use of biomass fuel is nearly universal (Asante, Afari-Asiedu, Abdulai, Dalaba, Carrion, Dickinson, Abeka, Sarpong & Jack, 2018).

In spite of all these, statistics from Ghana Statistical Service (2014) showed that rural areas have about three-quarters (75%) of their households depending on wood or charcoal for cooking, while less than one-quarter (22.3%) use LPG and in urban areas 43.6 percent of households use charcoal, while 35.8 percent use LPG. Ahunu (2015) in research for the Africa Centre for Energy Policy (ACEP) disclosed that a significant proportion of households still make use of traditional biomass energy sources, which is a major setback to the LPG campaign. Continuous efforts are still in motion to fine-tune LPG utilisation, with the latest being the proposition of the Cylinder Recirculation Model (CRM), which is as a result of the government identifying and mitigating challenges in LPG usage (Dalaba, Alirigia, Mesenbring, Coffey, Brown, Hannigan, Wiedinmyer, Oduro & Dickinson, 2018).

Till date, the Ghanaian economy continues to be burdened by numerous effects of biomass usage including massive environmental issues, retarding of the economy, impeding of women and children's empowerment and household air pollution coupled with the slow progress of LPG utilisation, denoting energy poverty amongst the inhabitants. The government was also not able to meet its policy target of increasing LPG access to households by 50% in 2020 (Mensah et al., 2013). Policy decisions on energy sustainability towards the expansion of

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LPG usage, needs to consider the stages of LPG utilisation that is adoption and sustained usage separately along with contextual differences because all these factors influence the reasons why people have not adopted LPG yet or are not using it sustainably. Given the paucity of evidence on the state of Ghana's LPG utilisation, it is fundamentally important to assess LPG utilisation, highlighting factors influencing adoption and sustained usage of LPG and the role organisational facilitators, namely regulators (Energy Commission and National Petroleum Authority) as well as LPG marketing companies, can play in scaling-up its utilisation in Ghana.

Problem Statement

Ghana, after several efforts to promote LPG utilisation still has about 70% of its population using biomass fuels and is far behind its policy target of increasing LPG access to 50% of households in the country since 2015 (Asante et al., 2018). Household air pollution and indiscriminate falling of trees for charcoal production continues to be a burden to the economy (WHO, 2018) along with other adverse effects such as impeding of women and children empowerment among others (Rosenthal et al., 2017).

Rosenthal (2015) explains that research is crucial if clean cooking is to achieve its full capacity to improve health, the environment and development goals. This is so because policy makers of countries need to continuously review and assess energy alternatives in the face of increasing population growth and differing national priorities for socio-economic, health and climate mitigation

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(Rosenthal et al., 2017). Few researchers have looked into the issue of LPG utilisation in Ghana from different perspectives focusing on LPG adoption, promotions and interventions, demand and supply of LPG and effectiveness of policies.

A preponderance of literature has captured LPG utilisation in developing countries in Sub-Saharan Africa, but specifically in Ghana, there are few studies. The few studies in the Ghanaian context, has mainly limited their scope of research to LPG adoption (Sepp, 2014; Mensah, 2014; Carrion et al., 2018; Rosenthal et al., 2017), which is only the preliminary stage of LPG utilisation, with specific focus on promotions, policies and interventions (Ahunu, 2015; Asante et al., 2018; Agyei-Holmes, Boakye-Danquah, Tuffour & Afi Kosi, 2020). Though useful, they are mostly outdated and too skewed towards LPG adoption rather than its sustained usage, making them inadequate for sustainability study. There is a growing understanding that household energy sustainability, requires both adoption and sustained usage of LPG, because one can adopt and not use it sustainably. This demonstrates a need for continued study and hence why this research is centred on both adoption and sustained usage.

Though fuel stacking is largely mentioned in LPG studies as impeding sustained usage, most studies have rather been centred on only the dynamics of energy transition and LPG usage in homes and hardly take other fuel usage into consideration. In reality, most households rely on traditional fuels (biomass) for certain activities, in addition to adopting modern fuels (LPG). This has made it difficult to study sustained usage without exploring fuel stacking. Only a few

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studies (Muller & Yan, 2018; Gould and Urpelainen, 2018; Ochieng, Zhang, Nyabwa, Otieno & Spillane, 2020; Yadava, Davies & Asumadu-Sarkodie, 2021) have undertaken a rigorous analysis of fuel stacking, whereas most studies have looked into adoption and sustained usage, making fuel stacking studies largely under-studied especially in SSA. Looking at the level of fuel stacked in a particular place helps give a picture of how much LPG is incorporated into daily activities in homes which can predict the current position of LPG sustained usage. It is in this light that the study will again investigate the level of fuel stacking in both study areas.

Another motivation for choosing this topic is that literature on LPG utilization has mostly highlighted only the contributions of government institutions through promotions and policies (Ahunu, 2015; Dalaba et al., 2018; Asante et al., 2018; Agyei-Holmes, Boakye-Danquah, Tuffour & Afi Kosi, 2020), with less attention paid to the role of organisational facilitators (key stakeholders in LPG supply such as LPG MC's, National Petroleum Authority and Energy Commission) in scaling up adoption and sustained usage of LPG. Over the years, there have been reported incidents of explosions from LPG refilling stations and homes, LPG shortages, LPG price hikes, and misconceptions about the locally manufactured LPG, which may affect user perceptions and, in turn, affect usage. Regulators contribute to policy setting and enforcement of laws while LPG MC's sell LPG at retail to domestic users. It is imperative to assess how their roles and contribute to scaling-up utilisation of LPG as missing in literature.

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Another basis for the study is the comparative analysis between the two study areas: Agona Nkwanta and Sekondi. In the past, Agona Nkwanta and its environs, Axim and Dixcove, among others, have benefited from the Rural LPG promotion programme through the sharing of LPG cylinders to some of the inhabitants. Sekondi, on the other hand has not directly benefitted from such promotions. Given this previous effort, it is necessary to investigate the current state of LPG utilisation in Agona Nkwanta, an area that has benefitted from an LPG promotion initiative and Sekondi, another area that has not benefitted from any initiative. This will contribute to future policy decisions.

The above discussions confirm the need to assess LPG utilisation in Agona Nkwanta and Sekondi in the Western Region of Ghana.

Purpose of Study

The main objective of this study is to assess LPG utilisation in Ghana through a comparative study of Agona Nkwanta and Sekondi. Working towards this goal, these specific objectives would be followed:

1. Assess the level of LPG adoption in Agona Nkwanta and Sekondi.
2. Assess the level of fuel stacking in Agona Nkwanta and Sekondi.
3. Assess the level of sustained usage of LPG in Agona Nkwanta and Sekondi.
4. Examine the challenges affecting LPG utilization in Agona Nkwanta and Sekondi.

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5. Assess the role of organisational facilitators (Gas marketers, National Petroleum Authority NPA and Energy Commission of Ghana) in scaling up LPG utilisation in Agona Nkwanta and Sekondi.

Research Questions

To meet the broad aim and objectives of this study, the study specifically uses the following research questions as a guide:

1. What is the level of LPG adoption in Agona Nkwanta and Sekondi?
2. What is the level of fuel stacking in Agona Nkwanta and Sekondi?
3. What is the level of sustained usage of LPG in Agona Nkwanta and Sekondi?
4. What factors are impeding LPG utilisation in Agona Nkwanta and Sekondi?
5. What is the role of Organisational facilitators in scaling up of LPG utilisation in Agona Nkwanta and Sekondi?

Significance of Study

This study will contribute to the recent and growing literature on LPG utilisation and serve as a source of reference for other related research works in the future. It will also reveal the main contextual factors that impede LPG adoption and sustain usage, with particular attention to drawing up suggestions to scale-up its utilisation. This will therefore aid energy policy designing in Ghana as well as contribute to the literature on energy modelling in the sense that it provides evidence of both current and future dynamics of LPG utilisation from an

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urban and rural perspective. This will help policymakers to take actions geared towards enhancing even growth in the country thereby working towards the sustainable development goals (SDGs). Lastly, this research will help both study areas to know the essence of using LPG and energy sustainability which will speed up their socio-economic development.

Delimitations

The study focuses on dimensions of LPG utilisation in Ghana, running a comparative study between the two areas, identifying challenges and suggestions to scale-up LPG utilisation, and therefore does not include studies on other forms of clean energy. The study area is delimited to Agona Nkwanta and Sekondi in the Western Region of Ghana in SSA. The study area therefore excludes all other towns and communities in Ghana.

Limitations

The study employed the use of a questionnaire in collecting data from households, which did not give the respondents the opportunity to express themselves much, as well as probing further into various constructs. A lot of the respondents could not read and write, and though provisions were made to guide them through filling out the questionnaire, the process was tiring and slow. Due to time constraints, only gas marketers, NPA and EC were interviewed for organisational facilitators, whereas the ministry of energy and Ghana National Gas Company, as well as other key stakeholders in the LPG value chain, could have been added for further knowledge.

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Organisation of the study

The study is organised into five chapters. The first chapter encompasses the introduction to the study; background to the study; statement of the problem; purpose of study; research questions; and significance of the study; delimitation of the study; limitations of the study; and lastly, the organisation of the study. The second chapter focuses on the review of related literature, both theoretical and empirical. The third chapter deals with the research methods, which includes the study area, the study design, research approach, population of the study, sampling and sample size, data needs, data collection techniques, data analysis techniques, sources of data, tools for data collection and the structure of the questionnaire, reliability and analysis of the data will be discussed. Chapter four deals with the analysis of data collected from the respondents. The analysis presents various results in graphs, figures, tables and diagrams. Chapter five presents the summary of the study, the conclusions from the analysis and discussion of the data and recommendations.

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CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter reviews relevant related literature on LPG utilisation by scholars and other researchers, delving deeper into the stages of utilisation that is, adoption and sustained usage, and exploring the driving forces behind households' choice of energy. It does this by first reviewing relevant theories that frame the present study and, thereafter, empirical works, documenting the results of other studies that are closely related to the research work. And finally, the summary of the chapter is presented.

Theoretical Review

Theories and concepts aid in structuring and guiding of knowledge production by serving as a foundation for building existing knowledge (Asamoah, 2014). This study draws on two theories for moderating household energy usage. They are the "energy ladder" theory and the energy stacking theory which is used to explain how and why households adopt and use the various domestic energy sources.

The 'Energy Ladder' Theory

The "Energy ladder" theory outlines how social and economic factors influence household energy choices and is commonly used in explaining household energy usage in developing countries (Muller & Yan, 2018). As a ladder of various household energy choices arranged according to increasing technological sophistication, it depicts a process of transition by which

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households switch from one fuel source to another (away from traditional fuel sources, e.g., biomass) as they are confronted with favourable factors. The journey up the ladder entails first switching from primitive fuels such as firewood to adopting intermediate fuels (kerosene, charcoal) and then finally using modern fuel sources (gas, electricity) which are more technologically sophisticated (Kowsari & Zerriffi, 2011). This theory also draws inferences from the income effect of consumer economic theory, which shows how consumers substitute inferior goods with necessary goods and luxury goods as their income rises (Muller & Yan, 2018). According to the concept as depicted in Figure 1, households transition from one fuel source to another on top of the ladder, at the speed and to the extent allowed by favourable factors such as household income, fuel and equipment costs, availability and accessibility of fuels, reliability of modern fuel distribution, and, to a lesser extent, relative fuel prices. Paunio (2018)

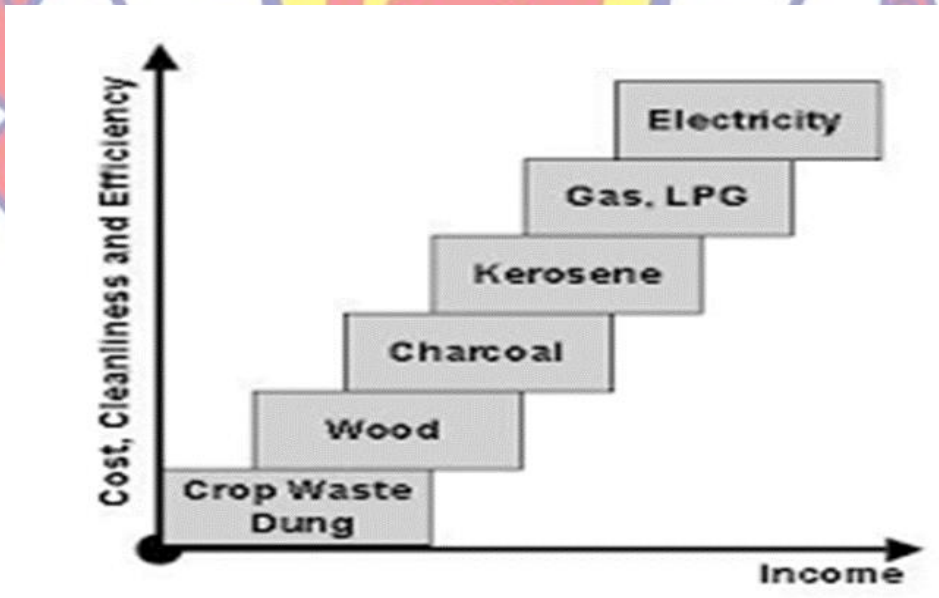

Figure 1: Energy Ladder

Source: (Kowsari & Zerriffi, 2011)

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discloses that the energy ladder theory was propounded by renowned American indoor air pollution (IAP) researcher Kirk Smith for the World Health Organisation in 1990.

The theory simply explains how socio-economic development enhances energy sustainability and vice versa. As people's socio-economic levels rise, they prefer modern energy sources (LPG and electricity) which leads to energy sustainability. However, an increase in energy sustainability also tends to promote socio-economic development. The theory helps to expose the rationality of humans.

The Energy Stacking Theory

Empirical studies on household energy consumption have proven that fuel switching is not unidirectional as suggested by the energy ladder theory and that households may switch back to traditional biofuels even after adopting modern fuel sources. This is due to the fact that fuels are imperfect substitutes and often specific fuels are preferred for specific tasks (Kowsari & Zerriffi, 2011). Therefore, instead of simply switching from one fuel source to another, households would rather keep and use a combination of fuels and conversion technologies depending on budget, preferences, needs and other factors. Figure 2 shows the concept of the Energy Stacking theory.

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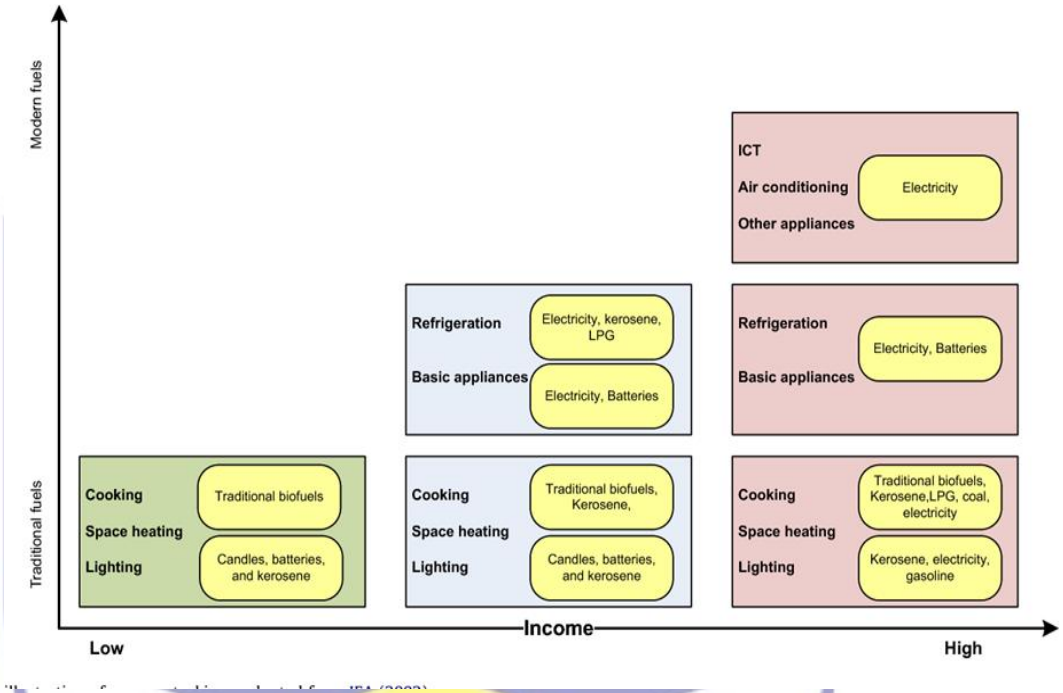

Figure 2: Energy stacking ladder

Source: (Kowsari &Zerriffi, 2011)

It depicts the multiple fuel use pattern, whereby households choose a combination of fuels from both the lower and upper levels of the fuel ladder and rotate between them (Amegah & Jaakkola, 2016). Studies have shown that in rural China and Brazil, even the wealthiest households still keep and occasionally use primitive fuel sources and that a complete switch to modern fuels (LPG and electricity) occurs only at the highest income level (Kowsari & Zerriffi, 2011). The complexity of this fuel-switching process thus suggests that there are multiplicity of factors that affect fuel use (Kowsari & Zerriffi, 2011).

Practically, the theory helps to understand how households juggle different energy sources for multiple reasons. And their preference to keep traditional

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energy sources as a backup in case modern energy supplies fail even after adoption. It highlights the difference between adoption and sustained usage. Many households have adopted LPG, but are not using it sustainably because they keep falling back to traditional biomass fuels as back-ups.

Relation of the theories to the study

The theoretical frameworks discussed above highlight energy usage patterns from a consumer's perspective, which provides the prominent explanation for household fuel transition in developing countries (Kowsari & Zerriffi, 2011). These theories have progressively integrated the way fuel decisions occur as part of household activities. They illustrate how and why households react towards fuel choices in selecting a suitable source of energy for their homes. This is pertinent to the study's objectives as they clearly outline the factors that drive energy choices. The energy ladder theory, which is the first theory in this study, explains how households switch from primitive fuels to modern fuels at a speed and extent only allowed by favourable factors (Muller & Yan, 2018).

These favourable factors which include household income, fuel and equipment costs, availability and accessibility of fuels, reliability of modern fuel distribution, and, to a lesser extent, relative fuel prices driving households to switch to LPG are social and economic factors that hammer on the essence of socio-economic development in clean energy (LPG) utilisation. This motivates the examining of the fourth and fifth objectives of this study. The objectives seek to determine the challenges facing LPG utilisation in the study areas and the role

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of Organisational facilitators in increasing LPG utilisation respectively. This is because the main argument of the energy ladder theory is that the reasons for households' fuel switching are induced by socio-economic factors. Based on the theory's deductions, the challenges to LPG utilisation can be classified as socioeconomic in nature. This thus, stresses the disclosure by the Ghana Statistical Service (2014) that a rise in LPG usage in urban areas as compared to rural areas where socio-economic development is retarded.

The role of the Organisational facilitators (EC, NPA and gas marketers) in this study is embedded in these favourable factors that induce households to switch to LPG since they play a part in policy formulation and decision making in terms of its accessibility, cost, availability and reliability of fuel distribution. Though the energy ladder theory captures the necessary reasons behind the household energy situation in most developing countries and the assumption of switching from primitive fuels to modern ones with a complete abandonment of the former. This theory is inconsistent with modern research (Kowsari & Zerriffi, 2011) since there may be other reasons for fuel adoption and switching other than socio-economic factors. People who move up the ladder to use modern fuels sometimes switch back to primitive fuels depending on the situation. Hence the addition of the energy stacking theory.

Contrary to the energy ladder, the energy stacking theory explains how households adopt a portfolio of energy sources and, instead of switching from one to another, switch between them as and when they want due to preferences, as an insurance against modern energy supply failure and to decrease vulnerability to

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modern energy price fluctuations by diversifying energy use. This theory disputes that fuel choices are not only influenced by socio-economic factors. Again, energy transition is not unidirectional, and even after adopting modern energy, households can keep primitive energy sources and alternate them according to their preference, so that no single energy source has monopoly power (Kowsari & Zerriffi, 2011).

The energy stacking theory is commonly practiced in some households and accounts for the partial usage and leisurely rise of LPG utilisation. Clearly, the theory highlights more on the two stages of LPG utilisation, which are adoption and sustained usage, and applies to the first, second, and third objectives of this study, which assess the level of LPG adoption, level of fuel stacking, and level of sustained usage, respectively. It further hammers on the fact that to tackle LPG utilisation, adoption and sustained usage have to be assessed separately, because a lot of households adopt LPG and alternate its usage with biomass fuels (Asante et al., 2018), which is not using it sustainably.

This accounts for the fact that the country continues to battle numerous consequences of biomass fuel usage. The theory best explains modern domestic energy usage patterns, especially for households in developing settings, which are mostly built on culture and conformity (Kowsari & Zerriffi, 2011), and exposes the need for education on the consequences of using biomass and the continued sustenance of good energy policies and promotions to promote LPG usage.

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Conceptual Framework

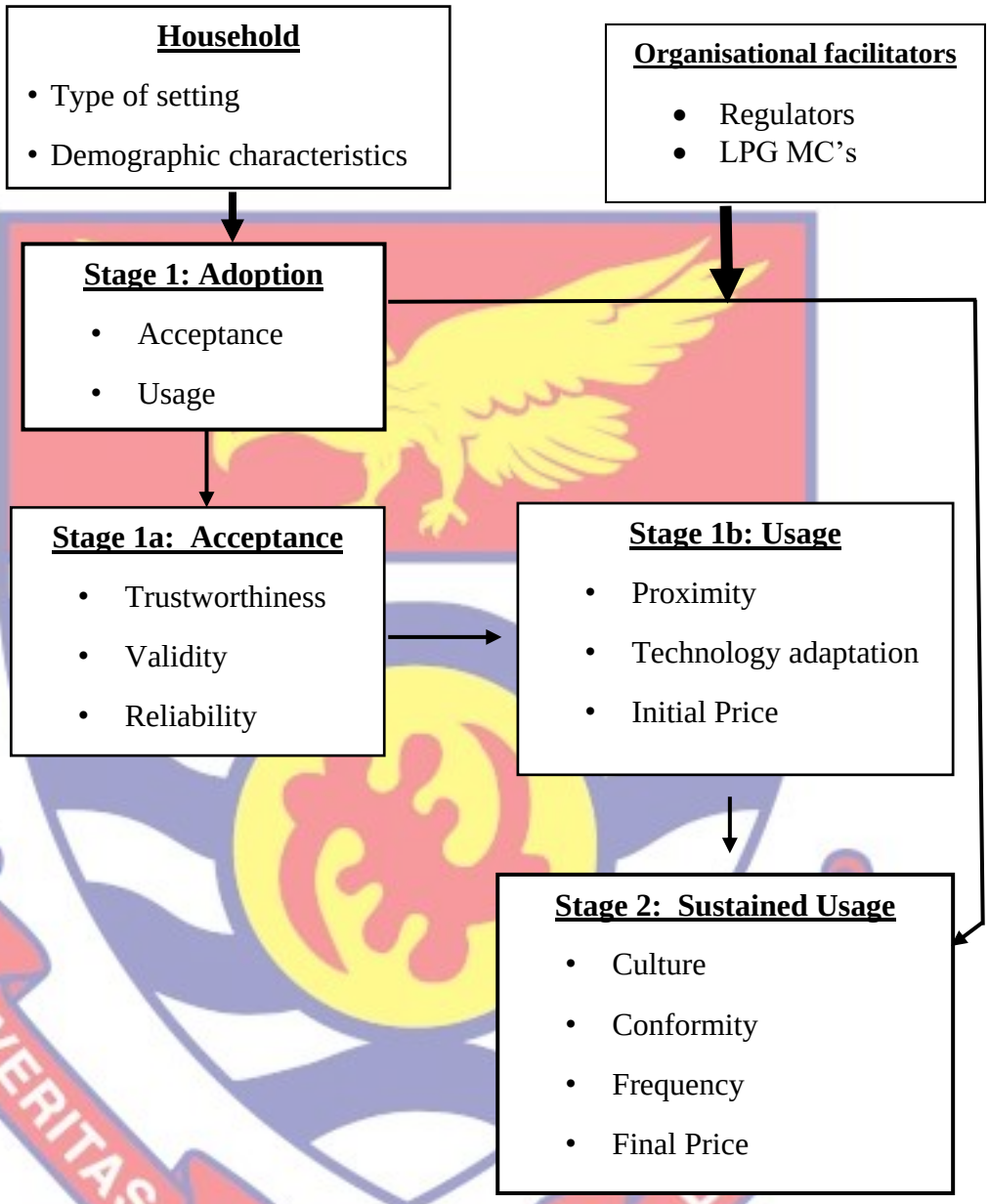

Figure 3: Conceptual framework for LPG utilisation

Source: Adapted from (Kowsari & Zerriffi, 2011; Ekouevi & Tuntivate, 2012; GACC, 2015).

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Figure 3 shows how households transition through the stages of LPG utilisation and projects the variables that are necessary for satisfying the theme of each stage. The transition is from household to stage 1, through stage 1a, stage 1b, and finally stage 2. The framework is relevant to the study since it projects the various variables that influence the stages of LPG utilisation and also shows how households are easily affected by such variables in their choices. Importantly, it considers the relevance of organisational facilitators in the LPG utilisation. The justification for the variables are as follows:

Existing literature points out a number of factors that affect or determine household energy choices. These decisions are based on complex interactions between social, economic, and demographic factors like type of setting (whether rural or urban), family size (large or small), level of education (formal or no formal), gender, level of income, and other environmental factors (access to natural resources) (Kowsari & Zerriffi, 2011).

Several recent studies that were discussed at the Global Alliance for Clean Cookstoves in 2015 in Peru led to the common deduction that adoption is a dynamic process that begins with acceptance and leads to usage. The acceptability of a product by customers depends on its potential to meet high quality standards (availability, validity, affordability, reliability, measurable advantages in terms of money and time saving), and also on its attractiveness (modern and desirable by users) (Ekouevi & Tuntivate, 2012). Based on such reviews, acceptance as the first stage of adoption is measured with four variables: information, trustworthiness, validity, and reliability in this study.

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Hannigan (2018) found that the individual factors affecting key outcomes of interest are mediated by other factors. Utz, Kerkhof and Joost (2011) explain trustworthiness as the readiness of one to be vulnerable to the actions of another with the expectation of delivering a particular action important to them. Essentially, it describes the ability of customers to rely on or subscribe to the product's potency and the dependability of its suppliers. A few factors affect the trustworthiness of customers towards the usage of a product, namely: competency, security, integrity performance, and shared values (Murthy, Mariadas, & Perumal, 2017). Murthy et al. (2017) continue to explain the factors as follows: competency: the act of service providers offering desirable and consistent performance in meeting customers' needs and wants; security: the level of harm that customers may fear in using the product; integrity performance: the ability of service providers to maintain quality demands from customers and shared values: the knowledge of and agreement of the customer on the benefits of the product to the universe. If these factors are positive, then customers' trustworthiness towards a product is high and they will accept the product.

Uppal, Ali, and Gulliver (2018) describe reliability and validity as the potential to perform the guaranteed service continually and squarely and the extent to which results are truthful, respectively. Reliability measures how suitable in usage a product is for the user in terms of quality, value for money, and orientation, and validity captures the fact that users find their experience with the benefits of the product in agreement with perceptions before usage.

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Usage as the next stage of adoption after acceptance is also measured with proximity, technology adaptation, price, and transportation. Proximity explains accessibility, which is how readily available LPG is to users. Sepp (2014) explains how LPG is often limited to urban areas and how LPG supply shortages are a frequent occurrence in rural areas. Adapting to LPG technology is also essential in its use. People have varying levels of awareness and familiarity with LPG, and this influences their usage. Dalaba et al. (2018) disclosed that several rural users of LPG reported not knowing how to use LPG and safety concerns as reasons why they had not gotten an LPG stove.

Price, denoting affordability, is one important variable in LPG utilisation. A large body of literature points to price and affordability as the main determiners of fuel choice and quantity to be used, which is the main reason for low usage (Broni-bediako & Dankwa, 2013; Sepp, 2014; Dalaba et al., 2018, Carrion et al., 2018). The adoption price encompasses the expenses involved in the initial acquisition of LPG stoves as well as earlier refills.

GACC (2015) describes sustained usage as a function of daily use, intensity of use, and other contextual (community, culture, institutional, external) factors. These factors can be reduced to culture, conformity, frequency, and price. Culture-influenced patterns like household preferences, beliefs, and habits such as food tastes and cooking practices also influence the choice of energy to be used (Kowsari & Zerriffi, 2011). The power of social contagion in technology adoption has been found to be significant in studies (Hannigan, 2018). Conforming to peer influence and societal lifestyles can influence sustained usage of LPG. As

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revealed in the definition, daily use and intensity of use are all functions of frequency, which is the basis for sustained usage. Sustained usage depends on how often LPG is integrated into cooking plans (Dalaba et al., 2018). The price, on the other hand, includes the consistent refiling of cylinders as they finish and the maintenance costs associated with long-term use. Price comparison among household fuels gives room for stove stacking. Most of these variables are in one way or the other affected by organisational facilitators, thus making their facilitating role very important in enabling LPG utilisation.

Just like the theoretical framework, the conceptual framework helped to structure the work. As the theoretical framework highlights the reasons behind household energy choices, the conceptual framework outlines the stages and variables influencing the choices on LPG utilisation. This facilitates the understanding of the objectives and the variables used to measure them.

Empirical Review

LPG adoption

Transition from Biomass Fuels and SDGs.

It is difficult to talk about LPG adoption without mentioning biomass fuels since they were the main fuel used before the discovery of LPG as the desirable fuel in homes. The impact of using traditional fuels (biomass) was a hot topic for discussion worldwide as the world became more conscious of sustainable development and poverty reduction. McDade (2004) discloses that during the time of the Johannesburg World Summit on Sustainable Development (WSSD) in

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2002, access to modern energy as a basic pre-requisite to development and human well-being was conceived. He went on to state that stakeholders concurred to support the shift to cleaner forms of energy, which are environmentally favourable, socially desirable, and cost-effective in relation to the challenges associated with traditional fuel usage.

Since then, a lot of researchers (Ahunu, 2015; Carrion et al., 2018; Asante et al., 2018; Dalaba et al., 2018; Asante et al., 2018; Agyei-Holmes et al., 2020) have developed an interest in the area of LPG adoption and transition from biomass, resulting in literature greatly evolving and continuous growth in LPG adoption. There was controversy over the complete eradication of biomass fuels. Sepp (2014), on the defensive side, argued that regardless of widespread belief, all fuels can achieve fairly clean combustion provided appropriate technologies and methods are used. On the other hand, IEA (2006) disclosed that the use of biomass itself is not the problem, but the numerous resources being harvested unsustainably without efficient energy technologies. In addition to the serious adverse effects on health, the environment, and economic development, the death of women and children prematurely every year due to household air pollution from exposure to biomass and the valuable time and effort lost to fuel wood collection instead of education or work is a cause for concern (Ekouevi & Tuntivate, 2012).

These effects of biomass are also tied to the 2030 Sustainable Development Agenda's Sustainable Development Goals (SDGs). Various literature on sustainability studies remark that a complete shift to clean cooking

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(LPG) and abandonment of biomass usage will push towards the achievement of at least five of these Sustainable Development Goals (SDGs), that is, SDG 3, 5, 7, 13, and 15, which will help in progress and development (McDade, 2004; Rosenthal, Quinn, Grieshop, Pillarisetti & Glass, 2018; Amegah & Jaakkola, 2016). Table 1 depicts the sustainable development goals and their relevance to LPG utilisation which further highlights the argument of transition from biomass to LPG.

Table 1: SDG's of particular relevance to LPG utilisation

GOAL	Target relevance to LPG Utilisation
(3) Health and Well-being	Reducing/ eliminating illness and deaths due to household air pollution (HAP) and indoor air pollution (IAP)
(5)Empowering women and girls	Remove factors that impede women empowerment and encourage productive activities.
(7)Access to reliable, efficient modern energy	Expansion and availability of LPG utilization to all through production and distribution networks.
(13) Combat climate change	Implement measures to curb climate change impacts.
(15)Sustainably manage forests and halt land degradation.	Protect and sustainably manage the forest and terrestrial ecosystem.

Source: (Rosenthal et al., 2018; Amegah & Jaakkola, 2016)

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Hence, by eradicating the use of biomass fuels and promoting the use of LPG, we work towards the targets and, in doing so, stand a chance of progressing towards achieving the Sustainable Development Goals (SDGs) (Rosenthal et al., 2018).

Liquefied Petroleum Gas Promotion

Adoption of potentially welfare-improving technologies remains low in many contexts (Hannigan, 2018), and LPG usage is a prime example of such technologies. Even with its potential health, environmental, and social benefits, the practice of cooking with primitive fuels remains dominant throughout the developing parts of the world (Amegah & Jaakkola, 2016). LPG promotion has been one of the most widely implemented initiatives heavily relied upon to increase LPG usage. Thus, for many years, countries, especially developing ones, have eagerly embarked on many policy promotions to spearhead it. Many researchers have shown considerable interest in clean cooking initiatives, and there have been a lot of research discussions (Quaye–Foli, 2002; Ekouevi, 2013; Ahunu, 2015; Asante et al., 2018; WHO, 2018; Ekouevi & Tuntivate, 2012; Rosenthal et al., 2018) on the policies and promotions carried out by countries towards this initiative as well as the viability of these promotions.

Several governments in SSA set initiatives along the LPG value chain that have greatly evolved over the years, but Agyei-Holmes et al. (2020) disclose that while a handful of developing countries have made progress in increasing clean energy access, there are still significant challenges in the provision of energy,

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especially to the poor and vulnerable. On the empirical front, a growing literature has examined some developing countries in SSA and their progress so far. Among the developing countries are Senegal, Kenya, and Ghana, which predominantly rely on biomass and continue to lag behind their set targets for LPG utilisation despite having launched several initiatives. These countries were chosen from among many others because there was sufficient empirical evidence on them to support the analysis being conducted.

Kenya, which joined Sustainable Energy for All (SE4All) in 2012, has set a long-term goal of adopting LPG in 35% of households (15 kilograms per year) by 2030. This initiative was set in motion by reducing the cost of LPG through a tax exemption (van den Berg, 2018). van den Berg (2018) disclosed again that after a sharp expansion from a baseline of just 2 kilograms in 2013, the growth remains slow and steady. This is because even though LPG is tax exempt, it is still more expensive than kerosene, which is VAT inclusive. The absence of subsidies, coupled with some supply bottlenecks, has made LPG expensive in Kenya, causing people to switch back to biomass.

Senegal has also had its fair share of LPG promotion. From subsidies and tax exemptions on LPG and its cooking equipment (2.75kg and 6kg cylinders) to the distribution of LPG stoves, among others. The initiative was well received and resulted in over 85% of households adopting LPG till the withdrawal of the subsidy. (Mckinney, 2017) revealed that the promotion was not favourable to rural dwellers as most refilling centres were situated in urban centres, causing rural dwellers to incur a higher cost to refill. Again, the subsidised 2.75kg and 6kg

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cylinders were mostly used by high and middle-income earners, as the low-income earners preferred smaller sized cylinders.

Ghana, just like Senegal has promoted LPG use since 1989 through promotion programs (LPG promotion programme and Rural LPG promotion programme) which were geared towards fostering broader adoption and the establishment of Ghana Cylinder Manufacturing Company (Ahunu, 2015; Agyei-Holmes et al., 2020), LPG subsidies and the current cylinder recirculation model with the overall target of increasing access to households by 50% by 2020 (Asante et al., 2018). The target has proven impossible within that time and has been further expanded to 2030, despite being previously moved from 2015 to 2020 in the past.

Several studies (Asante et al., 2018; Ackah and Tetteh, 2016; Ahunu, 2015; UNDP, 2014; Acharibasam & Apatinga, 2014; Biscoff et al., 2012) have criticised the LPG promotion programmes, pointing out that the rollout of these programmes was centred on the general population (both urban and rural areas) instead of targeting a particular group of people. Asante et al. (2018) further reported political interference in LPG promotion and the selection of districts and beneficiaries. Agyei-Holmes et al. (2020) also observed that though the LPG promotion programmes are good initiatives which have positively caused a shift by households to LPG access and usage, the initiative is mostly skewed towards urban centres and favourable to higher-income households, leaving the rural centres behind. Defenders of the promotions like Ahunu (2015), however, argue

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that since the inception of the promotion in 1990, there has been a gradual increase in LPG consumption by an average of (80%).

Reviewing enough empirical work is key to admitting that there is a lack of clear planning and policy coordination of LPG promotion programs. While LPG promotion programmes are positive initiatives, their sustenance and effectiveness should not be disregarded. According to Broni-bediako and Dankwa (2013), the initiative, since its inception in 1990, received good responses till 2010 when there was a mass shortage of LPG in Ghana, causing people to doubt its reliability and fall back on biomass. Obviously, the growing demand due to the widespread awareness of LPG was not factored into the energy policy plan, which boils down to poor sustenance.

Asante et al. (2018) also discovered in their research to assess Ghana's rural LPG program scale-up that nine months after the distribution of LPG cylinders and cook stoves exercise, more than half (58%) of the LPG target households had never refilled their 6 kg LPG cylinders after the initial refilling and only (9%) had refilled more than twice. Clearly, a lot of the inhabitants fall into the low income bracket and could not afford the expense of refilling their cylinders as and when they get used up.

Poverty is the underlying cause of the elongated use of biomass fuels (Mensah, 2014; Karimu, Mensah & Adu, 2016). It is therefore appalling to realise that the LPG subsidy was removed in 2013, and till date, LPG prices keep on escalating alongside fuel prices in the country. It is generally known that subsidies are expensive and put a lot of burden on budgets, and most developing countries

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find it difficult to sustain them (Bensch and Jörgthem, 2020), but this subsidy removal has caused a lot of households to revert back to biomass in order to make economic adjustments. In it all, it is evident that LPG promotion programmes have targeted its adoption rather than sustained usage, which is mediocre. The government failed to include important stakeholders like users, whose views are critical to the implementation and success of the programmes. Again, the programmes refused to factor in geographical and contextual differences, while a lot of studies (Asante et al., 2018; Agyei-Holmes et al., 2020) point out the exclusion of the poor and vulnerable from the beneficiaries.

Measuring LPG adoption

A large body of literature has addressed the issue of LPG adoption. It is widely accepted that adoption is vital in the usage process of a technology or product because of its importance in understanding and evaluating economic development (Hannigan, 2018). That is why it continues to be a central research topic in LPG utilisation studies. It is key to admit that there is a lack of a clear definition of LPG adoption. Different researchers have defined it differently to suit their type of study. Kumar et al. (2017) defined adoption in their study as the initial uptake of LPG, which is independent of the behavioural phenomena of sustained use of LPG.

In the framework of Puzzolo, Pope, Stanistreet, Rehfuess and Bruce (2016), adoption is also defined as "the initial technology acquisition and use for less than one year from acquisition." Other researchers, however, defined adoption by relating it to sustained usage. Carrion et al. (2018), for example,

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mention that even though most LPG utilisation studies have focused on initial adoption rather than sustained use, there is a contrast since adoption studies have largely focused on the enablers and barriers of initial stove acquisition and/or the use of the technology early in its adoption.

Upon closer review, one thing that runs through is that the definitions various researchers used to describe adoption suited their type of study and influenced the variables or models used to measure adoption. This study, upon broader review of related literature, defined LPG adoption simply as the acceptance and assimilation of LPG into households. This definition is justified by Global Alliance for Clean Cookstoves (GACC) as they defined adoption as a process that starts with user acceptance during their conference in 2015, dubbed "Beyond Distribution: Ensuring and Evaluating the Adoption of Clean Cooking and its Benefits". One thing all the definitions and studies have in common that is also pertinent to this study is that LPG adoption is different from sustained use, even though the two are almost alike and often used interchangeably. Adoption does not necessarily mean it will be used sustainably. There is no permanent definition for adoption, but the definition a researcher chooses should be based on what is feasible and impactful for the study (GACC, 2015).

On the research front, a lot of research has framed LPG adoption studies, which largely constitute individual case studies and randomised case control studies. These are largely accumulated around the implementation of LPG initiatives and interventions, and exploratory studies which assess LPG usage from a broader perspective. Some (Kumar et al., 2017; Carrion et al., 2018;

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Hannigan, 2018) case control studies have outlined numerous stipulations often woven around adoption. These stipulations have often been used as the basis for measuring adoption and directing its research.

Carrion et al. (2018) outline three pre-conditions or variables often influencing adoption, namely: household/setting characteristics, infrastructure, and knowledge and perceptions. These pre-conditions are all highly contextual issues that should be considered in tackling adoption and sustained usage. In their research to assess the effectiveness of two interventions on facilitating adoption and sustained use of LPG in Kintampo North Municipality and Kintampo South District in the Brong-Ahafo Region of Ghana, they employed two interventions; the Risks, Attitudes, Norms, Abilities and Self-Maintenance (RANAS) model to design a clean cook stove behavioural change intervention and an access intervention where the objects under study received direct delivery of refilled LPG cylinders. Even though the study opined that these interventions are necessary, especially the RANAS model, which targeted five behavioural factors that can promote LPG adoption by households, they were not sufficient to induce behaviour change, and the results displayed proved that though the interventions led to an increase in knowledge and attitude towards behaviour change, none of the interventions induced meaningful additional LPG use.

In his study to assess the effects of prices, peers, and perceptions on improved cook-stove adoption, Hannigan (2018) mentioned that a series of variables explain different economic, psychological, and sociological factors at play in adoption. In his findings, he made some relevant assertions on how

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subsidy or low price is essential in promoting initial adoption and the essence of peer influence, where a target group adopts a technology and their peers also end up knowing about it and subsequently adopting it if it is positive.

Kumar et al. (2017) also used a case-control study design to explore the impact of the 3As (affordability, accessibility, and awareness) on LPG adoption and sustained use in their study. The study further revealed that understanding key drivers of adoption and sustained implementation of them is very vital, and so the gap between understanding determinants of adoption and sustained use ought to be closed.

It is very satisfying to deduce that all the variables presented in these various case control studies have significant effects as drivers or determinants of adoption, ranging from sociological factors like household/setting characteristics to infrastructure, psychological factors like knowledge and perceptions, and economic factors like price, affordability, and many more. Though this is helpful as a basis for continued study, it is insufficient for generalisation or conclusions since adoption studies have evolved. A lot more factors are now seen to be behind the cause of low adoption rates, which can only be discovered through continued research.

Dalaba et al. (2018) looked at the demand and supply of LPG in the Northern region of Ghana. The study revealed that stove and fuel costs were the main reasons households had not adopted LPG in rural areas, while safety concerns were cited in urban areas, with shortages and disproportionally filled cylinders as minor reasons. The evidence in this literature has left us with a lot of

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variables to measure adoption. Psychological, sociological, and economic factors, household/setting characteristics, infrastructure, knowledge and perceptions, peers, price, accessibility, promotions, and interventions, among others, have been lauded as important drivers of LPG adoption by early proponents (Carrion et al., 2018; Dalaba et al., 2018; Carrion et al., 2021).

The bulk of existing empirical studies on the determinants of LPG adoption have not delved into adoption alone much and mostly concentrated on experimental studies on adoption and promotions in connection with LPG. However, distribution does not equate to adoption, though many aspects of distribution influence adoption, and expanded access to clean cooking (promotions) is not enough to achieve it, but rather targeted interventions (GACC, 2015).

Barring the factors driving adoption alone and integrating it into LPG studies is important and relevant for both research and policy. It is fundamental to understand what factors are likely to increase adoption itself (Haller & Siedschlag, 2014) before linking it with LPG. Understanding people's adoption behaviour toward something (feature, process or service) is extremely helpful in identifying the value it carries (Sharon, 2018). Sharon (2018), in his article, described adoption as an unbiased behaviour measurement and cited some important measures such as trustworthiness, validity, and reliability as important drivers of adoption. On the other hand, the conference organized by GACC proposed two phases for adoption; acceptance and usage (GACC, 2015) and further stated that adoption is a process that commences with user acceptance and

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most rejection is likely to occur in the acceptance phase, when the benefits are not fully comprehended.

In the course of reviewing various literature on measuring adoption, our analysis showed that some factors are persistent while new ones also emerge. Presently, literature generally uses possession, distribution, and sales as rough indicators of adoption. However, no comprehensive framework to define or measure adoption has been developed (GACC, 2015), and so this study did not employ any existing adoption framework or model but derived and adapted variables through a review of relevant literature.

Fuel Stacking

Though fuel stacking is largely mentioned in LPG studies as impeding sustained usage, most studies have centred on only the dynamics of energy transition and LPG usage in homes and hardly take other fuel usage into consideration. This has led to the complex reciprocities between cultural factors, social factors, and economic factors, leading to multiple fuel use patterns still widely under-investigated (Muller & Yan, 2018). Fuel stacking implies households partly switching to a different fuel or accumulating and continuing use of multiple fuels (Yadava, Davies & Asumadu-Sarkodie, 2021). In reality, most households rely on traditional fuels (biomass) for certain activities, in addition to adopting modern fuels (LPG). Only a few studies have undertaken a rigorous analysis of fuel stacking, whereas most studies have looked into adoption and sustained usage. Looking at the level of fuel stacked in a particular place helps give a picture of how much LPG is incorporated into daily activities in homes,

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which can predict the current position of LPG sustained usage (Puzzolo et al., 2016).

Empirical studies have shown that fuel switching in rural households is a function of income, education, household size, fuel availability, location and other social and regional demographic factors (Yadava et al., 2021). Yadava et al. (2021) assessed fuel choice and tradition in relation to fuel stacking and the energy ladder in India. The results of the study showed 59% of respondents using biomass while (22%) used LPG, with the rest of the 19% stacking both fuels. The study further disclosed income and fuel availability as key factors in fuel choices. Gould and Urpelainen (2018) also found (5%) of respondents in their study using LPG exclusively, with 60% combining LPG with biomass in India. Again, Celik and Oktay (2019) examined households' energy use behaviour in Turkey, emphasising households' fuel stacking behaviour, and disclosed a close link between household fuel choice and household demographic characteristics. Ochieng, Zhang, Nyabwa, Otieno and Spillane (2020) affirmed various studies with their findings showing that fuel stacking is a common practice.

These studies show that in understanding household fuel use behaviour, fuel stacking should not be overlooked. The previous problem of low adoption of modern fuels is now almost completely overcome by fuel stacking, as a lot of people have now adopted LPG and are combining it with multiple fuels in their homes. It is therefore difficult to study sustained usage without fuel stacking. That notwithstanding, the relative importance of energy stacking in the energy transition deserves attention (Celik & Oktay, 2019).

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LPG Sustained Usage

The bulk of existing empirical studies on LPG utilisation studies have focused greatly on adoption, while sustained use has been less investigated (Carrion et al., 2018). Partly because adoption is the first stage and is perceived to be the most important in utilisation. Unfortunately, behaviours are not constant and old habits die hard. Researchers have noted and cited situations with plausible reasons wherein LPG use has either gradually decreased or ceased after acquisition by participants (Carrion et al., 2018). Mani, Jain, Tripathi and Gould (2020) opined that despite the fact that adopting LPG as a clean source of cooking is necessary, it is not sufficient to eradicate household air pollution and other adverse effects of biomass fuels. Rather, the sustained use of cleaner fuels (LPG) and the cessation of biomass fuel use are needed.

Though there are a very limited number of studies centred on sustained use, especially on the local front, it is gradually gaining the attention of researchers because researchers are progressively noticing the relevance and complicatedness of the issue (GACC, 2015). Nonetheless, much work still remains. Kumar et al. (2017) define sustained usage as the number of times LPG is used and incorporated into users' daily behaviour. GACC (2015) also pointed out that sustained usage shows that consumers have no intention of reverting to biomass use. In a similar way, Mckinney (2017), taking cue from Puzzolo et al. (2016), suggests that sustained usage is deemed long-term use, covering utilisation of LPG as a cooking fuel for one year and beyond. The adequacy of these definitions is that they highlight the key words that frame sustained usage,

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that is, the amount of time and intensity of use. Dalaba et al. (2018) disclose that the main problem in sustained usage of LPG is fuel stacking, where biomass fuels are kept in addition by households as a fall-back or substitute for cooking certain foods.

The limited literature on sustained usage has largely employed qualitative, demonstrative, or observational study designs (Carrion et al., 2021) as well as control trials and has mostly focused on testing the impact of policy interventions on sustained usage. In their research, Mani, Jain, Tripathi and Gould (2020) assessed the impact of several factors including source of income, LPG promotion package, assessment of biomass fuels and LPG availability, among others, on LPG use in rural India. They suggested that interventions in promoting LPG usage must correlate with broader rural development after finding that households with sporadic and iffy cash flows have lower odds of making LPG their main cooking fuel, owing to the persistent and inflexible cost of LPG refills. The authors also cited peer influence and LPG availability as possible causes of increased LPG usage after discovering that a greater proportion of LPG users exist in places with LPG primary users.

In a more recent work, Carrion et al. (2021) employed the cluster-randomised controlled intervention trial in Kintampo North and South districts in the Bono Region (Ghana) in testing relevant policy interventions to increase sustained use of clean fuels. The authors estimated differences in the sustained use of clean cookstoves with two interventions; (one being) education and the (other being) free delivery access. Results showed that, though all intervention

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(arms) generated significant increases in sustained use, the education (arm) had the smallest increase ($p < 0.001$) whilst the free delivery (arm) had the largest ($p < 0.001$). This shows the importance of accessibility in energy usage as well as the extent to which transportation costs impact usage. Patil, Roy, Gore, Ghorpade, Pillarisetti, Chakma, and Juvekar (2021) also cited non-subsidised refills and unavailability of transport facilities coupled with ignorance of health effects caused by biomass usage as the main barriers impeding sustained usage of LPG in the Pune District in India.

Studies on LPG sustained usage have investigated and enlightened us on the impact of some policy interventions on sustained use of LPG. Though their findings are more susceptible to selection biases, their findings may not be generalisable and might be unable to provide sufficient evidence for basing large-scale policy interventions (Carrion et al., 2018). One thing that remains obvious is that to sustain the use of LPG, there has to be some targeted policy interventions. However, most policy interventions have been geared towards LPG adoption in the past. There is a need to merge domestic fuel policies with rural development in order to enable sustained usage and a complete transition to cleaner cooking fuels (Mani, Jain, Tripathi & Gould, 2020a). To achieve this, the government and policymakers need a better understanding of the factors that push households to discontinue LPG use after adoption as well as those that enhance sustained usage (Mani, Jain, Tripathi & Gould, 2020b). As a result, there is a continuing need for research into the factors that influence sustained usage.

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There is a need for more research to explore consumer behaviour, lifestyle and preferences, and this transcends beyond measuring sustained usage with stove use monitors (SUMS) or cylinder weighing scales, as a lot of sustained usage studies have utilised. GACC (2015) indicates sustained usage as a complex and strenuous process buried or fused with other processes of social change. The authors further stated that sustained use is a function of intensity of use and contextual factors such as community, culture, institutional, and external factors. These factors include a number of domains, ranging from household socio-economic characteristics and cultural inclination, through to government policy, regulation, and investment (Norad, 2020). Thus, based on this review, factors such as culture, conformity, frequency, and price can be accounted for as drivers for sustained usage.

Challenges affecting LPG utilisation

Challenges impeding LPG usage are investigated in almost all clean energy studies. Hammeed et al. (2016) opined that energy, which majorly constitutes household consumption, is the centre stage in development issues in SSA, especially for rural areas. The reason energy poverty persists is that lots of people are encountering challenges in accessing affordable, reliable, and sustainable modern energy. With the interconnection of energy sustainability to development, where health systems, education, rural development, urban development, the environment, gender equality, science and technology innovation, among others, are all tied to improved energy services, it is critical to

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improve global access to sustainable energy in order to facilitate equal development (Ghana Energy Commission, 2012).

Research shows that to enable a more thorough transition to LPG, it is imperative to deduce what factors can enable or serve as barriers to such an uptake (Norad, 2020). These enablers and barriers have been reviewed in a range of studies. A handful of studies (Ekouevi, 2013; Sepp, 2014; Kowsari & Zerriffi, 2011; Norad, 2020; Mani et al., 2020b) have centred on enabling factors that need to be in place to enhance a complete transition. These are, in particular, issues revolving around factors that govern the success or failure of efforts to promote household adoption and sustained use of LPG (Norad, 2020). Factors such as accessibility, affordability, awareness and convenience are found to influence household fuel choice and need to be put in place to enhance usage of LPG. Kowsari and Zerriffi (2011) explain that the affordability of a fuel is determined by its price, which is a vital determinant of household energy use, causing shifts between multiple fuels by households.

In support, Norad (2020) in its report on the potential for increased use of LPG for cooking in developing countries adds that affordability is a key potential barrier for LPG uptake. Ekouevi (2013) pinpoints availability and accessibility as major contributors to fuel choice; that is why biomass is prevalent in rural areas where firewood is readily available and LPG distribution is often insufficient or unavailable. Furthermore, a lack of awareness of the effects of biomass on the environment and individuals, combined with a lack of awareness of the convenience of using LPG, accounts for low LPG usage, particularly in remote

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areas (Sepp, 2014). Mani et al. (2020b) interestingly projected the combined effects/inter-relatedness of these factors by positing that the accessibility and availability of cooking fuels in the face of affordability is becoming more difficult day by day for poor people, many of whom are outside the modern energy system.

On the part of evidence-based research, literature has disclosed findings on challenges subjects face and barriers to LPG usage. Asante et al. (2018), in a case study of a sample of 200 LPG recipients in Nkoranza communities, evaluated that only 8% of sampled households remained using their LPG stoves 18 months after distribution, in comparison to 58% of sampled households who never refilled their cylinders, due to difficulty accessing LPG filling stations and the affordability of LPG fuel. From their case study conducted in some parts of the Northern region, Dalaba et al. (2018) also provide evidence of a lack of technical know-how, safety concerns, and high cost of LPG for both new entrants and existing users. Further engaging some households on the preferred fuel for cooking traditional dishes, the popular answer was biomass fuels.

In an assessment of the LPG utilisation study in Badagry State, Nigeria. Hammeed et al. (2016) found that lack of funds to purchase gas, scarcity of gas, high cost of refilling gas, and fear were ranked as the main challenges households face in using LPG. In 2016, Puzzolo et al. published a structured review that evaluated 44 case studies using diverse clean fuel technologies (solar, biogas, and LPG). The researchers identified important factors found across case studies as enabling and critical for clean fuel adoption. These factors included being able to pay for the clean stove and corresponding fuel, the ability to meet

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cooking needs, ensuring safe operations, and access to a reliable and affordable fuel supply.

Most of these factors are geographically and contextually sensitive. It is obvious that people living in urban areas won't have the same challenges as those from peri-urban and rural areas. Culture and preference also pose a complicated barrier in that, even in the presence of all these enablers, households can still use biomass for preferential reasons. Again, ease of access to readily available biomass fuels coupled with irregularity of income hinders LPG use, thus the need to merge cooking fuel policies with rural development in order to enable a complete transition towards cleaner cooking fuels (Mani et al., 2020b). There is a universal consensus across studies that household energy use patterns are inadequately understood and require further theoretical and empirical studies to concoct purposeful policies and intervention strategies (Kowsari & Zerriffi, 2011).

Role of Organisational Facilitators

Norad (2020) proposes that the key dimensions and factors needed for scaling-up LPG adoption and sustained usage involve industry structure, value chain and market rules, as well as energy pricing and cost. It is important to understand the interaction between these factors and why mere market mechanisms do not necessarily affect transition. These factors are handled by key players that work together towards facilitating/enhancing LPG operations for better outcomes. They are termed organisational facilitators in this study and comprise regulators and gas suppliers (Gas marketing companies). The term

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"organisational facilitators" in this study was adapted from Carrion et al. (2018). The authors described the LPG access-related factors (tax and subsidies, market development, regulation, legislation, standards, programmes, and policy mechanisms) as broadly defining organisational facilitators.

Hammeed et al. (2016) opined that robust and collaborative government action is crucial for effective LPG usage, along with augmented funding from both public and private sources. Over the years, the government, together with some private organisations such as WHO, GACC and UNFCCC, has rolled out a lot of promotions and policies to enhance clean cooking and LPG utilisation, which has been greatly captured by literature (Broni-bediako & Dankwa, 2013; Ahunu, 2015; Dalaba et al., 2016; Asante et al., 2018; WHO, 2018). In their study, Broni-bediako and Dankwa (2013) and Dalaba et al. (2018) further reviewed some key players in the LPG supply chain and marketing (downstream) in their study. In their study assessing LPG utilisation in Tarkwa, Broni-Bediako & Dankwa (2013) found technical constraints e.g. technical malfunctions and systematic failures, financial and transportation disruptions, and natural disasters (accidents) as the main problems affecting operations of OMC's and often leading to shortages in their study assessing LPG utilisation in Tarkwa.

Dalaba et al. (2018) interviewed LPG suppliers in the Northern region on challenges with LPG adoption and options to scale-up. The operators reported that the price of LPG fluctuates due to the deregulation of petroleum products, world market prices, and inflation. It is clear that regulators and gas suppliers are key stakeholders in LPG utilisation, though their roles in scaling-up utilisation have

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been less investigated in the extant literature, exposing a big gap in research and a viable area for continued study.

Ghana has two main regulators in charge of energy and petroleum products. The WHO (2018) classifies them as implementing agencies who are in charge of implementing policies in conjunction with the Ministry of Energy. The Energy Commission (EC) was set up by the Energy Commission Act, 1997 (Act 541) to regulate, develop, and manage the usage of energy resources (electricity, natural gas, and renewable energy industries) in Ghana, while the National Petroleum Authority (NPA) is in charge of regulating the marketing, sale, and distribution of both imported and refined crude oil as well as petroleum products including LPG, transport, and industrial fuels. Furthermore, Broni-Bediako and Dankwa (2013) describe the work of gas suppliers as LPG Marketing Companies (LPGMC's) who have the license to procure and sell petroleum products to the general public through retail stations. Regulators owe customers the duty to protect their interests, while sellers owe customers the duty to provide quality services to their customers.

The Energy Commission's 2012 Sustainable Energy for all (SE4all) plan discloses the bottlenecks to the promotion of LPG as a household fuel for cooking. Among the issues raised include: "inadequate supply of LPG to meet the increasing demand; inadequate storage, filling and distribution infrastructure; inefficient LPG distribution model; inefficient LPG cylinder management and lack of standards on LPG cookers and cylinders, causing serious safety concerns on the quality of LPG cookers and cylinders; unsustainable and inequitable LPG

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subsidy policy for cooking, which is prone to abuse; and limited awareness, education, and outreach to existing and potential consumers (on benefits and safety)". To date, some of these bottlenecks are still impeding the success of clean cooking. With the (50%) LPG target by 2030 in mind, the question that begs to be answered is: what is the way forward? The government proposes the cylinder recirculation model to solve safety issues in households (Dalaba et al., 2018), but this policy project has been long overdue and we are yet to see it spring to life.

Regulation, legislation, and standardisation are key factors in creating an enabling environment for utilisation. Policy and legislation are fundamental to controlling LPG price volatility, including importation issues and regional price variations (Norad, 2020). Puzzolo et al. (2013) also add that price volatility and lack of control over large regional price differentials adversely affect the adoption and sustained use of LPG, while creating demand through appropriate channels and setting specific strategies is important for LPG uptake (demand and scaling-up). Again, Norad (2020) posits that effective enforcement of standards is required to ensure LPG safety; a lack of oversight mechanisms and insufficiently regulated expansion of the LPG market contribute to the release into the market of unsafe products, accidents, lawlessness of LPG marketing companies, and other safety issues that may further reinforce general fears concerning the use of LPG.

Hammeed et al. (2018) suggest that policies to promote LPG utilisation should form a central component of broader development strategies. This way, both urban and rural areas will have a fair share of modern energy and energy poverty will be gradually curtailed. The roles of both regulators and gas suppliers

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should therefore not be overlooked in research and have to be assessed towards the scaling up of LPG adoption and sustained usage.

Deductions from Literature

The existing theoretical and empirical review gives a clear indication of household behaviour towards LPG utilisation. One thing that runs through is the level of complication and complexity in dealing with determinants of adoption and sustained usage due to contextual and cultural differences (GACC, 2015). Literature on LPG utilisation studies have employed qualitative, demonstrative, control trials and observational case studies to measure the level of adoption and sustained usage by implicating policy interventions (Carrion et al., 2018). The popular findings are that though it was effective, it didn't cause a significant change. This is because a lot of factors frame household energy choices.

An overarching theme is that LPG utilisation is a function of economic, social, and policy factors (GACC, 2015). A lot of literature has placed overemphasis on particular determinants while underestimating others in household decisions on energy use and transition. This is a common shortcoming in energy studies. Despite the fact that various variables influencing household energy use patterns have been investigated, much of the research has focused on economic factors such as price and income (Kowsari & Zerriffi, 2011).There are a range of non-economic variables such as social and cultural factors, including cooking habits, preferences, and household characteristics that are central to explaining household decisions regarding energy use that have not been considered much. Therefore, developing frameworks that take all these factors

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into account will enable a better characterisation of adoption and sustained usage, as well as its key drivers and determinants.

Again, most empirical studies have been silent on the role of regulators and gas marketers in scaling-up LPG adoption and sustained usage, which is very vital to research as customers are rational and mostly react to actions from the supply side. A number of studies point out challenges affecting LPG utilisation as well as the relevance of policies and interventions in scaling-up LPG utilisation but do not provide insight into the dynamics of the supply side as to how and why such factors still persist and what current standing or actions are being taken to address such issues by regulators and gas marketers.

Chapter Summary

This chapter presented the literature review of the study. The chapter begins by explaining the theories framing the study. The study employed the Energy Ladder theory and the Energy Stacking theory, which posit household behaviour in switching between different household fuels and the reasons behind it. It continued to relate the theories to the study as well as expose its weaknesses and strengths. The chapter again reviewed the related literature on LPG adoption, LPG sustained usage, challenges affecting LPG usage, and the role of organisational facilitators. Thereafter, deductions made from literature were presented, followed by the conceptual framework employed in the study.

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CHAPTER THREE

RESEARCH METHODS

Introduction

This chapter presents the research methods, that is, the procedures and measures systematically employed in the comparative assessment of LPG utilisation in the two study areas while justifying their fitness for the study's objectives. In view of this, the chapter will touch on two broad issues. Firstly, the methodology adopted and used in conducting the research, which entails the research paradigm, research design, data collection procedure, data processing tool and analytical technique, among others. Pallant (2007) discloses that methodology aids in comparison with other studies, enhancing the possibility of replication of the study and deepening appreciation of the work. Secondly, the study will lay out discussions with vivid explanations of the field work, instrument design and ethical considerations.

Research Paradigm

A research paradigm is the basic belief system that guides a research investigation, dictating the ways to conduct social research, which includes the selection of a particular research methodology. This study is framed by the Pragmatism research paradigm, which mirrors the concept that the most important defining factor of a research philosophy to be adopted in a research work are the research questions (Saunders, Lewis & Thornhill, 2007). It propounds that more than one particular approach may be useful for answering particular questions in a set of research questions, whether positivist or interpretivist philosophy, and it is

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perfectly possible to work with both. Tashakkori and Teddlie (1998) remarked, as cited by Saunders et al. (2007) that at some points, a researcher and his or her objects of study may be interactive, while at others, one may easily stand apart from his or her objects of study, and that is the case of pragmatism. This approach therefore combines the quantitative and qualitative approaches in its study, which is popularly termed the mixed method. This is because some of the research questions in the study require the collection of data, analysis of collected data, and presentation of findings quantitatively, whilst the other research questions deal with the collection and analysis of data qualitatively. The method, however, is not only adopted because of the nature of the study objective and research questions, but also due to its advantage of being intuitively appealing and largely avoiding engagement in pointless debates on concepts such as truth and reality.

Research Design

The study employed a descriptive research design to explain the relationship between the variables under study. Morris, Allen, Kuratko, and Brannon (2010) describe descriptive research as the name suggests, describing data about the population being studied and not trying to set up causal relationships between events. It is used to explain events or to provide an accurate and factual description of the population under study. It is based on a clear specification of what, who, where, when, and how the research is to be done. The descriptive design can also be seen as an extension of, or a forerunner to, a piece of exploratory research or a piece of explanatory research (Saunders et al., 2007). The descriptive design of this research will employ, specifically, the cross-

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sectional survey and interview research strategy to investigate the variables at play:

Cross- sectional survey

Surveys involve the collection and analysis of large amounts of quantitative data from sizeable population using descriptive and inferential statistics (Tabachnik & Fidell, 2007). This will be especially useful in conducting the comparative study of the two study areas, allowing people's feelings and perceptions of LPG to be elicited. In this field research, the print survey method will be used to administer close-ended questionnaires on research objectives 1-3 to households.

Interviews

Semi-structured interview was chosen for the last objective because the study sought the opinion and current vision of the subjects of study and the sample size is also very small giving opportunity for retrieving a more detailed information on the topic of discussion.

Study Areas

Agona Nkwanta

Agona Nkwanta, also called Agona, is the capital of the Ahanta West District in the Western region of Ghana. It is 7km inland and en route between Takoradi and Tarkwa. The main ethnic group of the town is the Ahanta, and the main language spoken is Ahanta. The inhabitants are mostly engaged in agriculture, mainly crop farming, which is generally at a subsistence level, forestry, and fishery workers, with others in craft and sales or trade. Due to

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limited jobs in the localities, a lot of inhabitants are forced into trade and are self-employed. However, the geographic position of the district for oil and gas exploration has resulted in several industries springing up in the localities, causing a lot of migration (GSS, 2014). This has caused a considerable increase in population in the area, forcing a once rural area to pre-maturely grow into a peri-urban area with limited infrastructure and amenities to match the growing population. Though Agona is largely regarded due to its whopping population, a lot remains to be done in terms of infrastructure, standard of living, and economic development.

As much as there are a lot of other less developed areas to be considered for this study, Agona Nkwanta was chosen because it is considered an emerging economy and trade, creating a need for proactive measures to guard against energy poverty, which is a significant problem impeding socio-economic development.

Sekondi

The recorded history of Sekondi dates back to the 15th century, the period when European traders arrived on the shores of West Africa. Sekondi and Takoradi are popularly called the twin cities of Sekondi-Takoradi, which are found in the Sekondi-Takoradi Metropolis and also the capital of the Western Region of Ghana. Sekondi is one of the largest cities in the region and a fast-growing city in the country. The basic language spoken by Sekondi people is Fante. It is characterised by industries and a commercial centre, with the primary job being fishing. Industries in Sekondi include timber, cocoa processing,

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plywood, shipbuilding, harbour and railway repair and, more recently, oil and gas companies. Commercial activities have drawn a lot of investors and tourists to the city, causing a boom in the hospitality industry and a rise in the standard of living.

There have been no studies on LPG usage in Sekondi, despite it being a commercial hub and one of the biggest cities in the country with the likes of Accra and Kumasi. The recent growth in economic activity in the city, however, raises concerns if indeed this development corresponds with modern energy usage, and with no research to prove otherwise, this has necessitated the selection of the area for the study. Again, given the variations in urban structure between Sekondi and the other big cities in Ghana, like Accra, the dynamics of household energy usage might be different. This suggests the need for context-specific research on the issues, which would allow for comparison of findings.

Study Population

A population is the entire set of cases from which a sample is taken. The population for the first phase which comprise of the quantitative aspect of the study is all households in the study areas. As depicted in Table 2, Agona Nkwanta had a total population of 14,104 with 3,407 households as at 2014 whiles Sekondi had 30,453 with 8,316 households. This is the study population from which the sample was drawn.

Table 2: Number of households (population) in the study areas

Study Area	Total population	Total number of households.
Agona Nkwanta	14,104	3,407
Sekondi	30,453	8,316

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Source: (Ghana Statistical Service, 2014)

Target Population

Specifically, the study targeted households that use LPG. This is because the study is centred on finding users' experiences with LPG. The participants were heads of households, either men or women. The criteria for selecting the study respondents were households with an adult male or female member (18 years and above). A female respondent who was capable in the sense of expressing herself and giving consent to the study, and the primary cook of the house or a male person (also known as the main male decision maker of the house) who was able to provide consent for the study and contributes to upkeep of the house. All respondents were residents of the household since the last 12 months from the date of enrolment of the exercise.

This is because the selected male or female were in the position to provide appropriate responses to the study since they had the capacity to form intentions and relay experiences as decision-takers in the household.

The target population for the second phase of the study was managers or supervisors in charge of gas service stations selected and project managers for the National Petroleum Authority and Energy Commission. The target population was chosen for the second phase because of their position and nature of work in the institution.

Sample Size and Sampling Procedure

For some studies, it is feasible to obtain data from an entire population because of its manageable size, but for others, it is not. The vast area of the two

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study areas and the large number of households that make up the population necessitated a representative sample to be drawn. Again, time and budget constraints make surveying the entire population nearly impracticable. In order to conduct an effective sample, a sample size that is representative of the population is needed.

A sample size, then, is the number of cases or elements that are included in a research study (Zikmund, Carr, & Griffin, 2013). Bryman (2012) discloses that the best sample size is dependent on the degree of accuracy required, the degree of variability and diversity in the population, and the number of different constructs tested simultaneously when analysing data. Based on the Krejcie and Morgan (1970) sample determination table, a sample size of 370 households was drawn for both areas. Roscoe (1975) emphasizes that to select an optimal sample size, picking between 30 and 500 is suitable for most research studies. In order to obtain a moderate sample size for both study areas, the number of households in both study areas as tabulated in Table 2 was added and run through a Krejcie and Morgan (1970) sample determination table to obtain 370 households, which was further shared between the study areas using ratio and proportion in order to get a representative number for both areas and avoid bias. The procedure is showed in as follows:

In defining the variables involved, where A be number of households for Agona Nkwanta, S be number of households for Sekondi, N be total population for both areas. Formulae for sample size allocation is therefore:

$$\frac{Sample\ size\ (number\ of\ households\ for\ a\ particular\ area}{total\ number\ of\ households} * 370.$$

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Table 3: Sample size allocation for both areas

Study Area	Number of house holds	Formulae	Proportioned Sample Size
Agona Nkwanta (A)	3,407	(A/N*370)	108
Sekondi (S)	8,316	(S/N*370)	262
Total (N)	**11,723**		**370**

Source: Field survey (2021)

However based on the nature of the study and the specific criteria of meeting only households with LPG, an additional ten households were added to the sample size for each study area to cater for the assumption that some households might not have LPG. Therefore, bearing in mind the likely response rate, allowance is made by additional ten households to allow for possible non-response due to lack of LPG in the household since cumulative non- response can result in the final wave of the survey being too small to analyse (Fox, Hun & Mathers, 2009). Per table 3 a minimum sample size of 108 households is needed for Agona and 262 for Sekondi, adding ten more households will now push the sample size of 108 to 118 households for Agona and 262 to 272 households for Sekondi and that will be the final sample sizes for the study areas which will be 390 households in all.

Sampling Technique

In choosing a sampling technique, a researcher must make various considerations such as: necessity, effectiveness, and time and cost limitations (Saunders et al., 2011; Sarantakos, 2005). The sampling techniques should

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correlate with the research methodology and that is why this study employs both probability and non- probability sampling techniques in sampling. The first phase of this study which caters for the research objectives 1-4 is quantitative inclined and therefore focuses on probability sampling by adopting the Simple Random sampling to select households to administer the questionnaires.

The second phase which addresses the last objective adopted non-probability sampling technique. Specifically convenience sampling to choose Gas suppliers who are close to hand for the interview and homogeneous purposive sampling to interview staff from Energy Commission (EC) and National Petroleum Authority (NPA). This was done because the goal was to collect specific cases, events, or actions and opinions thereby deepening the understanding of the situation and its context.

Data Collection Instruments:

Questionnaire

Questionnaires are normally employed for descriptive and explanatory research. Descriptive research, as in the case of this research, is undertaken using opinion and attitude questionnaires as well as questionnaires of practices, which enables the researcher to identify and describe the variability in different situations (Saunders et al., 2011). Oppenheim (2000) argues and discusses how difficult it is to develop a good questionnaire, ensuring the collection of precise data required to answer the research question(s) in order to achieve the objectives, which is frequently underestimated by people. Questionnaires are appropriate in research that deals with large volumes of data and a large sample size, serving as

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an efficient way of gathering responses from a large sample prior to data analysis (Bell, 2005). This makes questionnaires applicable in this study, looking at the sample size involved.

A standardised interviewer-administered paper based questionnaire was used to solicit for information in the first phase of this study. This approach was chosen due to the importance of reaching specific respondents (household heads) and of course the need for genuineness (free from contamination and distortion) in respondents' answers. Lastly a lot of people in the localities where the research is being conducted have low level education or no formal education, thus the need for questionnaire administrators to be present to explain the questions regarding the issues under study so that respondents can genuinely understand and be guided.

The questionnaire comprised of several investigative constructs subdivided into detailed investigative questions seeking opinions, behaviours and attributes with regards to the research question. The questions were direct and close-ended to facilitate the process and control the scope of the research, making answering quicker and easier and also aid in comparison. The questionnaire design process involves grouping the investigative questions into parts and arranging the parts under sections according to the variables they are measuring. In view of this, the questionnaire is in four sections lettered A- D (see appendix B), according to the research questions of the study. All sections, except section A which sought after demographic and socio-economic background information of respondents, were measured with point rating scales (five-point and three-point).

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Yates (2003) defined a likert-scale as a measurement instrument that assists one to connect qualitative constructs with quantitative metric units. It is the most reliable and widely used scale in measuring people's attitudes, opinions and beliefs due to its advantage of being easy to construct and enables researchers to put together respondents' scores on a diverse range of items into a single index. The scales consisted of check boxes that listed the choices available to the respondents allowing them to 'check' or 'tick' one suitable to them or more where necessary.

Section B sought after the level of fuel stacking and level of LPG adoption and was divided into three main groups: acceptance, usage and fuel stacking. Acceptance and usage was further assessed with variables having investigative questions under each. Section C was also about level of LPG Sustained usage. It was measured with 4 variables with investigative questions under each. Section D comprised of investigative questions on Challenges affecting LPG utilisation. In all, 68 questions were drafted.

The instrument had an introduction and closing remarks where respondents were informed clearly and concisely about the purpose of the survey and appreciated for their time and co-operation. Again it was coded and themed appropriately for data analysis. Responses were transformed into a directory for each question/item and analysed. A careful concern was placed on the areas related to the research objective, potential respondent, communication method, time and cost availability, content and layout structure (that is: wording, language, structure, sequence, and length).

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Semi-structured Interview

Kahn and Cannell (as cited in Saunders et al., 2007) define an interview as a purposeful discussion between two or more people. The type of interview chosen should be consistent with the purpose of your research and the research strategy adopted, as well as research objectives and research questions pertaining to the study. The use of interviews helps to gather valid and reliable data that is relevant to research questions and objectives. This method was adopted for objective 5, the second phase of the study, which determines the role of organisational facilitators in scaling-up LPG utilisation. The interviews were conducted in sequence, first with LPG marketing companies and then with LPG regulators, to make room for seeking clarification on issues that popped up during the earlier engagements. Two interview guides were derived based on themes corresponding to the level of LPG adoption, level of LPG sustained usage, and challenges in LPG usage. Under the themes were questions, which were made open to encourage depth and vitality in order to accept new concepts.

All three sections (lettered A-C) were derived from the interview guide for LPG MC's. With the first section (A) on background information of the interviewee, the next (B) on LPG adoption, which had questions on trustworthiness, reliability of LPG MC's, proximity, price, and usage issues, and then Section C on sustained usage, which also outlined the demand patterns and challenges both customers and gas suppliers face. The interview guide for regulators, that is NPA and EC, was however, based on various issues that were noted during the engagement of both respondents and LPG MC's and consisted of

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questions which basically captured the enforcement of regulatory measures and challenges faced by consumers and their solutions. The semi-structured interview was done as the second phase of the study, so a lot of customers' concerns will be put across to organizational facilitators for their take on them. This was very relevant to the study and its objectives.

Measuring variables

After defining the theories underpinning the study and carefully reviewing literature on conceptualising one's own research, the researcher needs to be clear about the relationships that exist between variables prior to designing the questionnaires. The main dependent variable of this study is LPG utilisation, which is further expanded into levels of LPG adoption and levels of LPG sustained usage. These variables are dependent because a change in them is infused with a change in other variables.

Specifically, in measuring research question 1, the level of LPG adoption, the study employed constructs from the definition of adoption drawn from the GACC, conference held in Peru in 2015 as per this study, which described adoption with two constructs: acceptance and usage. These two constructs were further measured with variables that also had items under them. Acceptance as the first variable for measuring the level of LPG adoption was further divided into 3 sub-variables, namely: trustworthiness (Bt), validity (Bv) and reliability (Br) as adapted by Tomer (2018) in his article titled measuring user adoption. These are proposed variables effective for measuring adoption of a product and very appropriate for this study, which are also reviewed in the literature.

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Trustworthiness was measured with 5 items (Bt1, Bt2, Bt3, Bt4, Bt5, see appendix B); Validity was also measured with 4 items (Bv1, Bv2, Bv3, Bv4, see appendix B); and lastly Reliability was also measured with 4 items (Br1, Br2, Br3, Br4 see appendix B): all with a Likert-type scale from 1 (weak agreement) to 5 (very strong agreement). The items were coded appropriately to match their descriptions.

Usage as the second construct for measuring the level of LPG adoption also had three variables. These variables include: proximity (BUp), which was measured on a Likert-type scale with 4 items that are BUp1, BUp2, BUp3 and BUp4 (see Appendix B); technology adaptation (BUt), which was measured on a Likert-type scale with 5 items i.e. BUt1, BUt2, BUt3, BUt4 and But5 (see Appendix B); and initial price (BUpr), which was measured on a Likert-type scale with 3 items that are BUpr1, BUpr2 and BUpr3 (see Appendix B). Again, all items were measured with a Likert-type scale from 1 (weak agreement) to 5 (very strong agreement).

The level of fuel stacking as per research question 2 was measured on a five-point scale labelled with the various domestic fuel mixes in the home; that is, 1 for charcoal, 2 for firewood, 3 for kerosene, 4 for electricity and 5 for LPG. It was structured into two parts; the first part accommodated multiple selections, while the second part was strictly based on single selections.

The level of LPG sustained usage being research question 3 was measured at the dimensional level with a set of items derived from various literatures (Hannigan, 2018; Dalaba et al., 2018) to have an effect on sustained usage of

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LPG. The variables are culture, conformity, frequency, and price. Culture is measured with 4 items (CC1, CC2, CC3 and CC4, see appendix B). Conformity is measured with 5 items (CCn1, CCn2, CCn3, CCn4 and CCn5). Frequency is also measured with 5 items (CF1, CF2, CF3, CF4 and CF5). Lastly, the final price is measured with 3 items, which are CP1, CP2 and CP3. All scales on a Likert-type scale were keyed from 1 (weak agreement) to 5 (very strong agreement).

The last section, also measuring research question 4, sought the challenges facing LPG utilisation and was measured with a set of 10 items (CU1, CU2, CU3,.., CU10, see appendix B) on a 3 point Likert-type scale from 1 = not significant, 2 = severe, and 3 = very severe. These items were directly adapted from Hammeed, Orifahb, Ijeomac, and Tijanid (2016) in their work to assess the constraints to LPG use in the Badagry area, Lagos State.

Calculation of weighted mean

Due to the set of different measurement constructs and variability in number of items used in measuring the research objective 1 and 3, a weighted mean was derived to calculate for an overall mean in other to analyse and compare the level of LPG adoption and sustained usage in the two study areas. This is because some data points/constructs contribute more weight than others and to use the simple mean would not be representative enough. To calculate for the weighted mean, the weighting factor was first derived by dividing the number of items under each construct with the total number of items under all constructs measuring the particular objective. Tables 4 and 5 show the procedure adopted.

Calculation for the weighting factor for level of LPG adoption:

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Table 4: Calculation of weighting factor for acceptance

Variables		(N)	Weighting factor
Trustworthiness (Tw)	Bt1 – Bt5	5	$\frac{5}{13}$
Validity (V)	Bv1 – Bv4	4	$\frac{4}{13}$
Reliability (R)	Br1 – Br4	4	$\frac{4}{13}$
Total		13	1

Table 5: calculation of weighting factor for usage

Variables		(N)	Weighting factor
Proximity (P)	BUp1 – Bup4	4	$\frac{4}{12}$
Technology adaptation (T)	But1 – But5	5	$\frac{5}{12}$
Price (Pr)	BUpr1–Bupr3	3	$\frac{3}{12}$
Total		12	1

After deriving the weighting factor as in Tables 4 and 5, it is then inputted in the final formulae for weighted mean. Two weighted means are calculated for acceptance and usage to determine the level of each, the two weighted means are then added and divided by two to get the mean for level of LPG adoption. This is done for each study area.

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$Acceptance_W = \frac{5}{13}(TW_M) + \frac{4}{13}(V_M) + \frac{4}{13}(R_M)$ for each study area,

$Usage_W = \frac{4}{12}(P_M) + \frac{5}{12}(T_M) + \frac{3}{12}(Pr_M)$ for each study area.

Where M is the overall mean for each variable and w is the weighted mean.

Final mean for level of adoption is therefore = $\frac{Acceptance_w + Usage_w}{2}$

Calculation for the weighting factor for level of LPG adoption:

Table 6: calculation of weighting factor for sustained usage

Variables		(N)	Weighting factor
Culture (C)	CC1 – CC5	5	$\frac{5}{18}$
Conformity (Cn)	CCn1 – CCn5	5	$\frac{5}{18}$
Frequency (F)	CF1 – CF5	5	$\frac{5}{18}$
Price (Px)	CP1 – CP3	3	$\frac{3}{18}$
Total		18	1

Source: Field survey (2021)

After deriving the weighting factor as in Table 6, it is then substituted in the weighted average formulae to find the weighted mean for level of sustained usage.

Sustained Usage $_W = \frac{5}{18}(C_M) + \frac{5}{18}(Cn_M) + \frac{5}{18}(F_M) + \frac{3}{18}(Px_M)$ for each study area.

Pre-test and Questionnaire Modification

A pre-test is an important part of research. Its purpose is to give the researcher a chance to refine the questionnaire in order to eliminate problems in answering and recording data (Saunders et al., 2011). Pre-testing of survey

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questionnaires can provide useful information for uncovering biased or ambiguous questions, and through that, adequacy, reliability, and validity of the research instrument can be achieved. Zikmund et al. (2013) refer to the pre-testing process as "a collective term for any small-scale exploratory research technique that uses sampling but does not apply rigorous standards." Literature has presented different viewpoints concerning pilot study sample size. Hunt, Sparkman, and Wilcox (1982) suggested a sample size of between 12 and 30; Blumberg, Cooper, and Schindler (2008) also suggested a sample size of between 25 and 100.

The first version and prototype of the survey questionnaire for this study was pre-tested on a convenience sample of 20 heads of houses in Cape Coast, using the simple random sampling technique. Cape Coast was chosen for the pilot study because of its proximity to the researcher and its homogenous characteristics with the two study areas in the study in terms of language and lifestyle. This enhanced the completion and understanding of questions and items and also helped to improve investigator familiarity with respondents. The respondents were asked to express their views on the overall wording, presentation, design and layout, syntax, question and item validity, integration, comprehensibility, ambiguity, and time duration of questionnaires. Based on the 20 returned responses, the survey questionnaire was further restructured where it was appropriate. Issues found included: ambiguity of some instructions and wording; lengthiness of some questions; uneasiness about disclosing income; and some respondents being tempted to compare their experiences with others.

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Validity of instruments

The data collection instruments were validated by the research supervisor along with some able-bodied lecturers in the field who gave consent to them. Again, the UCC Institutional Review Board also reviewed them with ethical clearance approval identification: (UCCIRB/CHLS/2021/45). Finally, the constructs in the instruments were adapted from existing empirical studies that have been tested and validated, not to mention the fact that the instrument was pre-tested and duly modified.

Data Collection Procedure

The data collection procedures depend on the availability of facilities, time, costs, the degree of accuracy, the expertise of the investigator, and other data gathering resources and techniques (Sekaran, 2010). Due to the vast area of the study areas and large sample size, three research assistants who are graduates with bachelor's degrees were recruited from the study areas and trained to aid in the data collection. These people were oriented on the purpose and objectives of the study, maintaining confidentiality and anonymity of participants as well as Covid-19 protocols that ought to be observed during data collection to ensure that the outcome of the research was not compromised. The role of the assistants was to help the investigator in the distribution and administering of questionnaires to respondents under the supervision of the investigator. The duration for the administration of the questionnaire for households and interviews for gas suppliers was about 3 weeks.

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A survey questionnaire can be administered by two approaches: interview-completed, where the researcher reads and explains the questions and statements and then records the respondent's answers; and respondent-completed, where the respondent reads and fills out the questionnaire without help (Blumberg et al., 2008). Other important factors of questionnaire administration are that the investigator considers the quality and rate of responses as well as the practicalities and problems of administration to be able to reduce the likelihood of non-response bias and common method bias (Creswell, 2013). Based on this knowledge, both methods were adopted.

The respondent completed approach was basically used to obtain data from respondents who could read and write, while the interview completed approach was used for respondents who could not read and write or those who were partially educated. In each case, however, the researchers were present to probe any incomplete answers and to clarify any unclear questions (Sekaran, 2010). The wait-and-collect approach, where assistants wait on respondents to finish answering the questionnaire and take them back instantly, was used with the advantages of administrative speed, response rate, questions and item clarity, motivation, anonymity, and sample and quality control (Creswell, 2013). Every piece of data collected was kept confidential, especially the names of the gas service stations, with the exception of the gas regulators, whose names were mentioned.

Upon arrival, the principal investigator lodged at a house in Bakaano Zongo, a locality in Sekondi, in order to easily mingle with the inhabitants.

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Personnel from the district assembly and some assemblymen from both areas were engaged for information on localities, and these localities were arranged in clusters for easy sampling. In all, there were about thirteen localities in Sekondi and nine localities in Agona Nkwanta.

The exercise took place from June 28th, 2021 to July 19th, 2021. After three weeks of field work, the whole survey procedure and interview of gas suppliers were completed. The research assistants took off every morning at 8 a.m. GMT and returned at 7 p.m. GMT. Many of the inhabitants were traders and nursing mothers, so they were available at all times. The interview with gas station managers was also smoothly carried out in the process of administering questionnaires. The interviews with regulators (NPA and EC), however, took time since an introductory letter from the department had to be sent to their head offices in Accra alongside several follow-up calls to secure a date for the interviews.

Data processing, editing, and coding

After collection of data, the data went through processing, editing, and coding before entering and analysis. The large amount of raw data collected during this research study requires editing, sorting, coding, error checking, and mathematical calculation (Zikmund et al., 2013). Raw data is subject to editing and coding to check and verify errors before the statistical analysis is conducted. The data editing process checks and adjusts data for omissions, reliability, and consistency before coding and later transferring to data storage processes (Sekaran, 2010; Zikmund et al., 2013).

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Upon receipt, the investigator checks the survey questionnaire completeness and eligibility of respondents and keeps it in a brown envelope labelled according to the study area. Since the questionnaire was primarily pre-coded, all questions and items were examined and checked to ensure that they were consistent with the pre-coded data. When data types are assigned numerical codes, it helps the data to be entered quickly with fewer errors and makes subsequent analyses more straightforward (Saunders et al., 2011).

Response rate

The survey questionnaire research strategy was selected to study 390 households in Sekondi and Agona Nkwanta using multi-stage sampling, which is comprised of cluster sampling, simple random sampling, and criterion sampling. Of the 390 households surveyed, 380 questionnaires were fully administered, with the excuse that some of the households selected didn't have LPG. Out of the 380 administered questionnaires, 1 was rejected for incomplete response, leaving 379 fully administered questionnaires. Thus, providing an effective sample to proceed with the survey questionnaire analysis process, which represented 97.1% of the total number of survey questionnaires sent, the expectations of the survey response rate are within the response rates of 50%, 60%, and 70% as proposed by Babbie (2005) to be adequate, good, and very good, respectively. This is depicted in Table 7.

Table 7: Response Rate

Categories	Frequency	Percentages
Target Sample	390	100

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Total responses	379	97.1
Incomplete responses	1	0.3
Not eligible	10	2.6
Total usable responses:		
Sekondi 268		
Agona 111	**379**	**97.1**

Source: Field survey (2021)

Data Analysis

The Statistical Product and Service Solutions (SPSS) software has been recognized as a convenient tool for analysing primary data. The questionnaire instrument data were coded, entered, and analysed using SPSS software version 21.0.The questionnaire was used to collect data on research questions 1-4 and the results were analysed using descriptive statistics (i.e., frequencies, percentages, mean and standard deviation) and the results were projected using simple tables and bar graphs. Specifically, research question 1, which sought to assess the level of LPG adoption, had its six variables all measured with a Likert-type of scale and described with mean and standard deviation on an interval scale. The second research question, which sought to find the level of fuel stacking, was measured with questions requiring five alternative choices and using frequencies and percentages in its analysis. This is because the items to be analysed were not quantifiable and needed ranking.

The third research question, which sought to find the level of LPG sustained usage, had four variables to measure it. And each variable was also

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described with the mean on an interval scale. The fourth research question and the last on the questionnaire, which sought to find the challenges facing LPG utilisation, was measured with ten items, which were analysed with frequencies and percentages. A comparative analysis was then conducted by comparing the results of the analysis made on the two study areas for research questions 1 and 3 with a weighted mean using an independent t-test. The data for the last research question (number 5), which sought to assess the role of organizational facilitators' data, was collected by means of an interview and employed thematic analysis in its analysis and interpretation.

The interviews were analysed thematically, following Braun and Clarke (2006)'s method of conducting thematic analysis by first transcribing audio recorded interviews, assigning codes to the transcribed content, generating and reviewing themes from the assigned codes, and finally writing a report. The analysis carried out was for standard deviation and mean on an interval scale, frequencies, percentages, weighted mean, independent t-test and thematic analysis. Descriptive statistics normally measure central tendency and dispersion. The descriptive statistics presented include the mean, which is the measure of average, the standard deviation, which is the measure of the degree of variability, and frequency, which is the number of occurrences of a variable, and percentages, which measure the proportion of a variable within a given quantity of 100%.

The mean is the most frequently used measure of central tendency because it includes all the data in its calculation and is very easy to understand and use. The assessment was done using a scale ranging from 1 to 5, with 1 to 2.9

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representing low levels and 3 to 5 representing high levels of a variable. In describing the central tendency of a variable, it is important to describe how the data values are dispersed around the central tendency as well, which is why the standard deviation is also employed. The weighted mean was also employed to generate the mean for the independent t-test. This was to bring out the weights contributed by each measuring variable since some data points/constructs contribute more weight than others and using the simple mean would not be representative enough.

In comparing two distinct groups using a descriptive variable, the likelihood of these groups being different can be assessed using the independent t-test, which compares the difference in the means of two groups using a measure of the spread of the scores. Thus, it makes it appropriate for the comparative study between the two study areas. The t-test was analysed with a probability of 0.05, which is statistically significant.

Ethical Consideration

Ethical clearance approval was sought from the University of Cape Coast Ethical Review Board (UCC-IRB) with approval identification of (UCCIRB/CHLS/2021/45). Respondents' anonymity and confidentiality were strictly respected in this study. This was further buttressed by the exclusion of questions bordering on the identity of respondents and their respective firms. Informed consent was also obtained from participants before the interview and administering of the questionnaire, as well as an opportunity available for research participants to withdraw where they were no longer interested in

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continuing with the process, especially in the case of the Energy Commission and National Petroleum Authority, whose company names are disclosed in the research. These were some of the steps taken to ensure adherence to accepted ethical standards and practices, respect for participants, as well as trust and confidence in the integrity of the study.

Chapter Summary

The study employs the pragmatism research philosophy and therefore uses the mixed method approach as well as the descriptive research design. A total of 379 households were sampled for the quantitative part of the study, with Agona Nkwanta holding 111 and Sekondi also holding 268 samples. The simple random sampling technique was adopted with questionnaires for data collection. The qualitative part also uses the semi-structured interview as its instrument, with homogeneous purposive and convenient sampling as sampling techniques. The data was processed with SPSS and thematic analysis to examine the specific objectives of this study. Descriptive statistics such as mean, standard deviation, frequencies, and percentages were employed in the analysis for the specific objectives of the study.

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CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

This chapter presents the findings from analysing the data collected in lieu of the research questions, as well as the corresponding discussions. The chapter starts with a brief recap of the research methods and analytical procedures employed in the study and follows with background and demographic characteristics of the sample population. The study then delves into presenting the results for the entire study as per the research questions. It follows in the order of assessing the level of adoption, level of fuel stacking to sustained usage, challenges affecting LPG usage, and finally, the role of facilitators in scaling-up LPG utilization. The results of both study areas are presented and compared. Each finding is then evaluated and discussed with respect to its theoretical and empirical standing.

Background and Demographic Characteristics of Respondents in Sekondi

This section presents the demographic characteristics of respondents in Sekondi and as such, covers gender, age category, marital status, level of education, years of stay in the area, number of people in the household, employment status, level of income, and cylinder size of the respondents. From the study, the majority (54.9%) of the respondents were females, whilst the remaining 45.1 per cent were males. The gender dimension of the analysis was important because literature on energy studies has often pointed out differences in attitudes and perceptions as a result of variances in socio-cultural roles assigned to

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both sexes in societies (Muller & Yan, 2018). Since women are culturally responsible and normally engaged in cooking in the home, they are most likely to prefer biomass whiles men who seldom have time for cooking will likely go for LPG since it is faster.

The next item on the table is age, which was presented in various cohorts. The majority of respondents (34.0%) fall into the youthful age group of 29–39 years, followed by 18–28 years and 40–50 years, which had 20.9% and 20.5%, respectively. 21.3% of respondents fall into the mature age group of 51–61 years, and just 3.4% were found in the old age cohort. The results therefore showed that the respondents were spread across the active working age cohorts since majority of the population fall within the working age.

Level of education as the next characteristic, the projected majority of respondents (41.4%) were classified under others, which captured low literacy and informal education such as dropouts, basic education, technical and vocational skills training, and adult education. 28.0% had completed SHS, 20.1% had a diploma certificate, while 7.1% and 3.4% had 'O' level and 1st Degree respectively. Even though higher education is low among the respondents, there is a great disposition of literacy and skills, as none of the respondents lack formal education. Muller and Yan (2018) mention that higher levels of education offer a higher likelihood of clean fuel adoption and a lower chance of using fuel wood. The study also considered the years of stay in the area, which only reflected how conversant respondents were with the area in terms of familiarity of settlements and location of gas service stations. The majority of respondents have stayed in

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the area for a long period of time; 34.7% for 11 years and above, 14.2% for 3 to 6 years, and 24.3% from 7 to 10 years, even though a fair percentage (26.9%) had stayed in the area for 2 years and below. The marital status of respondents was checked to measure the level of commitment and responsibility of respondents. Results indicated that more than half (86.6%) of the respondents were single, 3.4% were married and divorced, respectively, while 6.7% were unfortunately widowed.

Subsequently, the study considered the household size of respondents. While Muller and Yan (2018) and Celik and Oktay (2019) disclose that the effect of the number of people in a household on their fuel switching remains ambiguous empirically, a few studies have shown that large households prefer traditional biomass most often to modern fuels. The majority of respondents (55.2%) had 3 to 6 people in their households, 20.9% had 11 people or above, while 10.4% and 13.4% had 7 to 10 people, and 2 and below, respectively. This shows a high dependency burden on house heads and this can put pressure on the household finances and in turn, cause them to use biomass fuels.

With employment status, nearly half (45.1%) of the respondents were traders, with 23.9% being clerics, i.e., those in office jobs as well as public servants. 13.4% fell under "others," which encompassed pensioners and technical and vocational workers. 10.4% were unemployed and 7.1% were farmers. The level of income of respondents was as follows: 52.2% have 500 cedis and below, 27.6% have 600–1000 cedis, 16.8% have 1100–2000 cedis, and lastly, 3.4% have 2100 cedis and above. Celik and Oktay (2019), among many studies, assert that

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the likelihood of households' fuel switching from traditional to modern fuels is heavily dependent on a rise in household income levels. Though the majority of respondents fall into the low income bracket, the income level is fairly distributed since quite a number of respondents earn higher incomes.

With regard to the type of cylinder used in the household, the majority of respondents (62.3%) use the 14.5kg cylinder, 34.3% use the 6kg cylinder, and 3.4% use the 3kg cylinder. The essence of the cylinder type is to track the quantity of LPG bought by respondents. The results indicate that respondents prefer to purchase large quantities of LPG. Table 8 expands the characteristics with frequencies and percentages.

Table 8: Demographic characteristics of respondents in Sekondi

Item		Frequency	Percentage
Gender:	Male	121	45.1
	Female	147	54.9
	Total	**268**	**100**
Age category:	18 – 28yrs	56	20.9
	29 – 39yrs	91	34.0
	40 – 50yrs	55	20.5
	51 – 61yrs	57	21.3
	More than 61yrs	9	3.4
	Total	**268**	**100**
Level of education:	'O' level	19	7.1

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	SHS	75	28.0
	Diploma	54	20.1
	1st Degree	9	3.4
	Others	111	41.4
	Total	**268**	**100**
Years of stay in area:	Less than 2yrs	72	26.9
	3 – 6yrs	38	14.2
	7 – 10yrs	65	24.3
	11 – 14yrs	27	10.1
	More than 14yrs	66	24.6
	Total	**268**	**100**
Marital status:	Single	232	86.6
	Married	9	3.4
	Divorced	9	3.4
	Widowed	18	6.7
Number of people in the household:	Less than 2	36	13.4
	3 – 6 people	148	55.2
	7 – 10 people	28	10.4
	More than 11people	56	20.9
	Total	**268**	**100**
Employment status:	Farmer	19	7.1
	Trader	121	45.1
	Clerics	64	23.9

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Unemployed	28	10.4
Others	36	13.4
Total	**268**	**100**
Level of income: 500 cedis and less	140	52.2
5100 – 1000 cedis	74	27.6
1100 – 2000 cedis	45	16.8
2100 cedis and more	9	3.4
Total	**268**	**100**
Domestic cylinder size: 3 kg	9	3.4
6 kg	92	34.3
14.5 kg	167	62.3
Total	**268**	**100**

Source: Field survey (2021)

Background and Demographic Characteristics of Respondents in Agona Nkwanta

The demographic characteristics of respondents in Agona cover the same constructs as mentioned earlier in the presentation of Sekondi. From the study, more than half (66.7%) of the respondents were females, whilst the remaining 33.3 per cent were males. Age being next, a majority of respondents (39.6%) fell into the youthful age range of 18–28 years, with 29–39 years being next with 25.2% and both 40–50 years and 51–61 years following with 14.4%. People in the

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above 61 cohort ranked last with 6.3%. The results indicate that respondents are spread across active working age groups. The level of education of respondents came next, with the majority of the respondents (40.5%) classified under SHS, followed by 32.4% whose level was JHS, then 13.5% having an "O" level certificate, followed by 6.3% and 7.2% whose level was Diploma and others, respectively. Higher education is very low, though all respondents have had some form of education.

The years of stay in the area projected that almost all the respondents have stayed in the area for a long time (more than 2 years). 59.4% have spent 11 years or above, 20.7% have spent 3 to 6 years, 6.3% from 7 to 10 years, with a few (13.5%) having spent 2 years or below. This proves that respondents are very familiar with their surroundings and are deeply rooted in their communities. Results on marital status indicated that a majority (54.1%) of the respondents were single, 32.4% were married, 7.2% were divorced, and 6.3% were unfortunately widowed. The household size of respondents subsequently projected a greater part of respondents (45.9%) having fewer than 2 people in their households, 40.5% having 3–6 people and 13.5% having 7 to 10 people, depicting a low dependency burden on house heads.

In the area of employment, a greater part (52.3%) of the respondents were artisans, with 14.4% being farmers, 13.5% falling under others, and 12.6% being clerics. Their corresponding level of income is as follows; 87.4% have 500 cedis or below and 12.6% have 600–1000 cedis. The level of income shows that a lot of respondents have very low incomes, which is as a result of a lack of better means

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of livelihood in the area. Most respondents are engaged in low earning and menial jobs. Lastly, most households (51.4%) use the 14.5kg cylinder, with the rest (48.6%) using the 6kg cylinder. Table 9 projects the frequencies and percentages of the constructs explained.

Table 9: Demographic characteristics of respondents

Item		Frequency	Percentage
Gender:	Male	37	33.3
	Female	74	66.7
	Total	**111**	**100**
Age category:	18 – 28yrs	44	39.6
	29 – 39yrs	28	25.2
	40 – 50yrs	16	14.4
	51 – 61yrs	16	14.4
	More than 61yrs	7	6.3
	Total	**111**	**100**
Level of Education:	JHS	36	32.4
	'O' level	15	13.5
	Diploma	7	6.3
	Others	8	7.2
	Total	**111**	**100**
Years of stay in area:	Less than 2yrs	15	13.5
	3 – 6yrs	23	20.7

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7 – 10yrs	7	6.3
11 – 14yrs	30	27.0
More than 14yrs	36	32.4
Total	**111**	**100**
Marital status: Single	60	54.1
Married	36	32.4
Divorced	8	7.2
Widowed	7	6.3
Total	**111**	**100**
Number of people in the household: Less than 2	51	45.9
3 – 6 people	45	40.5
7 – 10 people	15	13.5
Total	**111**	**100**
Employment status: Artisan	58	52.3
Farmer	16	14.4
Trader	8	7.2
Clerics	14	12.6
Others	15	13.5
Total	**111**	**100**
Level of income: 500 cedis and less	97	87.4
5100 – 1000 cedis	14	12.6
Total	**111**	**100**
Domestic cylinder size: 6 kg	54	48.6

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	14.5 kg	57	51.4
	Total	**111**	100

Source: Field survey (2021)

Results for Research Question 1: What is the Level of LPG Adoption for Both Study Areas?

Based on the first objective of the study, the study sought to assess the level of LPG adoption in both study areas. As demonstrated and explained in the empirical review and conceptual framework in chapter two, the assessment was made according to the two stages of adoption, (i.e., acceptance and usage). Acceptance was measured using three variables: trustworthiness (Bt), validity (Bv), and reliability (Br), while usage was measured using three variables: proximity (BUp), technology adaptation (BUt), and initial price (BUpr).The study therefore resorted to six variables adopted from various literatures to measure the level of LPG adoption. It became necessary to determine the level of each of these variables using a mean scale of 1 to 5, with 1 to 2.9 indicating low levels and 3 to 5 indicating high levels.

The assessment of each variable was to enhance understanding of the effect of each variable on user behaviour as well as household opinions on the measures of adoption in order to expose problems and find their relevant recommendations. However, the positivity or negativity of its interpretation is determined by the direction of the constructs under the variable. The cut-off point was arrived at using the mean of the scale.

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Acceptance

Trustworthiness

Trustworthiness is comprised of a primary motive that is satisfied by suppliers' competency and integrity performance, security, and shared values of using the product (Murthy et al., 2017).In that light, households having a predisposition that LPG service providers offer consistent and quality services, in addition to having the notion that the level of harm in using LPG can be mitigated and that using LPG largely benefits the universe, will have a strong trust in LPG, thereby fully accepting it. A high mean, therefore, indicates that respondents have trust in LPG as a product and its suppliers.

The results gathered from the study show that the respondents have trust in the usage of LPG. Despite having a high total mean score of (μ = 3.6799), they expressed disagreement with LPG marketing companies in the area supplying quality gas to them (μ = 2.6716). They agreed that there is a risk associated with the use of LPG (μ =3.8993), which can be mitigated by taking precautions (= 4.6269).They also agreed to suppliers offering consistent services (μ=3.5970) and patronizing LPG helping the environment (μ=3.6045). Results are projected in Table 10.

Table 10: Trustworthiness of respondents to LPG in Sekondi

Trustworthiness	Mean	Std. Deviation
I find risks associated with LPG usage.	3.8993	1.58206
Adherence to safety measures will help mitigate the risk associated with using LPG.	4.6269	.84065

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LPG suppliers are consistent (without breaks) in the supply of LPG services.	3.5970	1.42013
LPG suppliers provide desirable and quality services.	2.6716	1.49294
Patronizing LPG will help promote green investment and prevent negative effects of biomass on the environment.	3.6045	1.54832
Total	**3.6799**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

The results from the data generated from the respondents at Agona also indicated that the respondents place great trust in using LPG with a total mean score of (μ=3.9459). However, they don't agree (μ=1.2523) with the shared value that using LPG will help promote green investment by preventing effects of biomass. They strongly agreed to LPG having risk associated with its usage (μ=5.0000) and observing safety measures helping to mitigate the risk (μ=5.0000). They also agreed that LPG service stations in Agona offer consistent services (μ=4.7477) and also provide quality services (μ=3.7297). Results are projected in Table 11.

Table 11: Trustworthiness of respondents to LPG in Agona

Trustworthiness	Mean	Std. Deviation
I find risks associated with LPG usage.	5.0000	.0000

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Adherence to safety measures will help mitigate the risk associated with using LPG.	5.0000	.0000
LPG suppliers are consistent (without breaks) in the supply of LPG services.	4.7477	.66699
LPG suppliers provide desirable and quality services.	3.7297	.99037
Patronizing LPG will help promote green investment and prevent negative effects of biomass on the environment.	1.2523	.97671
Total	**3.9459**	

Scale (Mean): 0-2.9= low and 3-5= high

Source: Field data, Adu (2021)

Validity

Validity focuses on the extent to which user experience in terms of the benefits of a product agrees with the perceptions they held before usage of the product. Murthy et al. (2017) further describes it as weighing the extent to which actual results on LPG usage correlates with its perceived benefits. A high validity proves that indeed LPG meets its perceived benefits. A high mean indicates that LPG is valid to respondents.

The results from respondents in Sekondi show that the respondents admit that their experience in using LPG matches the benefits perceived during pre-usage. A high average agreed that LPG is cheap (μ=3.6567), efficient (μ=4.3209),

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safer (μ=4.3209) and cleaner (μ=4.7985) with a total mean score of (μ=4.3685). Results are projected in Table 12.

Table 12: Validity of LPG in Sekondi

Validity	Mean	Std. Deviation
Using LPG is the cheaper.	3.6567	1.83843
Using LPG is safer.	4.3209	1.19675
LPG is more efficient.	4.6978	.94119
LPG is cleaner.	4.7985	.79587
Total	**4.3685**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

The results from Agona shows that the respondents do not agree that LPG meets all the attributes perceived about it before usage. Even though an overall mean of (μ=4.2883**)** signals strong validity of respondents, they agreed to LPG being efficient (μ=5.0000), safe (μ=5.0000) and clean (μ=5.0000) but however disagreed to LPG being cheap (μ=2.1532). Results are projected in Table 13.

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Table 13: Validity of LPG in Agona

Validity	Mean	Std. Deviation
Using LPG is the cheap.	2.1532	1.82008
Using LPG is safe.	5.0000	.0000
LPG is more efficient.	5.0000	.0000
LPG is clean.	5.0000	.0000
Total	**4.2883**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

Reliability

Reliability explains the potential of LPG to perform its guaranteed services in terms of quality, suitability, value for money and orientation (Murthy et al., 2017). To be reliable to households, LPG has to suit their lifestyle, its components should be free from defects, be easy to operate and be worth the amount spent on it. A high mean denotes that LPG is reliable to respondents.

In that light, results showed that respondents in Sekondi displayed a high reliability of LPG with a total mean score of (μ=4.0364) by agreeing that they have adequate know-how and can operate LPG cooking components (μ=4.0485), they haven't experienced defects with LPG cooking components (μ=3.5410), their current households are favourable for LPG usage (μ=4.3955) and LPG offers value for money (μ=4.1604). Results are projected in Table 14.

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Table 14: Reliability of LPG in Sekondi

Reliability	Mean	Std. Deviation
I have adequate insight with respect to the materials and components that make up the LPG cooking structure.	4.0485	1.21225
There are no defects with LPG associated components. (Cylinder, stove).	3.5410	1.57288
My current household condition is favourable for LPG usage and storage.	4.3955	1.26028
Using LPG offers value for money for my household.	4.1604	1.49294
Total	**4.0364**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

The results of data from Agona also showed that respondents rely on LPG with an overall mean score of (μ=4.0811), in terms of having insight in its components (μ=4.3784), the components being free from defects (μ=3.1982), their household condition being conducive for LPG usage (μ=4.5135) and LPG offering value for money (μ=4.2342). Results are projected in Table 15.

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Table 15: Reliability of LPG in Agona

Reliability	Mean	Std. Deviation
I have adequate know-how with respect to the materials and components that make up the LPG cooking structure.	4.3784	1.27959
There are no defects with LPG associated components. (Cylinder, stove).	3.1982	1.76233
My current household condition is favourable for LPG usage and storage.	4.5135	1.11897
Using LPG offers value for money for my household.	4.2342	1.35482
Total	**4.0811**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

Based on the results from the variables projected, the study zooms to determining the level of acceptance in adoption of each study area with the weighted mean and independent t-test as presented in Table 16. The results show that respondents from both study areas have accepted LPG. The mean difference is not significant, indicating that both areas have equally accepted LPG.

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Table 16: Independent t-test for level of LPG acceptance in study areas

Study areas	N	Mean	SD	Mean diff.	df
Sekondi	268	4.0038	.66443	.09012	377
Agona N.	111	4.0940	.26810	.09012	376.832
Scale (Mean): 0-2.9= low and 3-5= high					

Source: Field data (2021)

The results of high LPG acceptance in adoption is not surprising as LPG has been recognized as desirable fuel in the home amid a lot of revised efforts by the government to address challenges and promote usage (Ahunu, 2015). However respondents disagreed with some constructs which nearly posed a problem to acceptance. Respondents in Sekondi disagreed to the supply of quality LPG by refilling stations (LPG finishes early). Dalaba et al. (2018) also reported a similar complaint by respondents on not getting the right amount filled in their cylinders in the Northern region. These disagreements are genuine concerns that ought to be tackled in order to achieve maximum acceptance. Meanwhile, respondents in Agona disagreed to LPG promoting green investment and preventing adverse effects of biomass which expresses the lack of awareness of adverse effects of biomass by respondents in Agona.

Usage

Usage as the last stage of adoption after acceptance is measured by proximity (BUp), technology adaptation (BUt) and price (BUpr). It basically

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captures variables affecting households' experiences with LPG in their early stages of LPG usage.

Proximity

Proximity measures how readily available LPG is to users. After acquiring LPG and its components for usage, one needs to be refilling from LPG refill stations. The ease, adequacy, citing and access to refill stations contribute to its subscription by households. Sepp (2014) accounts how people in the rural areas struggle with continuous LPG supply which discourages them from using it. A high mean denotes that respondents don't have issues with proximity in terms of supply of LPG.

The results for Sekondi shows that respondents don't have any issues with proximity with a total mean score of (μ=3.7174). They agreed to having LPG point of sale close to them (μ=4.0485), and admitting that the LPG points of sale are at vantage points for quick and easy refill (μ=4.4963). They also admitted to LPG points of sale being enough to meet their demands (μ=3.7910) and only disagreed to transporting LPG before and after a refill being simple (μ=2.5336). Results are projected in Table 17.

Table 17: Proximity of LPG in Sekondi

Proximity	Mean	Std. Deviation
I have an LPG refill point of sale close to me hence no problem with refilling.	4.0485	1.21225
I have observed that LPG refill points of sale are at	4.4963	.99624

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vantage points for quick and easy refill.		
I have observed that LPG refill points of sale are adequate and enough to meet the LPG demands of inhabitants.	3.7910	1.37976
Transporting LPG cylinder before and after a refill is simple.	2.5336	1.68124
Total	**3.7174**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

However, the results for Agona showed that respondents have problems with proximity as they showed great disagreement with having LPG refill points of sale close to them (μ=2.8108), having adequate and enough LPG points of sale to serve the community (μ=2.0090) and transporting cylinder before and after refill being simple (μ=2.1351). They only agreed to LPG service points of sale being at vantage points for quick and easy refill (μ=3.2432). In all there was a total mean score of (μ=2.5495). Respondents in Agona having proximity problems is in line with empirical studies as Asante et al. (2018) cited inadequate LPG refilling stations and closeness of refilling stations as problems impeding LPG usage in especially rural areas. Results are projected in Table 18.

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Table 18: Proximity of LPG in Agona

Proximity	Mean	Std. Deviation
I have an LPG refill point of sale close to me hence no problem with refilling.	2.8108	1.32469
I have observed that LPG refill points of sale are at vantage points for quick and easy refill.	3.2432	1.17718
I have observed that LPG refill points of sale are adequate and enough to meet the LPG demands of inhabitants.	2.0090	1.68143
Transporting LPG cylinder before and after a refill is simple.	2.1351	1.70287
Total	**2.5495**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

Technology adaptation

Technology adaptation outlines the varying levels of familiarity and orientation people have with LPG and its components which influence their usage. Every technology has its own orientation which has to be learned and adapted to. In their findings, Dalaba et al. (2018) disclosed that a lot of rural inhabitants confessed not knowing how to use LPG as a reason why they had not gotten an LPG stove and cylinder. A high mean interprets that respondents have adapted to the LPG technology.

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The results derived from respondents in Sekondi on technology adaptation showed that the respondents are adapted to the LPG technology. With a total mean score of (μ=3.1687) they agreed to being able to disconnect and connect the components (π= 4.2463), being able to respond in emergency situations (π=3.2612), not being scared of LPG (π=3.5709) and the LPG components not being complex for them (π=3.1455). They only disagreed to not using convenient devices to light their LPG stoves (π= 1.6194) which is not pleasant because convenient devices like lighters and automatic burners other than matches have been reported to help in reducing fire outbreak from stoves. Results are projected in Table 19.

Table 19: Technology adaptation of LPG in Sekondi

Technology adaptation	Mean	Std. Deviation
I have the technical know-how in connecting and disconnecting the LPG cooking system so operation is not a problem.	4.2463	1.52353
In case of emergencies, my household is adequately equipped to respond before notifying authorities.	3.2612	1.69568
I use convenient devices (lighters, automatic turners) in my kitchen that facilitates in turning on/off the LPG stove.	1.6194	1.37824
I'm not scared using LPG.	3.5709	1.52833
I find the LPG cooking system simple.	3.1455	1.75602

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Total	**3.1687**
Scale (Mean): 0-2.9= low and 3-5= high	

Source: Field data (2021)

The results of Agona indicated that respondents are adapted to some aspects of the LPG technology though not all. With a total mean score of (μ=3.5568) they agreed to being able to disconnect and connect the components of LPG (π= 4.4955), not being scared of LPG (π=4.4595) and the LPG components not being complex for them (π=4.9369). They however, also disagreed to not using convenient devices to light their LPG stoves (π=1.7928) and being able to respond in emergency situations (π=2.0991). Results are projected in Table 20.

Table 20: Technology adaptation of LPG in Agona

Technology adaptation	Mean	Std. Deviation
I have the technical know-how in connecting and disconnecting the LPG cooking system so operation is not a problem.	4.4955	1.33399
In case of emergencies, my household is adequately equipped to respond before notifying authorities.	2.0991	1.39450
I use convenient devices (lighters, automatic turners) in my kitchen that facilitates in turning on/off the LPG stove.	1.7928	1.39450

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I'm not scared using LPG.	4.4595	1.22685
I find the LPG cooking system simple.	4.9369	.24418
Total	**3.5568**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

Initial Price

Price affects affordability which determines purchasing power of users. Broni-bediako and Dankwa (2013) and Sepp (2014) mentions price and affordability as one of the pertinent issues affecting LPG uptake especially in rural areas. Initial price in adoption captures the cost involved in using LPG for the first time and early years. A high mean denotes that respondents are affected by initial pricing issues with LPG.

Results from Sekondi shows that the initial price of LPG is a problem to respondents as they agreed to all items measuring initial price including the initial price of acquiring LPG and components is a problem for them (π=3.6157), refilling cost of LPG is too expensive (π= 3.9552) and refilling LPG as and when it gets finished is a burden to them (π= 3.9254). The total mean score was (μ=3.8321). Results are projected in Table 21.

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Table 21: Initial Price of LPG in Sekondi

Initial price	Mean	Std. Deviation
The initial cost (acquiring LPG stove, cylinder, filling and installation) is too expensive for me.	3.6157	1.76887
The cost of refilling LPG cylinders is too expensive for me.	3.9552	1.37863
Refilling LPG cylinder as and when it gets finished is a burden on my income as compared to traditional fuel mix.	3.9254	1.61281
Total	**(3.8321)**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

Results from Agona showed that respondents have a higher problem with initial price of LPG with a total mean score of (μ=4.3394). They expressed agreement to the initial cost of LPG and its components being too expensive (π= 3.5586) and strong agreement to the cost of LPG refill too expensive (π= 4.8559) and refilling LPG as and when it gets finished being a burden on their income (π= 4.6036). These results are in line with the reports of Dalaba et al. (2018), who disclosed stove and fuel cost being a common problem with both rural and urban samples with the rural sample obviously having a higher proportion. Results are projected in Table 22.

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Table 22: Initial Price of LPG in Agona

Initial price	Mean	Std. Deviation
The initial cost (acquiring LPG stove, cylinder, filling and installation) is too expensive for me.	3.5586	1.19609
The cost of refilling LPG cylinders is too expensive for me.	4.8559	.35283
Refilling LPG cylinder as and when it gets finished is a burden on my income as compared to traditional fuel mix.	4.6036	1.00254
Total	**(4.3394)**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

In view of the results from variables projected under usage of LPG in adoption, the study proceeds to determining the level of usage in adoption of each study area with the weighted mean and independent t-test as presented in Table 23. The results show that respondents from both study areas have a very low usage in adoption of LPG. However, Sekondi has a higher mean (μ_w=1.5998) than Agona (μ_w=1.2504) with a mean difference of .34949 indicating that Agona's usage is much lower than Sekondi, which is not surprising looking at the contextual differences. Cecil and Oktay (2019) found in their study that less developed areas were 45% less likely to use modern fuels than those living in urban areas.

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Table 23: Independent t-test for level of LPG usage in adoption by study areas

Study areas	N	Mean	SD	Mean diff.	df
Sekondi	268	1.5998	.65742	.34949	377
Agona Nkwanta	111	1.2504	.33447	.34949	361.912
Scale (Mean): 0-2.9= low and 3-5= high					

Source: Field data (2021)

The problematic areas that accounted for low usage under the variables is first of all price, respondents highly expressed agreement to high refill cost and LPG expenses being a burden which is consistent with literature as a lot of studies including: Dalaba et al. (2018), Carrion et al. (2018) and Asante et al. (2018) among others mention price and cost of LPG as one of the main reasons for its low usage. The second problem was proximity issues concerning adequacy of LPG refilling stations in Agona and the tedious nature of transporting and refilling of cylinders in both study areas.

This is consistent with studies as Asante et al. (2018) cited inadequate LPG filling stations in his study in the Northern region as one of the problems they face. It is hopefully anticipated that adoption of the cylinder recirculation model will help address these issues. The third problem is the disagreement of respondents of Agona to being able to respond to emergencies in using LPG before notifying authorities. Again this exposes lack of awareness and adequate education on safety measures of LPG usage in remote areas.

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Level of LPG adoption for both study areas

Table 24 presents a final conclusion on research question 1. The results showed that both the two study areas have a low level of LPG adoption, with Sekondi having a much higher mean (μ_w=2.8018) than Agona (μ_w=2.6722).

Table 24: Independent t-test for level of LPG adoption in study areas

Study areas	N	Mean	Std. deviation	Mean diff.	df
Sekondi	268	2.8018	.56474	.12969	377
Agona Nkwanta	111	2.6722	.23425	.12969	376.995
Scale (Mean): 0-2.9= low and 3-5= high					

Source: Field data (2021)

Despite having an impressive high level of acceptance, the level of LPG adoption remains low due to the low level of usage in adoption. This clearly depicts that many respondents have accepted LPG but have issues with its usage and implies that despite several promotions by the government in the past, there is a lot of work to be done to boost adoption of LPG.

This Results are not different from other empirical studies as Asante et al. (2018), Hammeed et al. (2016) and Carrion et al. (2018) found low adoption as a result of barriers impeding LPG usage in their study. Comparatively, Sekondi's level of adoption though low, was higher than Agona's because of the contextual differences. This is in agreement with Dalaba et al. (2018), as their results found the proportion citing cost barriers to adoption was higher in the rural sample than the urban sample. Sekondi's respondents have a high level of income and higher

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education level than Agona. These are some of the socio-economic factors that are connected to modern fuel (LPG) usage which according to the energy ladder theory helps people to adopt LPG. It is surprising for Agona having benefitted from the Rural LPG promotion programme in the past to still have a low LPG adoption in comparison to Sekondi, and this clearly exposes the inadequacy of the promotion as pointed in literature. This also points out potential policy directions for Energy policy makers, in the sense that societies have moved from benefitting from distribution of free cylinders to policies that would make using LPG convenient.

Hammeed et al. (2018) discloses that understanding the issues arising from the utilisation of LPG will help create a road map for its sustainable usage. Ekouevi (2013) also discloses that large-scale adoption is not materializing due to a set of context specific barriers both on the consumer and producer/distributor sides. The issues that accounted for low adoption in the study as discussed above dwells on proximity, technology adaptation and initial price. It is safe to say that these issues are on Organisational facilitators' (marketers and regulators) sides rather than households and this clearly throws a challenge to Organisational facilitators in stepping up in their roles.

Results of Research Question 2: What is the Level of Fuel Stacking?

Fuel stacking entails the number of domestic fuels kept and used in the home. A lot of households keep various types of fuel for domestic use in their homes and switch between them as and when the need arises. This is depicted by

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the energy stacking theory as explained in Chapter Two and disclosed in empirical studies (Muller & Yan, 2018). In modern times, households keep LPG as their main fuel and back it up with biomass to guard against inconsistencies. The level of fuel stacking measured the various types of fuel mixes respondents kept in their households and their perceptions of them in terms of affordability, safety, cleanliness, and ability to cook fast.

The results in Table 25 shows that a majority of respondents in Sekondi engage in fuel stacking. Only 17.2% of respondent households use only LPG, while 41.8% use charcoal and LPG, 27.6% use LPG, electricity and charcoal, and 13.4% use LPG, charcoal and firewood. This is consistent with empirical studies as a handful of studies (Asante et al., 2018; Dalaba et al., 2018; Gould and Urpelainen, 2018; Celik and Oktay, 2019) disclosed fuel stacking as pervasive among households in their study.

Table 25: Various fuel mix kept by households in Sekondi

Fuel type	Frequency	Percentage
Charcoal and LPG	112	41.8
Charcoal, electricity and LPG	74	27.6
LPG	46	17.2
Charcoal, firewood and LPG	36	13.4
Total	**268**	**100**

Source: Field data (2021)

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Perception and usage of LPG in comparison to other fuels in Sekondi

Out of the fuel mix projected in table 27 above, 169 respondents (63.1%) had LPG as their main cooking fuel, 81 (30.2%) used charcoal as their main cooking fuel and 18 (6.8%) used firewood as their main cooking fuel. With the perception of most affordable, 159 respondents (59.3%) chose LPG as most affordable, 82 respondents (30.6%) chose charcoal and 27 respondents (10.1%) chose firewood. 38.1% chose LPG as safest, 3.4% chose firewood and 58.6% chose charcoal as safest. In terms of fast rate of cooking, 223 respondents (83.2%) agreed that LPG is fastest, 27 (10.1%) agreed that charcoal is fastest, 9 (3.4%) chose firewood as fastest and 9 (3.4%) also chose electricity as fastest. 241 respondents (89.9%) chose LPG as cleanest fuel, 18 (6.7%) chose electricity and 9 (3.4%) chose charcoal as cleanest. This is presented on a bar chart in Figure 3. Though LPG usage is high and majority of respondents think it is the fastest, most affordable and cleanest, sustained usage is still not achieved as some respondents keep reverting to biomass fuels with a handful perceiving that biomass fuels are fastest, cleanest, most affordable and safest.

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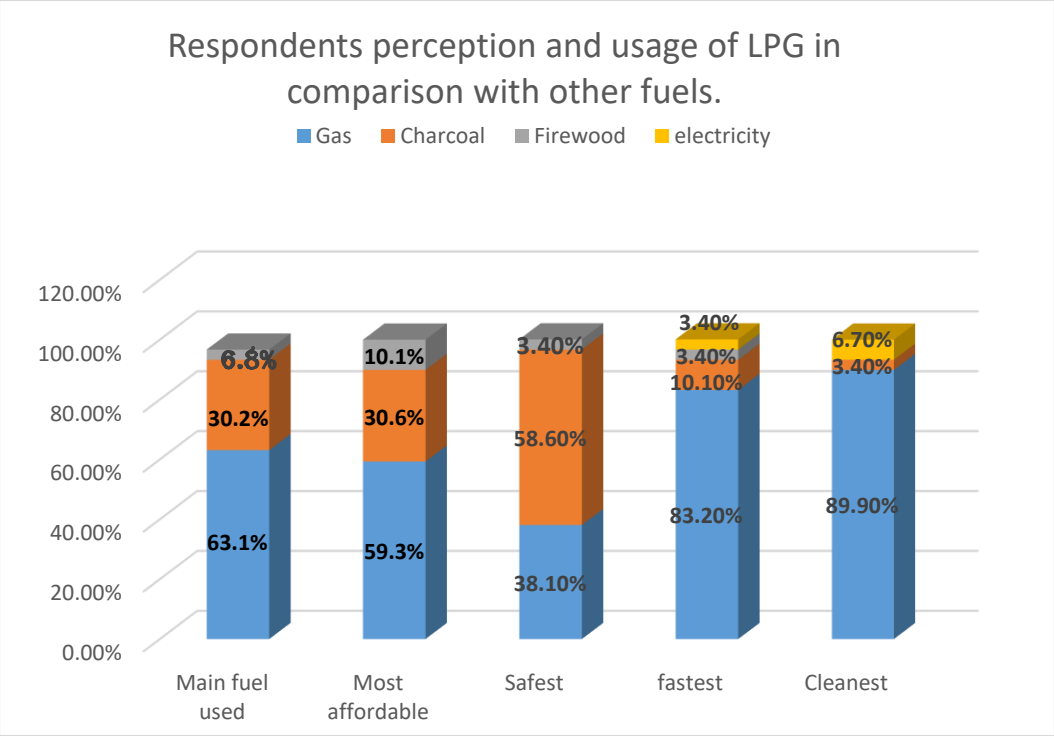

Figure 4: Perception and usage of LPG in comparison to other fuels in Sekondi

Source: Field data (2021)

The results for Agona as presented in Table 26, highlights that respondents stack various fuel types in their homes. 19.8% were found to use only LPG whilst 73.0% use LPG and charcoal as well as 7.2 % use charcoal, LPG and firewood.

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Table 26: Various fuel mix kept by households in Agona

Fuel type	Frequency	Percentage
Charcoal and LPG	81	73.0
LPG	22	19.8
Charcoal, firewood and LPG	8	7.2
Total	**111**	**100**

Source: Field data (2021)

Perception and usage of LPG in comparison to other fuels in Agona.

Out of the fuel types projected in Table 26, 96 respondents (86.5%) had LPG as their main cooking fuel, 7 (6.3%) used charcoal as their main cooking fuel and 8 (7.2%) used firewood as their main cooking fuel. With the perception of most affordable, 83 respondents (59.3%) chose LPG as most affordable, 28 respondents (25.2%) chose charcoal. On the safest fuel in the home, 65% picked LPG, 20% picked charcoal and 15% picked firewood. In terms of fast rate of cooking, 60 respondents (54.1%) agreed that LPG is fastest, 35 (31.5 %) agreed that charcoal is fastest and 16 respondents (14.4%) chose firewood as safest. With cleanest fuel, all 111 (i.e. 100% of respondents) agreed that LPG is the cleanest, as presented (on a bar chart) in Figure 4. The statistics show that though majority of respondents have their main fuel as LPG and perceptions that LPG is safest, fastest, most affordable and safest, there is still room for improvement.

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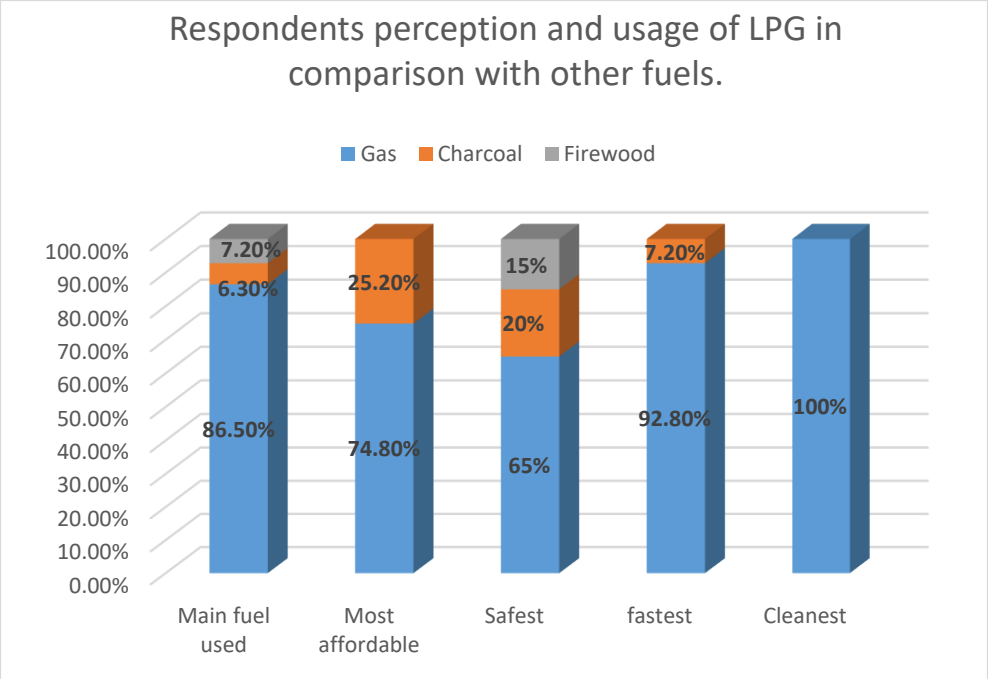

Figure 5: Perception and usage of LPG in comparison to other fuels in Agona

Source: Field data (2021)

Level of fuel stacking for both study areas

Respondents in both study areas engage in high level of fuel stacking. However, respondents in Sekondi seem to have a higher level of fuel stacking than Agona. From Table 25, 17.2% of respondents in Sekondi use only LPG in their homes as compared to 19.8% of respondents in Agona from Table 27. Again, 86.5% of respondents have LPG as their main cooking fuel in Agona from Figure 5 as compared to just 63.1% in Sekondi from Figure 4. Again, in analysing the perception of LPG in comparison with other household fuels from Figures 4 and 5, a lot of respondents in Agona held LPG in high esteem than respondents in Sekondi.

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Muller and Yan (2016) mentions that it is generally accepted that larger households are more likely to choose a mix including traditional and modern fuels. According to the demographic characteristics of respondents in Sekondi from Table 7, there is a high dependency burden on house heads, judging from the household size in each household as compared to Agona. It is therefore not surprising that respondents in Sekondi have a higher level of fuel stacking than Agona.

The findings of the study support other studies that have proved stacking to be a common practice. Masera and Mercado (2015) outlined socio-economic factors such as income and education and socio-ecological factors such as level of access to fuel and climate conditions as factors inducing fuel stacking among households. This is applicable to respondents from both study areas, as higher education and income levels are low, in addition to settlements getting easy access to firewood and charcoal. Respondents in Agona, for instance, have 7.2% of respondents using firewood (Figure 5) as their main fuel as compared to 3.4% in Sekondi (see Figure 4), signalling easy access of respondents in Agona to firewood.

Ochieng, Zhang, Nyabwa, Otieno and Spillane (2020) in their case study of two communities in western and northern Kenya, identified "using fuel stacking as a fall-back to LPG dysfunction" as the reason why all barriers to LPG need solutions. The serious implications of this high level of fuel stacking cannot be brushed under the carpet.

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Results of Research Question 3: What is the Level of LPG Sustained Usage?

Level of sustained usage looks at the variables that affect the intensity of LPG usage. GACC (2015) expresses sustained use as resulting from daily use and contextually influenced factors such as community, culture, institutional and external factors. Carrion et al. (2018) also points out that without proper interventions to respond to external stimuli, consistent stove use can falter. These external stimuli include fall in income and breakdown of LPG components among others. Reviewing various literature, level of sustained usage was measured with four variables namely; Culture (CC), conformity (CCn), frequency (Cf) and price (Cp). The level of each variable was independently determined, using a mean scale of 1 to 5 with 1 to 2.9 indicating low levels and 3 to 5 indicating high levels, however the positivity or negativity of its interpretation depended on the direction of the questionnaires under each variable. The cut-off point was arrived at using the mean of the scale.

Culture

Cultural factors such as lifestyle, cooking habits, food tastes and cultural beliefs are found to be closely correlated to fuel use behaviour (Muller & Yan, 2018). A lot of people are used to the traditional way of doing things and find it difficult to change their habits. Dalaba et al. (2018) affirmed that respondents in their study rated traditional stoves as being best for cooking their traditional dishes especially “tuo zaafi”. A high mean denotes that respondents are not influenced by cultural beliefs in LPG usage.

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The results gathered from Sekondi as presented in Table 27 showed that respondents are not really affected by cultural factors. With a total mean score of (μ=3.3492), they agreed to preferring the shift from collective cooking to individual cooking (π= 3.7910), the promotion of men inclusive in cooking (π= 4.5634) and cooking certain traditional dishes with LPG appropriate (π= 3.3284). They however only disagreed to LPG usage not making people lazy (π= 2.3843) and the type of food being cooked not affecting LPG usage (π= 2.6791).

Table 27: Cultural perception on LPG in Sekondi

Culture	Mean	Std. Deviation
I prefer LPG usage because it enables individualism over collectivism.	3.7910	1.74637
I find LPG usage promoting a cultural shift from woman exclusive to man inclusive in cooking activities which is desirable.	4.5634	1.02756
The type of food I cook doesn't affect the extent of LPG usage.	2.6791	1.88668
I find cooking certain traditional dishes with LPG appropriate.	3.3284	1.92471
LPG usage doesn't result in laziness.	2.3843	1.73682
Total	**3.3492**	

Scale (Mean): 0-2.9= low and 3-5= high

Source: Field data (2021)

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The results for Agona as presented in Table 28 also show that respondents are not affected by cultural factors. With a total average of (μ=4.1757), they strongly agreed to preferring the shift from collective cooking to individual cooking (π= 4.6216), the promotion of men inclusive in cooking (π= 5.0000), cooking certain traditional dishes with LPG appropriate (π= 3.3423) and only strongly disagreed to LPG usage not making people lazy (π= 1.2523) as well as the type of food being cooked not affecting LPG usage (π= 2.4865). This is in line with empirical studies as stated earlier that Dalaba et al. (2018) found respondents in the northern region preferred cooking the local dishes on traditional stoves. This validates respondents in both areas accepting that the type of food to be cooked affects LPG usage.

Table 28: Cultural perceptions on LPG in Agona

Culture	Mean	Std. Deviation
I prefer LPG usage because it enables individualism over collectivism.	4.6216	.78687
I find LPG usage promoting a cultural shift from woman exclusive to man inclusive in cooking activities which is desirable.	5.0000	.00000
The type of food I cook doesn't affect the extent of LPG usage.	2.4865	1.40690
I find cooking certain traditional dishes with LPG appropriate.	3.3423	1.84635

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LPG usage doesn't result in laziness.	1.2523	.97671
Total	**4.1757**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

Conformity

Hannigan (2018) has mentioned social contagion to be very significant in technology adoption. Peer influence and societal doctrines have an effect on peoples' lifestyles. People want to conform to the society rather than stand out and feel odd. A lot of people subscribe to a certain technology because others are on it and not for their personal reasons and LPG is no different. A higher mean denotes that societal conformity and peers influence respondents LPG usage and vice versa.

Results on conformity in Sekondi (Table 29) shows respondents are not influenced by peers or their surroundings and for that matter are not affected by conformity factors as the overall mean score was (μ=1.7724). They disagreed with all items under conformity including using LPG because of its popularity instead of benefits (π= 2.0149), using LPG because it's applicable to their lifestyle (π= 2.0522), households that use LPG being well to do (π= 1.8955), using LPG because of neighbours (π= 1.0336) and using LPG because it is easy to get as compared to others (π= 1.8657).

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Table 29: Conformity of respondents in Sekondi

Conformity	Mean	Std. Deviation
My household uses LPG because of its popularity instead of its benefits.	2.0149	1.68485
My household uses LPG because it is applicable to our lifestyle and setting.	2.0522	1.54006
I think that households that use LPG are well to do.	1.8955	1.26473
I don't really like LPG, I use it because a lot of my neighbours and friends are using it	1.0336	1.92471
I use LPG because it is easy to get as compared to the others.	1.8657	1.55205
Total	**1.7724**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

Results of conformity of respondents in Agona as presented in Table 30 indicate that the respondents have low tolerance for conformity with a total average of 1.6991 as they disagreed with all items under conformity except using LPG because it's applicable to their lifestyle (π= 3.4685). They disagreed with using LPG because of its popularity instead of benefits (π= 1.2523), using LPG because, households that use LPG being well to do (π= 1.6486), using LPG

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because of neighbours (π= 1.1261) and using LPG because it is easy to get as compared to others (π= 1.0000).

Table 30: Conformity of respondents in Agona

Conformity	Mean	Std. Deviation
My household uses LPG because of its popularity instead of its benefits.	1.2523	.97671
My household uses LPG because it is applicable to our lifestyle and setting.	3.4685	1.82816
I think that households that use LPG are well to do.	1.6486	1.18051
I don't really like LPG, I use it because a lot of my neighbours and friends are using it	1.1261	.48836
I use LPG because it is easy to get as compared to the others.	1.0000	.00000
Total	**1.6991**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data (2021)

Frequency

Frequency of LPG use is a result of daily usage and intensity of use. How often LPG is used and integrated into daily cooking plans denote sustain usage. Carrion et al. (2018) disclosed that researchers have noted high intensity of usage with new stove upon acquisition which decreases over time. Frequency of LPG in sustain use studies involves intensity of use, duration of use and arrangements to

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ensure continuous usage. The higher the mean, the higher the frequency of LPG in households.

The results of Sekondi indicated that respondents are quiet frequent with LPG usage with an overall mean score of (μ=3.0504). Even though there is a high average total of 3.0504 (see Table 31), it's still not encouraging. Respondents agreed to using LPG for more than two years (π= 4.6642), always refilling LPG immediately it gets finished (π= 3.4739) but disagreed to using only LPG throughout the year (π= 2.4067), having filled backup cylinders to guard against emergencies (π= 2.3864) and having more than one stove to guard against emergencies (π= 2.3209).

Table 31: Frequency of LPG use in Sekondi

Frequency	Mean	Std. Deviation
I have been using LPG for more than two years.	4.6642	1.01630
My household always refill our LPG immediately it gets finished.	3.4739	1.64535
I use only LPG throughout the year without any shift or switching.	2.4067	1.74032
My household always have filled back-up cylinders to guard against emergencies.	2.3864	1.82002
My household has more than one LPG equipment (cookstove, hose, and regulator) to guard against emergencies.	2.3209	1.84858

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Total	**3.0504**

Scale (Mean): 0-2.9= low and 3-5= high

Source: Field data (2021)

The results for Agona showed that respondents' frequency of LPG is very low with a total mean score of (μ=2.1459) as presented in Table 32. They only agreed to using LPG for more than two years (π= 4.2072) whilst strongly disagreeing to refilling LPG immediately it gets finished (π= 2.2252), using only LPG throughout the year (π= 1.7928), having filled backup cylinders to guard against emergencies (π= 1.5045) and having more than one stove to guard against emergencies (π= 1.0000).

Table 32: Frequency of LPG use in Agona

Frequency	Mean	Std. Deviation
I have been using LPG for more than two years.	4.2072	1.60180
My household always refill our LPG immediately it gets finished.	2.2252	1.57644
I use only LPG throughout the year without any shift or switching.	1.7928	1.60180
My household always have filled back-up cylinders to guard against emergencies.	1.5045	1.33399
My household has more than one LPG equipment (cookstove, hose, and regulator) to guard against emergencies.	1.0000	.00000
Total	**2.1459**	

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Scale (Mean): 0-2.9= low and 3-5= high

Source: Field data (2021)

Final Price

Price in sustained usage entails cost of consistently refilling LPG when it gets finished and the cost of maintaining LPG components. This is one of the barriers posing threats to LPG sustained usage as evidently reported in empirical studies (Asante et al., 2018; Dalaba et al., 2018; Carrion et al., 2018; Hameed et al., 2016). A higher mean denotes respondents have problems with price.

The results for Sekondi in Table 33 shows that respondents have problems with price of LPG in the sustained usage of LPG. With an overall average of 3.5525, they strongly agreed to refilling LPG continuously being a burden on their household (π= 4.7477) as well as not factoring LPG expenses in their budget (π= 4.3694) and only disagreed to LPG maintenance cost being a burden (π= 1.5405). Here maintenance cost entails cost of repairs and change of parts to LPG components.

Table 33: Price of LPG in Sekondi

Price	Mean	Std. Deviation
Refilling LPG continuously is a burden to my household.	4.7477	.97671
I don't factor LPG refill expenses in my budget.	4.3694	1.37463
The cost of LPG maintenance is a burden.	1.5405	1.37367

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Total	**(3.5525)**
Scale (Mean): 0-2.9= low and 3-5= high	

Source: Field data (2021)

The results of Agona showed that respondents are partially affected by price in sustained usage though the overall mean score was of 2, 6903 from Table 34. They agreed to refilling LPG continuously being a burden on their household (π= 3.1791) as well as not factoring LPG expenses in their budget (π= 3.2873) and only disagreed to LPG maintenance cost being a burden (π= 1.6903).

Table 34: Price of LPG in Agona

Price	Mean	Std. Deviation
Refilling LPG continuously is a burden to my household.	3.1791	1.85566
I don't factor LPG refill expenses in my budget.	3.2873	1.83890
The cost of LPG maintenance is a burden.	1.6045	1.14832
Total	**(2.6093)**	
Scale (Mean): 0-2.9= low and 3-5= high		

Source: Field data, Adu (2021)

Level of LPG sustained usage for both study areas.

Finally, based on the results from the variables above, the study uses the weighted mean and independent t-test to determine the level of sustained usage in both study areas. The results as presented in Table 35 shows that respondents in

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both study areas have a low level of LPG sustained usage which is expected due to the high level of fuel stacking in both areas.

Table 35: Independent t-test for level of LPG sustained usage in study areas

Study areas	N	Mean	Std. deviation	Mean diff.	df
Sekondi	268	2.0279	.59653	.42004	377
Agona Nkwanta	111	1.6079	.32292	.42004	351.443
Scale (Mean): 0-2.9= low and 3-5= high					

Source: Field data (2021)

This is consistent with a lot of studies including Dalaba et al. (2021), Asante et al. (2016) and Carrion et al. (2021) whose results also indicated low sustained use of LPG among respondents in the Kintampo North Municipality and Kintampo South District in the Brong-Ahafo Region of Ghana, Nkoranza communities and some communities in the Northern region. Comparatively, Sekondi had a much higher mean (μ_w=2.0279) than Agona (μ_w=1.6079) indicating that the level of sustained usage in Sekondi though low, is much better than Agona which is not surprising since Sekondi is much developed and has a higher level of socio-economic factors such as income and education.

The issues that accounted for the low level of sustained usage include price with respondents agreeing to consistent LPG refills being burden to them and not budgeting for LPG expenses. Price has largely been mentioned in empirical studies as a barrier to LPG utilization. However, the inability of

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households to factor LPG expenses in their budget makes them unprepared for impromptu refills paving way for fuel stacking. This aspect of price has not been discussed much in literature. The findings also projects lack of frequency in LPG usage which basically entails respondents not refilling their cylinders on time, not using LPG exclusively throughout the year as well as not having back-up cylinders and stoves to guard against current dysfunctions among others. These behaviours reflects and emphasizes the practice of fuel stacking due to price and low income.

Lastly there was a culturally induced challenge where a lot of respondents think LPG makes users lazy as well as allowing the type of food to dictate the fuel to be used. Yadava, Davies and Asumadu-Sarkodie (2021) mentioned respondents giving anecdotes of favoured taste of foods cooked on biomass fuels in their study in rural areas in India and suggested that to curb cultural preference for biomass as a cooking fuel, targeted education programs must be initiated.

The findings compare favourably with the reports of Yadava et al. (2021), Gould and Urpelainen (2018), Ochieng et al. (2019), Celik and Erkan (2019) that exclusive use of LPG by households remains relatively low and rare in some cases, calling for immediate address. Again, the findings portray how responsive households are to LPG price and continue to reveal the need for policies that induce continuous usage of LPG. It also exposes hidden factors such as culture that has affected perceptions towards LPG usage.

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Results for Research Question 4: What are factors impeding LPG Utilisation?

Lots of people encounter problems in accessing reliable, affordable and sustainable modern energy (Hammeed et al., 2016). Research proves that in order to enable a complete transition from biomass to LPG, it is important to find out what factors can enable or serve as barriers for such an uptake (Norad, 2020). Most of these barriers are contextual and geographically based and this is why various factors that have been identified by empirical studies as barriers to LPG utilization are being tested in both areas to know the most pressing ones that need attention and resolve.

Results from Sekondi as presented in Table 36 indicates that respondents have experienced all the challenges which were indicated in the questionnaire. However majority chose six of them as most pressing challenges with LPG usage as presented in Figure 6.

Table 36: Challenging factors affecting LPG in Sekondi

Challenges	Code	Mean
Lack of funds for initial purchase of LPG components (cylinder and stove).	DC1	1.8769
High Cost of refilling gas cylinders	DC2	2.5858
Inadequate number of Gas service stations	DC3	1.7799
Long distance of refilling stations.	DC4	1.6791
Fear of risks associated with using LPG (explosions,	DC5	1.9142

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leakages and suffocating)		
Lack of technical know-how.	DC6	1.5075
Frequent scarcity of LPG.	DC7	1.5821
Preference for biomass.	DC8	1.7052
Unreliable supply of Gas.	DC9	1.3694
Not suitable for current kitchen condition	DC10	1.3358
Scale (Mean): 0-1.5= low and 1.6-3= high		

Source: Field data (2021)

The challenge with the highest mean of as shown by the bar chart in Figure 6 is high cost of refilling of Gas cylinders whose mean was (π= 2.5858), next is fear of risks associated with Gas usage (π= 1.9142), followed by lack of funds for initial purchase of LPG components (π= 1.8769), inadequate number of Gas filling stations (π= 1.7799), preference for biomass (π= 1.7052) and finally long distance of LGP filling stations (π= 1.6791).

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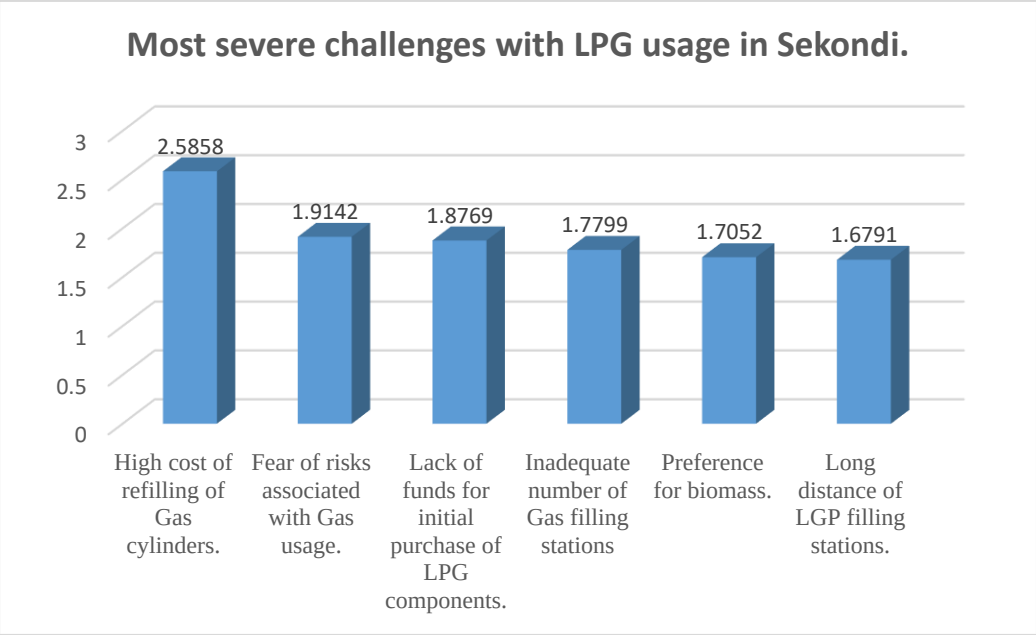

Figure 6: Bar chart of most severe challenges with LPG usage in Sekondi

Source: Field data (2021)

Subsequently, results from Agona in table 37 indicates that respondents have experienced all the challenges which was indicated in the questionnaire, with majority also choosing six of them as most pressing (severe) challenges with LPG usage in Figure 7.

Table 37: Challenging factors affecting LPG in Agona

Challenges	Code	Mean
Lack of funds for initial purchase of LPG components (cylinder and stove).	DC1	2.0450
High Cost of refilling gas cylinders	DC2	3.0000
Inadequate number of Gas service stations	DC3	2.6757

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Long distance of refilling stations.	DC4	2.7477
Fear of risks associated with using LPG (explosions, leakages and suffocating)	DC5	1.7027
Lack of technical know-how.	DC6	1.0000
Frequent scarcity of LPG.	DC7	1.5856
Preference for biomass.	DC8	1.8559
Unreliable supply of Gas.	DC9	1.0000
Not suitable for current kitchen condition	DC10	1.0721
Scale (Mean): 0-1.5= low and 1.6-3= high		

Source: Field data (2021)

The six most severe challenges with LPG usage selected by respondents in Agona as projected by the bar chart in Figure 7 starts with high cost of refilling of Gas cylinders whose mean was (π= 3.0000), followed by long distance of LGP filling stations (π= 2.7477), inadequate number of Gas filling stations (π= 2.6757), lack of funds for initial purchase of LPG components (π= 2.0450), preference for biomass (π= 1.8559) and finally fear of risks associated with Gas usage (π= 1.7027).

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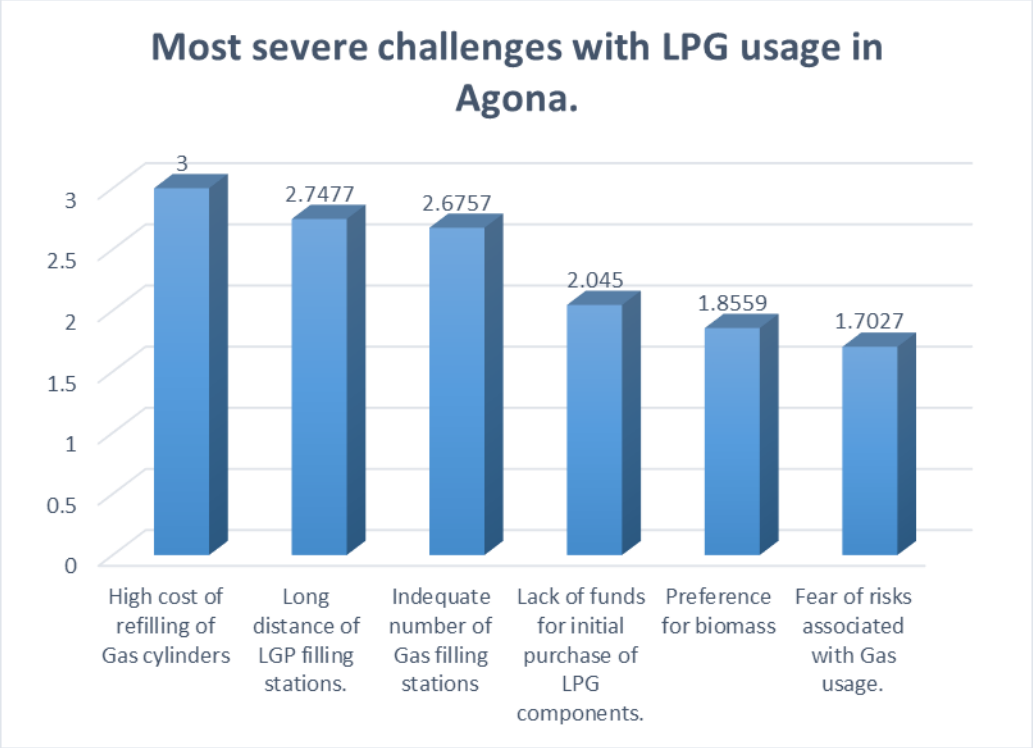

Figure 7: Bar chart of most severe challenges with LPG usage in Agona

Source: Field data (2021)

Surprisingly all study areas have the same six most severe challenges with a different scale of most pressing and this affirms Carrion et al. (2018)'s assertion that factors related to LPG adoption may have inconsistencies in their underlying constructs which may be due to contextual and geographical differences. High cost of refilling gas cylinders however, managed to be first for both study areas. Impliedly and per extant studies, one can say price of LPG refills is a big obstacle to LPG utilization geographically. Long distance and inadequate number of LPG filling stations was also cited by respondents to be a challenge. However, Dalaba et al. (2018) in his study in Northern Region of Ghana found this to be an insignificant barrier to owners of LPG but mentioned that long distance of LPG filling stations from homes is likely to be a barrier to people in the rural areas.

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This is consistent with their claim, given that it is the second most severe challenge for Agona as compared to being last for Sekondi.

Fear of risks with LPG use was ranked second by respondents in Sekondi but last in Agona. This can be attributed to the type of setting and context considering that Sekondi has a larger household size with a lot of children and close positioned settlement. This is consistent with Dalaba et al. (2018) as they found majority of safety concerns with LPG were mentioned by urban respondents. Preference for biomass was also cited as a challenge by respondents in both areas. Some have been oriented and imprinted on traditional fuel usage and find it difficult breaking free and this is proved by Yadava et al. (2020) as respondents disclosed their preference for taste of food cooked on biomass.

To sum up based on the findings, the choice of household LPG usage is influenced by some factors, among them is price which is considered to be a major factor, the availability and ease in getting and using LPG, as well as the perception surrounding its usage. The extent of these factors are contextually based and plays a major role in the intensity of LPG usage in the home. The absence of these factors challenges users to switch or stack fuels, it is therefore imperative that these challenges are addressed.

Results for Research Question 5: What is the Role of Organisational Facilitators in LPG Utilisation?

Objective five is the second phase of the study which used the qualitative approach and adopted semi-structured interview as its data collection instrument.

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The interview was conducted in two sections with two separate interview guides, the first was for managers of LPG marketing companies in study areas and the next was for LPG regulators (Energy Commission and National petroleum Authority). The interviews were analysed with thematic analysis, going by Braun and Clarke (2006)'s method of conducting thematic analysis.

Analysis of role of LPG marketing companies.

The role of LPG marketing companies was assessed with an interview guide containing questions centred on their role in level of LPG adoption and sustained usage. These questions were based on their opinions, how they carry-out some of their duties and what they can do to help customers. There were three sections on the interview guide which also form the areas of analysis i.e. background information of interviewee, role in level of LPG adoption and role in level of LPG sustained usage.

Background of interviewees

Four managers were interviewed on behalf of the LPG MC's (LPG refilling stations/ points of sale) operating in the study areas. Each study area has two LPG service stations/ points of sale. Among the four managers, only one was female. Three were in the age bracket of 25 - 40 years with only one above 65years. All were literates with the minimum of SHS and maximum of first degree. Three had working experience of ten years and above whilst only one had 2 years' experience. Three were married whiles one was single.

Results of Role of LPG Marketing Companies in level of adoption

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Under the role in level of LPG adoption was four items namely trustworthiness, reliability, proximity and price which was used in measuring the role of LPG MC's in level of adoption.

Trustworthiness

Trustworthiness measured how LPG MC's play their role of securing customers trust in them in order to promote patronage of LPG in terms of offering good services. The role covered their knowledge on and practice of safety measures at their premises, educating customers on safety measures. This role is partly necessary because of the fatal gas explosion accidents occurring at LPG refilling stations from 2014 – 2017 (The Global LPG Partnership, 2018). Based on the thematic analysis conducted, three themes were derived from the codes under trustworthiness. These are awareness of LPG benefits and risk, safety measures in operations and ensuring customer safety.

1. Awareness of LPG benefits and risk

Awareness of LPG benefits and risk as a theme disclosed managers' knowledge concerning some of the benefits and reasons why people use LPG as well as the risk these people face. All managers were cautious of the benefits and reasons why people use LPG with almost all of them stating that it is faster and quicker to use. However with the risk users face in using LPG, all of them seemed confused and failed to mention some specific risks involved but were however conscious and mentioned some measures to curb the risk users can face with LPG.

2. Safety measures in operations.

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This theme disclosed the preparedness and adherence of LPG MC's to safety protocols. The Gas Service Stations at Sekondi were adequately prepared for emergencies and had effective customer protection measures. Their premises are spacious and they cited efforts to detect fire, possession and usage of safety kits and prohibition of phones at premises among others as their measures. On the other hand, the Gas service stations at Agona Nkwanta were not adequately equipped for emergencies as their premises was not spacious enough and was packed, though they had customer protection measures and cited daily checks for leakages and usage of safety kits.

3. Ensuring customer safety

This was used to theme codes that talked about customer protection measures or efforts by LPG MC's to ensure customer safety at their premises. Almost all managers disclosed inspection of cylinders as number one action. One of them mentioned talking to customers and advising them whiles the remaining cited sending customers back for old cylinders.

Reliability

Reliability of LPG MC's focused on their efforts to educate customers on Gas usage and to supply quality LPG as customers have been complaining the LPG they buy sometimes doesn't last as expected. Two themes were used to analyse codes under reliability i.e. education on handling of LPG and Quality control.

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1. Education on handling LPG

All managers agreed to educating customers on LPG usage aside selling to them. Among the education given include being cautious of kids around LPG in their house, seeking help when encountered with faults and not overfilling cylinders. One manager from Agona Nkwanta added that some customers however resist the not overfilling their cylinders whiles others are forget the advice given.

2. Quality control

All managers disclosed not having control over quality of the LPG they sell since they don't refine it themselves. One manager from Sekondi said the LPG supply chain is centralized and dismissed customer claims of not getting quality Gas. The other from Sekondi however disclosed that there are two sources of LPG (local from Atuabo and foreign from Tema) in the system, with observed claims that customers prefer the foreign one since its denser and last longer. And so they patronize more of the foreign one to meet customer satisfaction.

The managers from Agona re-echoed the second manager from Sekondi's submission, and also mentioned that the quality of gas is determined by its source. And further disclosed that the type of LPG purchased by LPG MCs is dependent on proximity. One manager however added that quality is not controlled by suppliers but quantity is, as some unscrupulous persons might adjust their scales and pumps to fill lesser gas than expected.

Usage

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Usage was used to measure patronage of LPG and measures put in place to continuously and consistently supply LPG to customers. Two themes were derived from the analysis namely demand for LPG and continuous supply strategies.

1. Demand of LPG

All managers agreed that LPG patronage has increased over the years with three of them indicating that despite sharing customers with competitors, they are able to make steady sales. One manager remaining from Sekondi also pointed that the gas from Tema attracts more sales.

2. Continuous supply strategies

All managers had continuous supply strategies. Three mentioned smart distribution network with the use of 10% - 5% re-order level whereas the other mentioned being a distributor of LPG as well as a marketing company and using large storage tanks.

Proximity

Proximity measures the siting of the LPG marketing company in consideration to being accessible by a lot of customers. It was analysed with one theme (i.e. citing of company).

1. Siting of company

All managers mentioned that their companies are strategically sited and within reach of customers. The managers at Sekondi disclosed that their refill stations are at the centre of the city whiles those at Agona mentioned that they are concentrated at one region of the town.

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Price

Price measured the escalation of gas prices, complaints from customers and its impact on demand. This was analysed with two themes namely price issues and impact of price fluctuations.

1. Price issues

Managers expressed lamentations of frequent increases in Gas prices and their lack of control. They mentioned customer complaints and blame on government.

2. Impact of price fluctuations.

Managers mentioned that price increases does not affect demand but the quantity demanded. One manager specifically said "No, they don't stop buying but they reduce the quantity they buy. For example if they buy 90 cedis they can reduce it to 50 cedis". Meaning that whenever prices rises, customers buy less quantity of LPG.

Results of role of LPG MC'S in level of LPG sustained usage.

Role in level of sustained usage measured supplier challenges, customer challenges and how suppliers can help and nature of demand of LPG. It was analysed with themes including nature of demand, supplier challenges, supplier role in promoting LPG usage and supplier role in customer challenges.

1. Nature of demand

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All managers agreed that demand is consistent and very high on weekends and during occasions like Christmas. They cited refilling of multiple cylinders by some customers.

2. Supplier challenges

One manager in Sekondi mentioned they had no challenges in their refilling station whiles the other expressed price complains by customers as a challenge. In Agona, one manager expressed power fluctuations as a challenge as they have to fall on plants which bring them additional costs. The other expressed technical faults with machines as a challenge.

3. Supplier role in promoting LPG usage.

One manager was not aware of suppliers' role in promoting LPG usage and expressed awareness of government role instead. The three others admitted of having a role to play and cited education of customers, protection of customers at premises as roles they play towards LPG promotion.

4. Supplier role in customer challenges.

One of the managers in Sekondi mentioned education on the right amount of Gas to fill in a cylinder, fixing faulty components of the LPG cooking system and education on safety measures whiles the other mentioned educating customers, rejection of old cylinders and reduced intake of Atuabo gas. Agona mangers expressed education on detecting leakages with one disclosing his intention to start education on a talk show on their local radio stations to help customers.

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Analysis of role of regulators

The role of regulators was assessed with an interview guide which was derived based on the outcome of the interviews with LPG MCs in the study areas. It focused on areas such as escalation of gas prices, quality of gas, enforcement of safety measures, projects to promote LPG usage. One Staff member from NPA and EC were interviewed respectively on the areas captured in the interview guide. The interview sought to seek clarification on salient issues that popped up during questionnaire administration and interview of LPG MCs as well as current government stance on promotion of LPG towards Ghana's sustainable energy for all goal.

Results of Role of regulators in LPG utilization.

The interview was centred on four areas of concern. These areas needed explanation from regulators as well as the actions to be taken. The outcome of the interview was assessed with codes and themes under the areas namely escalation of gas prices, quality of gas, enforcement of safety measures and projects to promote LPG usage.

Escalation of Gas prices

This area sought clarity on the recent escalation of gas prices and the actions taken by the regulators to stabilize it.

1. Gas pricing

Regulators mentioned that gas pricing is dependent on several factors beyond their control (exchange rate, importation cost etc.) and that currently

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petroleum products pricing is deregulated so NPA sets a margin/ threshold for MCs to sell their products. However when asked about what can be done in the situation? The answer given was that NPA operates under government and is not in control of prices and can only prevent MCs from cheating customers but government can lower taxes on LPG.

Quality of Gas

The quality of gas item on the interview guide discussed the various sources of LPG in Ghana and whether their variance reflects their quality.

1. Variance in quality

Both regulators admitted that indeed there is a difference between the locally produced LPG from Atuabo and foreign imported LPG in Ghana. This is as a result of the proportions of butane and propane in them. They admitted that this has been a back and forth conversation mostly discussed at top level however no empirical evidence has proven that the LPG at Atuabo is substandard making those claims a fuss.

Enforcement of safety measures

The enforcement of safety measures was centred on how effective NPA performs its duty of supervising safety measures among LPG MCs and how they are addressing fear of LPG by users. It was analysed with two themes namely safety measures and concern for fear.

1. Safety measures:

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The interviewee expressed NPA's major concern with safety and gave assurance of consistent checks with LPG MCs on safety measures. The main challenge was recalcitrance of some operators.

2. Concern on fear:

The interviewee expressed genuine concern for fear of LPG by customers and admitted that NPA needs to step up their game in educating the public on safety practices in using gas such as checking of expiry dates on cylinders, replacing of black valve and maintenance of cylinders and other components.

Projects to promote LPG usage

This area catered for clarification on issues concerning the cylinder recirculation model which is the latest project to promote LPG usage especially in the rural areas as well as address loopholes in the policy.

1. Cylinder recirculation model (CRM) in rural areas.

They disclosed that after conducting several pilot test on the policy, it needs massive education especially in the rural areas. Again another important question was on how the policy will address the fact that some consumers don't fill their cylinder to their right capacities. They gave the assurance that one advantage with the CRM is the categorization of prices which is the essence of it. The interviewee from NPA disclosed that "Someone with 10 cedis should be able to afford 10 cedis worth LPG with a smaller cylinder size. The policy caters for all that."

Conclusions on the interviews

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Based on the findings from the interview, it is evident that indeed LPG marketers and regulators have a role to play in scaling up LPG utilization though this has been less studied in extant literature. Norad (2020) asserts that for LPG usage to increase in Sub-Saharan African countries, there must be an enabling environment as well as focus on policy and strategic level with clear responsibility allocation and proper regulation for the sector. It is in this light that LPG filling stations and regulators' role towards LPG utilization was assessed.

The study found moderate to weak effort on the part of some LPG filling stations especially those in areas far from big cities (Agona) in observance and enforcement of safety protocols at their premises as well as low knowledge in safety measures of using LPG which was evident in their answers to questions on safety. This makes them less reliable in the duty of educating customers on safety ways of handling LPG and their premises dangerous for customers at large. All LPG filling stations however, had effective measures (re-order levels) for continuous supply of LPG which is commendable.

With the continuous rise in prices of the LPG problem, findings showed that a lot of households adjust the quantity of LPG they buy to complement other fuels in their homes which affirmed the excessive fuel stacking. In seeking a solution to this obstacle, findings showed LPG price is deregulated and regulators do not have control over it because of a lot of complex and uncontrollable factors involved. However there is still an open conversation on it at the top level.

The misconception on the quality of the indigenous gas is due to its chemical compositions and does not make it substandard. However, the

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unfortunate adjustment of pumps and scales by some unscrupulous LPG filling stations to reduce quantity in their attempt to make extra profit is fuelling this misconceptions by users which causes some customers to panic in using LPG. Most filling station operators are rather too concerned with making money and not aware of any additional role to help customers with gas safety practices. They ought to check and reject old and faulty cylinders from customers as well as strictly enforce and adhere to all other safety practices at their premises. Lastly the findings ironed out the essence of the cylinder recirculation model and its role in modification of cylinders to LPG prices to promote affordability and safety.

To conclude, Organisational facilitators need a step-up in their various roles to promote LPG usage. Regulators need to effectively monitor and supervise LPG marketing companies in their duty of selling LPG to households. They also need to intensify education and training of LPG marketing companies and households on safety practices in using LPG. Regulators also need to prioritise working on policies to curb rising prices of LPG.

Chapter Summary

The chapter has discussed the various results and findings obtained from 368 survey responses and 6 interviews concerning the research questions and objectives of the study. Specifically, it has systematically presented and discussed the results of all variables on the instruments used in the analysis, examined their implications, and pointed out their reference to previous studies. While findings of the study in both areas revealed that the level of LPG adoption and level of LPG sustained usage are very low owing to a high level of fuel stacking,

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comparative analysis between the two study areas also proved that Sekondi has a much better level of LPG sustained usage than Agona, and this is parallel to existing literature. The common challenges discovered for LPG utilization in both areas included price, safety concerns, preference for biomass, availability and ease of LPG supply, among others. LPG marketers and regulators have a role to play in easing off some of these challenges to pave the way for LPG adoption and sustained usage.

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CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter represents the final and concluding chapter of the study and presents the summary of key findings on each objective, conclusions drawn, as well as the recommendations offered for energy policymakers and future researchers.

Summary

This study provided an insight into LPG utilization in Ghana by conducting a comparative study of Agona Nkwanta and Sekondi in the Western region of Ghana. With five main objectives in mind, it delved into the stages of LPG utilisation by breaking down each stage and assessing it with variables that are dependent and effective for measuring it, such as; assessing the level of LPG adoption; assessing the level of fuel stacking; assessing the level of LPG sustained usage; examining the challenging factors affecting LPG usage; and finally assessing the role of organisational facilitators in LPG utilization.

The study was guided by two theories, namely the energy ladder and the fuel stacking theory, which posit factors that induce users to adopt and use LPG. Additionally, it assessed various empirical studies and drew visible lines on the current research position on each of the objectives. Based on the objectives and corresponding research questions, the study resorted to the pragmatism research paradigm and the mixed-method approach with the descriptive research design in its study. The survey method was employed to collect data from households

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sampled through simple random sampling in both study areas, whilst semi-structured interviews were relied on to collect data conveniently from LPG MCs in both study areas and purposively from LPG regulators (NPA and EC) in Ghana.

In all, 379 valid responses were obtained from questionnaires alongside 6 interviews. The questionnaire instrument was pre-tested and modified appropriately, with ethical clearance sought from UCC-IRB. The study was carried out in two phases: the quantitative phase was analysed with SPSS V.21 using mean, standard deviation, percentages, frequency, and an independent t-test; and the qualitative phase with thematic analysis. The major findings as they relate to the specific objectives and research questions of the study have been summarized accordingly.

The first objective sought to assess the level of LPG adoption in both study areas. The main issues that emerged were:

1. Respondents from both study areas exhibited a high level of LPG acceptance, which basically means that they trust LPG and LPG suppliers; LPG is reliable and LPG is valid.
2. Respondents in both study areas had a low level of LPG usage, which is due to proximity, price and safety issues.
3. Putting the level of acceptance and level of LPG usage together, respondents from both study areas had a very low level of LPG adoption, with Sekondi having a much higher mean (μ_w=2.8018) than Agona

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(μ_w=2.6722). This indicates that though they have accepted LPG, they are having problems with its usage.

The second objective focused on assessing the level of fuel stacking in both study areas. The outcome is as follows:

1. Both study areas recorded a high level of fuel stacking, with Agona's being much lower than Sekondi's. This implies that respondents are very responsive to LPG challenges, consistently and easily switching to other fuels.
2. Most respondents in Sekondi had a weaker perception of LPG being safer, cheaper, and cleaner in comparison with other fuels than respondents in Agona.

The third objective was tailored towards assessing the level of LPG sustained usage. The main issues that were found included:

1. Both study areas had a low level of LPG sustained usage, which affirmed the high level of fuel stacking.
2. Sekondi had a much higher mean (μ_w=2.0279) than Agona (μ_w=1.6079), indicating that Sekondi uses LPG more sustainably than Agona.
3. The reasons that are accounted for low sustained usage include low frequency of LPG usage, price, and cultural perceptions.

The fourth objective of the study determined the challenges affecting LPG utilisation. The findings included:

1. Six challenges out of the ten presented came out as most severe challenges in LPG utilisation from both study areas.

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2. Though the same challenges were chosen by respondents in both study areas, the rankings of the challenges differed, with the high cost of refilling LPG consistently being first for both areas. This illustrates how the price of LPG has become a universal problem for users.
3. The most severe challenges affecting LPG in both study areas include the high cost of refilling gas cylinders, inadequate gas filling stations, fear associated with gas usage, lack of funds for the initial purchase of gas and its equipment, preference for biomass, and lastly, the long distance between gas filling stations.

The fifth and last objective assessed the role of organisational facilitators in scaling up LPG utilisation. The main issues that were discussed included:

1. LPG filling stations, especially those in Agona, have moderate to weak observance of safety protocols. This implies that their workers and customers are not thoroughly safe at their premises.
2. Most LPG filling stations are too concerned with making money and are hardly aware of their role in helping customers in safe ways to handle LPG.
3. LPG regulators have no control over pricing.
4. LPG regulators need to step up their role of education on safety, and enforcing safety measures at LPG filling stations especially those in less developed areas.

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5. The misconception about the sub-standard of indigenous gas is due to the adjustment of scale and pumps to reduce the quantity of gas bought by some unscrupulous filling stations to make extra money.
6. LPG filling stations have good measures to ensure a continuous supply of LPG and avoid shortages.
7. There is a keen competition amongst LPG filling stations that drives them to work efficiently.
8. Regulators affirmed the essence of the cylinder recirculation model and its role in the modification of cylinders to LPG prices to promote affordability and safety.

Conclusions

This study has described the contours of LPG adoption and sustained usage in developed and developing settings. It can be concluded that there is a low level of LPG adoption despite its widespread acceptance due to the challenges users face in using it. As a result, LPG consumption remains low over time. Respondents see fuel stacking as a solution to minimising overreliance on LPG and guarding against its associated challenges while balancing household energy usage. This has made them very responsive to LPG challenges, which is reflected in the high level of fuel stacking. The findings also endorse the reports of Yadava et al. (2021), Gould and Urpelainen (2018), Ochieng et al. (2019), and Celik and Erkan (2019) that exclusive use of LPG by households remains relatively low and rare in some cases, calling for immediate address. The bottom line is that if LPG challenges are not addressed or immediately given attention to,

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biomass usage will continue to be a canker and the target of expanding LPG usage to 50% of households by 2030 will be unachievable.

Importantly, results from this study are based on well-established household cooking and decision-making patterns rare outside the intervention context as popularly dominated in literature, and as such, free from bias. Constructs used to derive information are detailed and constructive. In this light the study reveals that both initial price of LPG connection and price of LPG refills have almost become a universal problem as affirmed by a lot of studies (Dalaba et al., 2018; Asante et al., 2018; Celik and Erkan 2019; Gould and Urperlainen 2018; Norad, 2020; Carrion et al., 2021), that needs serious intervention. Though price seems to be the centre of attention in LPG utilisation, fear and safety concerns, preference for biomass, long distance of filling stations and inadequate number of filling stations are also contributing challenges. To ease and provide solutions to some of these challenges, gas marketers as well as regulators must recognize their roles towards specifically scaling up LPG utilisation in addition to carrying out their normal duties.

Additionally, the study has generated insight into the possible contributions gas marketers and regulators can make towards scaling up LPG utilization and revealed critical areas that need their attention and redress by exposing important misconceptions, perceptions, and discomforts many respondents have towards LPG, which has been less discussed in extant studies. Misconceptions about the quality of LPG, fear and lack of knowledge about handling LPG in the home, ignorance about the importance of using LPG to the

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environment, and cultural perceptions about LPG usage can all be addressed by organizational facilitators through extensive education and orientation.

Recommendations to energy policy makers

1. It must, however, be noted that sustainable LPG usage is closely linked with socio-economic factors. Therefore, the study recommends that in tackling challenges affecting LPG, the socio-economic well-being of people should be taken into consideration by means of job creation to increase income level and reduce dependency, improvement in education, and improvement in living standards.
2. The State, officials at the Energy Commission, and the National Petroleum Authority need to set an integrated action plan geared towards resolving issues with LPG utilisation and fine-tuning the scaling up of LPG utilisation as well as eradicating biomass usage. This can take the form of stabilising household LPG prices through the removal of taxes, orienting LPG filling station workers on safety practices and engaging customers on safe ways of handling LPG in the home, intensive checks on filling stations to ensure ethical operations, intensive enforcement of safety measures at filling stations, mass education on safer ways to handle LPG and the importance of using LPG for the environment. Again, the cylinder recirculation model policy, which aims to address a lot of LPG utilisation challenges, should be set in motion.
3. Agyei-Holmes et al. (2020) mention that poor targeting and generalisation of LPG promotion programs have plagued several LPG promotion

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policies. Therefore, policymakers should set targeting policies and action plans, especially to cater to those in less developed areas, the vulnerable and the deprived. This said, more efforts and research should be made on the feasibility of the implementation of the cylinder recirculation model in rural areas, considering the adequacy and distance of cylinder recirculation outlets. The State should again adopt innovative approaches to subsidise LPG solely for the poor and vulnerable without the risk of subsidy capture.

Suggestions for further research

1. The study was conducted among households in Sekondi and Agona Nkwanta in the Western Region of Ghana on LPG utilisation with respect to adoption, sustained usage, fuel stacking, and the role of organizational facilitators. The study suggests other studies be conducted in other parts of the country, like areas in the Central Region and the Upper East Region, among others that have not been studied yet.
2. The study again assessed the role of organizational facilitators, limiting the study to gas marketers and regulators. The inclusion of other LPG stakeholders such as the Ministry of Energy, Ghana Standards Authority, Public Utilities Regulatory Commission and Environmental Protection Agency will provide additional insight and a better understanding of tax and subsidies, market

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development, regulation, legislation, standards, programs and policy mechanisms concerning LPG.

3. Lastly, the study employed descriptive statistics to measure variables towards the level of particular objectives under study. An incorporation of inferential statistics where the effects of various variables and hypotheses under study are tested would have enhanced explanations.

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APPENDICES

APPENDIX A

Krejcie and Morgan's Sample Size Determination Table

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357

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100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

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APPENDIX B

Questionnaire

QUESTIONNAIRE ON LPG UTILISATION IN GHANA: A COMPARATIVE STUDY OF AGONA NKWANTA AND SEKONDI IN THE WESTERN REGION.

Dear Sir/Madam,

This research instrument is designed to **assess LPG utilisation in Ghana: a comparative study of Agona Nkwanta and Sekondi in the Western region**. This is in partial fulfillment in the award of a Master's degree at the University of Cape Coast. **As a result, any information given would be treated with utmost confidentiality**. Please select the appropriate options for the questions by checking their corresponding boxes.

Section A: Background of respondents

1. Sex of respondent: [ ] Male [ ] Female
2. Age (years) of respondent: [ ] 18 - 28 [ ] 29 – 39 [ ] 40 –50 [ ] 51 – 61 [ ] Above 61
3. Level of education: [ ] 'O' Level [ ] SHS [ ] Diploma [ ] 1st Degree [ ] Postgraduate [ ] Professional [ ] Others [ ] Non-formal education
4. Years of stay in Area: [ ] Below 2 years [ ] 3 – 6 years [ ] 7 – 10 years [ ] 11 – 14years [ ] Above 14 years
5. Marital status: [ ] Married [ ] Single [ ] Divorced [ ] Widow/ widower

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6. Number of people in the household: [ ] below 2 [ ] 3-6 [ ] 7-10 [ ] 11 and above

7. Employment Status: [ ] artisans [ ] farmer [ ] trader [ ] fisherman [ ] clerics [ ] unemployed [ ]others

8. Level of Income: [ ] below 500 [ ] 600-1000 [ ] 1100- 2000 [ ] 2100 and above

9. Cylinder size: [ ] 3kg [ ] 6kg [ ] 14.5kg

Section B: Level of LPG Adoption

This section will look at the level of LPG Adoption in your household. It is further divided in two parts: Acceptance and Usage.

ACCEPTANCE

Please indicate the extent of your **agreement** with the following statements on a 5-point scale. (Please circle your answer) **Where 1 = Weak agreement and 5 = Very Strong agreement**

Trustworthiness						
Bt1	I find risks associated with LPG usage.					
Bt2	Adherence to safety measures will help mitigate the risk associated with using LPG.					
Bt3	LPG suppliers are consistent (without breaks) in the supply of LPG services.					
Bt4	LPG suppliers provide desirable and quality services.					
Bt5	Patronising LPG will help promote green investment and prevent negative effects of biomass on the environment.					

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Validity						
Bv1	Using LPG is the cheaper.	1	2	3	4	5
Bv2	Using LPG is safer.	1	2	3	4	5
Bv3	LPG is more efficient.	1	2	3	4	5
Bv4	LPG is cleaner.	1	2	3	4	5
Reliability						
Br1	I have adequate know-how with respect to the materials and components that make up the LPG cooking structure.					
Br2	I experience often defects with LPG and its associated components.					
Br3	My current household condition is favourable for LPG usage and storage.					
Br4	Using LPG offers value for money for my household.					

USAGE

Proximity						
BUp1	I have an LPG refill point of sale close to me hence no problem with refilling.					
BUp2	I have observed that LPG refill points of sale are at vantage points for quick and easy refill.					
BUp3	I have observed that LPG refill points of sale are adequate and enough to meet the LPG demands of inhabitants.					

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BUp4	Transporting LPG cylinder before and after a refill is simple.					
Technology Adaptation						
BUt1	I have the technical know-how in connecting and disconnecting the LPG cooking system so operation is not a problem.					
BUt2	In case of emergencies, my household is adequately equipped to respond before notifying authorities.					
BUt3	I use convenient devices (lighters, automatic turners) in my kitchen that facilitates in turning on/off the LPG stove.					
BUt4	I'm not scared of using LPG					
BUt5	I find the LPG cooking system simple.					
Initial Price						
BUpr 1	The initial cost (acquiring LPG stove, cylinder, filling and installation) is too expensive for me.					
BUpr 2	The cost of refilling LPG cylinders is too expensive for me.					
BUpr 3	Refilling LPG cylinder as and when it gets finished is a burden on my income as compared to traditional fuel mix.					

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Fuel stacking

This part of section B measures the level of fuel stacking in the household by seeking for opinion and experience on the main domestic fuels used in Ghanaian households with great emphasis on LPG. Indicate your level of knowledge by ticking your answer. Where; **1 Charcoal 2 Firewood 3 Kerosene 4 Electricity 5 LPG**

	STATEMENTS:	**1**	**2**	**3**	**4**	**5**
Part one (multiple selection)						
1	The fuel mix kept by my household are…					
Part two (single selection)						
2	The main source of fuel for my household out of the fuel mix chosen above is…					
3	The fuel that is most affordable for my household is…					
4	The fuel that is safest for my household is…					
5	The fuel that cooks fastest is…					
6	The fuel that is cleanest is…					

Section C: Level of LPG Sustained Usage.

This section will look at the level of LPG sustained usage in your household. It is further divided in two parts: Extent and Amount. The section seeks for opinion and experience with LPG usage. Please indicate the extent of your **agreement**

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with the following statements on a 5-point scale. (Please tick your answer) **Where 1 = Weak agreement and 5 = Very Strong agreement**

	STATEMENTS	1	2	3	4	5
	Culture					
CC1	I prefer LPG usage because it enables individualism over collectivism.					
CC2	I find LPG usage promoting a cultural shift from woman exclusive to man inclusive in cooking activities which is desirable.					
CC3	The type of food I cook doesn't affect the extent of LPG usage.					
CC4	I find cooking certain traditional dishes with LPG appropriate.					
CC5	LPG usage doesn't result in laziness.					
	Conformity					
CCn 1	My household uses LPG because of its popularity and not its benefits.					
CCn 2	My household uses LPG because it is applicable to our lifestyle and setting.					
CCn 3	I think that households that use LPG are well to do.					
CCn4	I don't really like LPG, I use it because a lot of my neighbours and friends are using it					

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CCn 5	I use it because a lot of my neighbours and friends are using it.					
	Frequency					
CF1	I have been using LPG for more than two years.					
CF2	My household always refill our LPG immediately it gets finished.					
CF3	I use only LPG throughout the year without any shift or switching.					
CF4	My household always have filled back-up cylinders to guard against emergencies.					
CF5	My household has more than one LPG equipment (cookstove, hose, and regulator) to guard against emergencies.					
	Final Price					
CP1	Refilling LPG continuously is a burden to my household.					
CP2	I don't factor LPG refill expenses in my budget.					
CP3	The cost of LPG maintenance is a burden.					

Section D: Challenges facing LPG Utilisation

This section will look at challenges facing LPG utilisation and seeks for opinion and experience on the challenges you encounter in the course of using

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LPG in Ghana. Please indicate the extent of your **agreement** with the following statements on a 3-point scale. (Please tick your answer) **Where 1 = Not significant, 2=Severe and 3= Very Severe.**

	STATEMENTS	**1**	**2**	**3**
CU1	Lack of funds for initial purchase of LPG components (cylinder and stove).			
CU2	High Cost of refilling gas cylinders.			
CU3	Inadequate number of Gas service stations			
CU4	Long distance of refilling stations.			
CU5	Fear of risks associated with using LPG (explosions, leakages and suffocating)			
CU6	Lack of technical know-how.			
CU7	Frequent scarcity of LPG.			
CU8	Preference for biomass.			
CU9	Unreliable supply of Gas.			
CU10	Not suitable for current kitchen condition.			

Thank you!

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Appendix C

Interview guide for LPG regulators (NPA and EC)

As part of my thesis to assess LPG utilisation in Ghana by conducting a comparative study in Agona Nkwanta and Sekondi, I am required to collect data towards this objective. In the course of data collection, questionnaires were administered to 390 households randomly selected in Agona Nkwanta and Sekondi. In effect, various managers of Gas service stations were interviewed. Several pertinent issues popped up as concerns that ought to be addressed to promote LPG usage. As a regulator and key stakeholder in LPG utilization, these areas need attention, hence probing questions will be asked on;

a. Escalation of Gas prices

- What account for persistent increase in Gas prices over the years?
- Researchers have pinpoint gas prices as main cause of slow uptake of LPG, this was evident in my data collection. What can NPA as a regulator do about it?

b. Quality of Gas

- Is there any variance between the local and foreign gas?
- Some customers and Gas filling stations have complained about Gas from Atuabo being less dense than the foreign gas which makes it inefficient. Can something be done about it?

c. Enforcement of Safety measures at Gas Service stations.

- How and how often do you check up on gas filling stations for enforcement of safety measures?

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- A lot of customers are not using LPG because of fear, what can be done about it?

d. Projects to promote Gas usage

- With the cylinder recirculation model coming up, what measures are being put in place by your organization as a regulator for downstream petroleum sector to ensure its effectiveness especially in rural areas where it is needed most?

- In the course of the research, it was discovered that a lot of customers especially in remote areas don't fill their cylinders fully, with the cylinder recirculation model coming up it is going to pose a big problem, what do you think can be done about this?

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Appendix D

Interview guide for LPG MC's

INTERVIEW GUIDE FOR GAS SUPPLIERS ON LPG UTILISATION IN GHANA: A COMPARATIVE STUDY OF AGONA NKWANTA AND SEKONDI IN THE WESTERN REGION.

This research instrument is designed to assess LPG utilisation in Ghana: a comparative study of Agona Nkwanta and Sekondi in the Western region. This is in partial fulfillment in the award of a Master's degree at the University of Cape Coast. As a result, any information given would be treated with utmost confidentiality. The interviewer will ask the respondent these questions and record response.

Section A: Background information

1. Sex of interviewee
2. Age of (years) of respondent
3. Level of education
4. Years of working experience with LPG
5. Years of company operation in that Area:
6. Marital status

Section B: LPG Adoption

Information (Demonstration of knowledge on LPG)

i. Why is LPG preferred as a cooking fuel in the home? [features/ benefits of LPG] Probe.

ii. What are some of the risks associated with using LPG? Probe.

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Trustworthiness

i. What measures have you put in place to help deal with the risk associated with LPG storage and marketing? [Probe]

ii. How do you conscientise your customers to adhere to safety measures in using LPG? [posters/ chats/inspection/query] Probe

Reliability

i. Aside sales of LPG, do u educate customers on the safer way to handle the components of LPG cooking system? Probe

ii. Are your customers safe at LPG service premises?

iii. What measures have you put in place to supply quality LPG to customers?

USAGE

i. Do you think the number of customers using LPG is increasing?

ii. Is there any evidence to back or refute your answer?

iii. What are the imitative (s) put in place to ensure continuous and constitute usage of LPG?

Proximity

i. How strategic is the citing of your LPG service company? [accessibility] Probe

ii. Is your LPG storage plant adequate and enough to meet the LPG demands of inhabitants?

Price

i. Do customers complain about LPG prices?

ii. Have prices been consistent over the last 5 years?

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iii. Does price of LPG usage have an impact on LPG usage or in turning customers towards alternative energy sources usage

Section B: Sustained Usage

i. How would you describe the LPG demand in the area? (peak periods)

ii. How many times do people averagely refill their cylinders a year?

iii. What challenges do you face in supplying LPG to customers?

iv. Are you aware that LPG service companies have a role to play in promoting LPG usage?

Challenges

i. What are some of the challenges customers face in using LPG, and how can you help ease some of them?

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