MECS Modern Energy Cooking Services

Ghana

MECS - Intention for change

The landscape of energy for cooking in Ghana: A review

Submitted By

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EXECUTIVE SUMMARY (ES)

ES 1: Introduction

Energy drives all human activities in all sectors worldwide. As of 2018, the household sector was the third-largest energy consumer after industry and transportation sectors globally. The narrative differs significantly in Ghana. The residential sector consumed nearly 42% of the total final energy supplied to the country in 2019, followed by the transportation sector (37%). Several household activities depend on energy. However, research and infrastructural investments have focused on cooking, heating, cooling, and lighting end-uses in recent years. Though lighting, cooling and heating end-uses have pushed the frontiers of technology towards finding sustainable energy supply sources like renewables and demand technologies like energy-efficient appliances and light bulbs, cooking end-use has become a source of global health crisis in the home, as well as other environmental concerns it presents. This is due to the over-reliance on biomass especially, in developing countries. Therefore, understanding the choices around cooking fuels in the household has received significant research and policy attention over the last couple of decades to help plan sustainable transition alternatives for this sector.

The purpose of this review is to unearth the empirical realities in terms of what is known and unknown regarding the dynamics of meal choices, cooking processes, cooking fuels and fuel combustion technologies in the Ghanaian household.

ES 2: Energy policy landscape in Ghana: The place of the household, gender, health and the environment

The energy landscape of Ghana, in terms of the final energy consumed, is dominated by petroleum products (47.6%), biomass (37.4%) and electricity (15%) as of 2019. The consumption of biomass fuel is estimated at around 20 million tonnes annually by the household sector, with the supply mainly coming from the natural forest. Liquefied Petroleum Gas (LPG) is consumed mainly in urban households, with the supply coming from local and foreign sources and the latter source being dominant. Electricity is the least used fuel for cooking for various reasons; the supply is mainly from domestic power generation plants. By the end of 2019, a total of 18,189 GWh of electricity was generated by the various installed power generation plants in Ghana. Power generated from 14 installed thermal plants dominated the generation mix at nearly 60% for Ghana, while the shares of the hydro and renewables plants stood at 39.9% and 0.3%, respectively as of 2019. The energy sector policies reviewed have fairly covered issues around cooking fuels. However, the 2010 National Energy Policy (NEP) and the 2010 Energy Sector Strategy and Development Plan (ESSDP) are the two documents that extensively outlined specific goals and measures for the cooking end-use. Specific to sustainable cooking fuels, the NEP seeks to promote the production and use of improved and more efficient biomass utilization technologies and alternative fuels like LPG as substitutes for biomass fuels. The ESSDP, which is the implementation pathway document, revealed that the country sought to increase access to LPG from 6% as of 2010 to 50% by 2015. This 2015 target for LPG was missed as only 22.3% of Ghanaian households had access to LPG for cooking as of 2017. The SEforAll initiative targets the biomass and LPG sectors. The 2015 SE4All Agenda sought to ensure that all households using biomass fuels will adopt improved energy saving cookstoves by 2020.

Additionally, it sought to ensure the transition of 50% of households to the use of LPG as their primary cooking fuel by 2020. By 2017, only 24.7% of households in Ghana who use biomass fuel were using improved cookstoves, and only 22.3% of households were using LPG as their primary cooking fuel. Clearly, biomass and LPG fuels received the most coverage in the policy space, with little to no attention paid to electricity and biogas for cooking.

In terms of implementation effectiveness, there is still a long way from achieving the policy goals and targets. There are some notable initiatives, nonetheless. The promotion of improved biomass cookstoves has received considerable attention through support from international and local NGOs, development and research institutions, as well as government agencies. Initiatives such as the implementation of the LPG cylinder recirculation model (CRM), Ghana LPG promotion programme, and introduction of subsidies on LPG have been implemented to increase the adoption of LPG. Also, emphasis has been placed on the health and livelihood effects of biomass fuel consumption on women and children and the importance of sustainability in the energy mix.

ES 3: Cooking in the Ghanaian household: Understanding the related national markets of fuels and technologies.

Approximately 67% of households in Ghana use polluting fuels as their main cooking fuels together with traditional cookstoves as of 2016/2017 according to Ghana Living Standards Survey Seven (GLSS 7). These are mainly firewood (33.3%) and charcoal (34.1%). Firewood is predominant in the rural areas (63%), while charcoal (44.3%) and LPG (34.8%) dominate in the urban areas as the main cooking fuels. Less than 1% of households in Ghana use electricity as their main fuel source for cooking as of 2017. It is safe to say that many households use multiple fuels or technologies for cooking (a phenomenon termed “fuel/stove stacking”). The particular mix of fuels and technologies that are used differ from household to household based on geography and the available resources. Consumers are familiar with a broad range of cooking options for each fuel type. The charcoal cookstove market is dominated by traditional coal pots and ‘Gyapas’, while the 4-burner stove with oven is very popular among the users of LPG. The woodstove segment is still largely dominated by 3-stone hearths, although some alternatives such as tire-rims and clay stoves and the well-improved wood stove like Philips and ‘Envirofit’ wood stoves exist.

The biomass fuel market is highly informal. Private players dominate the supply chains of biomass fuels. Charcoal production is undertaken by groups of landless labourers using the “cut-and-burn” system. They usually produce an average of 10-15 bags of charcoal in a week, which are collected by the first layer of middlemen that are responsible for getting the bags to accessible roads. The net consumers of charcoal are the coastal regions, especially urban households. Fuelwoods are easily accessed by household members, especially women and children in the nearby bush or sometimes from distant farmland. But some private players produce and deliver firewood in bundles. Over the past two decades, there have been efforts to introduce and promote the adoption of improved and energy-efficient firewood and charcoal stoves in Ghana. The improved cookstove market of Ghana is currently dominated by ceramic lined charcoal stove and non-ceramic lined charcoal stove products.

LPG is currently distributed by about 42 LPG marketing companies to about 641 gas refilling stations across the country. These refilling stations serve customers who carry their empty cylinders to the gas refilling stations to get them refilled. Ghana is attempting to move towards the branded cylinder recirculation model, an approach in which cylinders are no longer owned by the customers but owned

by the LPG marketing companies to improve cylinder inspection, maintenance and overall safety. This model was initiated following the various LPG explosions that occurred in the country in the recent past. Regarding LPG indigenous production output from Ghana's Oil Refinery at Tema, with a capacity to produce 45000 barrels a day, has performed below capacity for decades, reportedly due to underinvestment, lack of maintenance and debt. Nevertheless, the government of Ghana has established the Ghana Cylinder Manufacturing Company and Sigma Gas Ghana, as well as three refilling stations in the coastal and northern areas around the 2000s to promote easy access to LPG in the country.

The continuous production of charcoal, which farmers see as a form of insurance to crop failure, cost (affordability), safety issues, non-availability of spare parts on the open market to replace broken stove accessories, stove suitability (particularly the size), household size and the lack of awareness of the environmental and health benefits, have been identified as potential barriers to the acceptance and adoption of clean cooking fuels and technologies in Ghana.

ES 4: Cooking practices in Ghana: Understanding the choices of different classes of households.

Households in Ghana consume wide varieties of staple foods, with some common similarities among certain groups, but others are native to specific groups of people. Households in Ghana generally adopt different cooking fuels, cooking methods and conversion technologies (stoves) based on fuel availability and affordability, staple food, and household sizes. The fuels used for cooking in Ghana are woodfuel (firewood), charcoal, LPG, and electricity using cooking devices including metal coal pot, three-stone open fire stove, improved cookstoves, and electric stoves and local and foreign-made LPG burners. Also, the practices of fuel stacking by households have been observed in Ghana, especially in the northern regions. The method of cooking, the quantity of food, the type of cooking activity, and the taste of food are some of the reasons associated with the practice of fuel stacking. The staple foods consumed by households are influenced by geographical location, type of food crop cultivated, and cultural and traditional practices. Documentations on the gender perspectives of cooking fuels' choices and foods cooked in the household have received little attention in the literature.

Income plays a major role in household cooking fuel and food decisions. Almost half (42.7%) of the household income is spent on food, unlike cooking fuels. The cost and benefits identified with types of cooking fuels determine the choice of the fuel. For instance, biomass fuels are the most adopted fuel type because of affordability, accessibility and availability despite the health hazards associated with their usage. LPG, which has a lot of benefits, especially convenience, is used mostly by urban households.

ES 5: Opportunities for cooking with electricity in Ghana

While 85% of the Ghanaian population has access to electricity, more than 70% still cook with biomass fuels. Specifically, household survey data show that less than 1% cook with electricity, although this is the cleanest way to cook with minimal negative impacts on cook's health and household air pollution. More interestingly, the country has a surplus of more than 30% peak generating capacity on the grid which can be taken up by households if electricity is promoted as a clean affordable option. Preliminary analysis based on the price of charcoal, LPG and the price of

electricity per kWh suggests that Ghanaian households could save 30-40% of fuel costs by switching to fully electric cooking with energy-efficient appliances. However, given Ghana's focus on LPG, promoting a clean fuel stack with LPG and electricity seems a more viable pathway and mitigates the risks of relying on one fuel source. Of course, these cost calculations do not price in the additional health benefits, convenience and time savings associated with electric cooking, with energy-efficient appliances. Electric cooking is currently not on the radar for most actors in the energy sector in Ghana, however looking at the electricity access, supply, and demand context in Ghana, there seems to be a good case for further investigation of electricity as a compliment to the government's existing push to increase LPG use in the population. Further work would need to explore the compatibility of Ghanian cuisine with modern energy-efficient appliances and explore how these new cooking devices might fit into the fuel stacks of modern Ghanaian households. Further analysis would need to evaluate the supply chain for these new appliances and explore potential delivery models that offer consumer financing developed in order to make electric cooking and the associated longer-term savings accessible to lower income households.

ES 6: Conclusion

The market for modern energy cooking services is not fully developed but can be described as one that is developing. The various energy policies reviewed concentrate more on promoting sustainable consumption of the traditional solid fuels (charcoal and firewood) than pushing for the transition towards modern cooking fuels like electricity and biogas. There are measures in the policy instruments promoting LPG as an alternative cooking fuel to traditional solid fuels, but the same cannot be said about electricity and biogas fuels.

Additionally, the potentials and the benefits of modern cooking fuels like electricity and biogas have not been extensively documented. The public, therefore, knows little about the many benefits of using these fuel sources for cooking. The lack of awareness coupled with the perceived high cost, unsuitable appliance designs and the continuous support given to traditional fuel systems have inhibited the development and adoption of modern cooking fuel services in Ghana.

It is important that government takes pragmatic steps to develop strategies to promote electricity and biogas as effective modern cooking fuels to support the achievement of the Sustainable Development Goal 7 target of ensuring universal access to affordable, reliable and modern energy services by 2030. The lack of documentation on the high potential on the use of electricity to cook, also presents an opportunity to investigate the dynamics around it, including exploring what people think and believe about electricity for cooking, the misconceptions and the unverifiable views and opinions about this fuel. Finally, interested stakeholders including the government will have to create more awareness amongst the wider population across the country in order to motivate households on the use of this clean cooking fuel source.

1 INTRODUCTION

1.1 Background

The importance of energy to the human society cannot be over emphasized as all human activities are driven by energy in different forms, types and structures. The household sector is the third largest consumer of energy globally as of 2018 after industry and transportation sectors (IEA, 2019). The sector, together with the commercial sector, is responsible for 20 percent of the world's energy consumption in 2018 and is expected to reach about 22% in 2050 (IEA, 2019). At national levels, the narrative may be different from the global picture. Of the total 11,052.8 kilotonnes of oil equivalent (Ktoe) final energy supplied to the Ghanaian economy in 2019, the residential sector consumed 43% followed by the transport sector (37%) and industry sector -13% (Energy Commission, 2020). The household sector attracts lots of attention from researchers, national and international organization due to the consumption of different types of fuels such as electricity, petroleum products like natural and liquefied petroleum gas, and biomass fuels like charcoals and woodfuel. On the bases of the supply and demand dynamics of the different fuels used in the household sector coupled with the socio-economic as well as environmental implications of the use of such fuels, the household energy landscape has become a heavily researched field over the past three decades.

Several household activities depend on energy, but recent research and infrastructural investments have focused on four major energy end-uses, namely cooking, heating, cooling and lighting. Cooling, heating and lighting end-uses are driven by technology advancement in terms of electricity infrastructure and electrical appliances (IEA, 2011). For instance, large scale use of fossil fuels and hydro-power technologies have long symbolised modernity and industrialization (Özçatalbaş & Imran, 2016). Electric power generated from these sources has become crucial element for all social and economic activities in the modern civilizations. As air conditioning in household and commercial buildings transition from being a luxury activity for only a select few to a necessary activity for a majority of people, the demand for electric power has also increased (Ürge-Vorsatz, 2015; Cabeza et al., 2014). This increased demand coupled with electricity wastage has fuelled further explorations in new frontiers of energy systems and energy efficiency technologies such as energy saving bulbs, energy efficient air conditioners and refrigerators (IEA, 2019).

Cooking energy end-use, however, presents a far greater concern to the world. Nearly 3 billion of the world's poorest people (mainly from low- and middle-income countries) rely heavily on solid fuels like wood, charcoal, crop wastes and animal dung for their cooking and heating needs (WHO, 2018; 2016). These fuels have as much destructive potency as fossil fuels in driving climate change; the biggest challenge for the world in present time (Özçatalbaş & Imran, 2016, Kaygusuz, 2010). Aside the environmental dangers these cooking fuels pose, they are responsible for some 4 million premature deaths annually among children and adults from respiratory and cardiovascular diseases and lung cancer due to their high levels of pollution (WHO, 2014). Household air pollution (HAP) was responsible for nearly 7% of the global disease burden as of 2018 and has been classified globally among the most important environmental health risk factors today (WHO, 2018; 2014). Women and children are particularly exposed to high risk of burns and injuries from the gathering, production and use of these solid fuels as well as poisoning from kerosene, a type of energy WHO frowns upon (WHO, 2016; 2014).

The over reliance on biomass for cooking and heating presents as much socio-economic and environmental concerns to Ghana as any other developing country especially, in sub-Saharan Africa

(SSA). The consumption of biomass (wood and charcoal) for cooking in Ghana dropped from 72.8% in the 2012/2013 period to 67% in the 2016/2017 period (Ghana Statistics Service, 2019; 2014). Though an encouraging downturn, biomass use especially in the rural part of Ghana is still significantly high and among the highest in the SSA region (GSS, 2019). The GSS recommended that alternative cooking fuel sources such as liquefied petroleum gas (LPG) and biogas are needed as a control measure to avoid devastating environmental degradation resulting from the over reliance on biomass cooking fuels (GSS, 2019).

Policy implementation gaps, resulting from lack of political will as well as public misconceptions have been some of the factors slowing down the transition to the use of modern cooking fuels in the Ghanaian household, especially electricity. The use of LPG as the main cooking fuel increased from 22.3% in the 2012/2013 period to 24.5% in the 2016/2017 period. This represents a mere 2.2 percentage point increment over the 2013-2017 period. The share of households using electricity as their main cooking fuel however remains the same at 0.3% from 2005 to 2017 (Energy Commission, 2020; GSS, 2019; 2014; 2008). Currently, in Ghana, the extent of the awareness level of households regarding modern energy cooking services is not fully understood. More so, the factors that determine the choice of food, cooking habits and cooking fuels can be understood from exploring the existing literature.

The purpose of this review is to unearth the empirical realities regarding the dynamics of meal choices, cooking processes, cooking fuels and fuel combustion technologies in the Ghanaian household. Specifically, the review seeks to explore these main questions by reviewing the empirical evidence uncovered by other researchers on the subject. The following questions give context to the review work.

- What is the place of the household, gender, health and the environment in the energy policy landscape of Ghana?
- What do we know about the market segmentations of fuels and fuel combustion technologies with respect to cooking in the Ghanaian household?
- What do we know about the choices of different classes of households in terms of cooking practices in Ghana?
- What opportunities exist to promote cooking with electricity in Ghana?

These questions are explored more comprehensively in the sections following the introductory, methodological and the contextualisation sections. The methodological processes involved in the development of the review are documented in Section Two. Section Three situates the review in the appropriate context of energy for cooking. In this section, the relevant propositions that put the review in the context of energy for cooking and the socio-economic and environmental implications are discussed. The energy policy landscape in Ghana that reveals the place of the household, gender, health and the environment are discussed in Section Four. In Section Five, relevant literature sources are reviewed to understand nationally, the market segmentations of fuels and fuel combustion technologies with respect to cooking in the Ghanaian household. Section Six discusses pieces of evidence on the choices of different classes of households with respect to cooking practices in Ghana, while Section Seven unpacks the opportunities that can foster the promotion of e-cook interventions in Ghana. The final section summarizes and concludes the review.

2 REVIEW METHODOLOGY

Section Objectives: This section seeks to highlight

- The main review procedure used for the review
- Procedures used for sampling materials
- Type of materials used for review
- Sources of materials

2.1 Introduction

The processes involved in the development of the review are discussed in this section. The section also sets the parameters for the review by clearly defining the scope, depth and boundaries of the review.

2.2 Methods

Desktop review techniques were employed to analyse the contents of selected empirical studies and technical reports/documents in the following areas: household cooking fuels, choices around food and cooking fuel decisions, gender dimensions of cooking fuels decision making in the household and policies on household cooking fuels in Ghana. These areas are basically the key search phrases used in various search engines and databases to identify relevant articles for the review. Over 100 online databases registered on the University of Ghana online library system were scouted for relevant articles for the review.

Desktop review is an effective technique (Snyder, 2019) that has been widely used to access, select (sample) and analyse relevant empirical studies on interested subjects. It is a technique that suits the purpose of the review to draw out evidence on policy considerations for household cooking fuels and the corresponding gender implications, the choice of food types prepared, and cooking fuels preferred in the household as well as the market dynamics of the different fuels demanded by the household in the urban space in Ghana.

2.3 Sampling and types of review materials

The main selection criteria used to sample the materials for the review is relevance. The fact that a particular material could enrich and add value to the review discussion was the first and most important criteria considered for sampling materials for the review. Once the authors considered the material as relevant, other features of the material count as secondary issues but not completely ignored. The period of publication was next considered for the selection of the materials. This criterion was important to ensure that aside relevance, recent materials produced particularly in the 2010-2019 period on the cooking fuel discourse received as much consideration as possible to reflect recent trends and dynamics in the energy market. Finally, the review also prioritised materials published in the English Language for easy understanding and analysis.

Based on these selection criteria, the review considered peer-reviewed journal articles, government and non-governmental technical reports as well as international conference materials on energy in general and cooking fuels particularly in Ghana.

2.4 Profile of review materials

An inventory of materials reviewed was compiled regarding the main themes of the review work. This entailed counting the materials/studies reviewed on the energy policy landscape in Ghana, market landscape of cooking fuels and technologies in the Ghanaian households, and cooking practices in Ghana. The purpose of the profiling was to assess the extent to which these themes have been researched and documented in Ghana. Table 2.1 presents the profiling of the reviewed materials under the various themes.

Table 2.1 Inventory of the reviewed materials according to the themes and types of materials

Themes	Extent of coverage (Number of research materials found)				Remarks
	Peer-reviewed journal articles	Government technical reports	Non-Government technical reports	Other	
Energy policy landscape in Ghana: the place of the household, gender, health and the environment	2	10	-	-	Documentation on energy policy is predominantly at government level. Few peer-reviewed journal articles have digested and reviewed national energy policies.
Cooking in the Ghanaian household: Understanding the market segmentations of fuels and technologies	9	5	8	-	There is fair amount of documentation on market segmentations of fuels and technologies in Ghana.
Cooking practices in Ghana: Understanding the choices of different classes of households	43	2	2	1	Issues of cooking practices and the choices households make have been well researched. A lot of the documentations

					are peer-reviewed materials.

Source: Authors' construct

2.5 Section Summary

The review employed desktop review techniques to understand the landscape of energy for cooking in Ghana. The materials used for the review were selected based on their relevance and period of publication (recent publications) with priority given to materials published in English Language. The types of materials considered varied from peer-reviewed journal articles to government and non-government related technical reports. In all, about 12 materials were reviewed to understand the energy policy landscape in Ghana, with critical focus placed on unearthing the place of the household, gender, health and the environment. About 22 materials were reviewed to understand the related national market landscape or 'marketscape' of fuels and technologies in regard to cooking in the Ghanaian household. Finally, about 48 materials were studied to understand the choices of different classes of households with respect to cooking practices in Ghana. The general notion is that, energy and related policies with significant considerations for the household, gender, health and the environment have received just a fair coverage in the literature while the dynamics of the national 'marketscape' for fuel and the combustion technologies as well as the choices concerning cooking practices in Ghana have been well documented.

3 CONTEXTUALIZATION OF ENERGY FOR COOKING

Section objectives: This section seeks to provide evidence on

- The importance of energy to all demand sectors including the household sector
- The contextualization of how energy affects household production and productivity (bringing issues of gender into perspective)
- Global, SSA and Ghana shares of energy consumed by the household sector and specifically, the share of total final energy consumed by cooking end-use
- How Goal 7 of the Sustainable Development Goals (SDGs) is linked to other SDGs
- How other local contents with respect to energy serve the cooking needs of the Ghanaian households.

3.1 Introduction

In this section, relevant documents are reviewed to establish the contextual linkages between cooking energy and households' socio-economic and environmental characteristics. Establishing these linkages ensured that the objectives stated above were achieved. These relationships are discussed in the subsequent sub-sections.

3.2 Global overview of energy for the household sector

Energy continues to play a pivotal role in the production and distribution activities of every sector across the globe. Its influence cannot be over emphasised, as all activities from production of goods and services to their distribution to the final consumers all require substantial amount of one or multi-forms of energy. This implies that energy is central to all major opportunities and challenges that the world faces today including jobs, productivity, welfare, security, access to energy for all, access to clean energy, climate change, good health and mobility (United Nations, 2018). Accordingly, the United Nations through a global consensus by countries, has set a target to ensure universal access to affordable, reliable and modern energy services by 2030. This target is to be achieved through increasing significantly, the proportion of the population with access to electricity and the proportion of the population with primary reliance on clean fuels and technology (UN, 2018).

As cities urbanise, expand and modernise, the pattern of residential fuel consumption shifts from biomass to kerosene, coal and ultimately to 'modern fuel' – LPG and electricity (Barnes, Krutilla & Hyde, 2005). The world is increasingly concerned about the types of fuels consumed by the household sector in 'undeveloped cities' and villages for two main reasons: environmental and health issues of users.

For environmental concerns, specifically climate change issues have bedevilled the world in the last couple of years. In consequence, there is a global alliance to move away from fossil-fuel powered electricity to renewable led electricity. The world wants to see a substantial increase in the share of renewable energy in the global energy mix by 2030 (UN, 2018). In the electricity sector, the global share of renewable energy in the total final energy consumption increased from 17.7% in 2010 to 24.7% in 2017. This significant jump is driven by the renewable energy technology adoption rate in the developed world and the Asian Tigers led by China. Unsurprisingly, though access to electricity

reached 90% in 2018, the biggest deficits are still concentrated in SSA, with nearly 548 million people living without electricity (UN, 2018).

The lack of clean cooking fuels in most parts of the developing world has created both environmental and health concerns over the years. Though the proportion of the global population with access to clean cooking fuel and technologies have seen a slow progress from 56% in 2010 to 63% in 2018, approximately 2.8 billion people worldwide remain without access (UN, 2018). From Modern Energy Cooking Services (MECS) perspective, four billion people around the world still lack access to clean, efficient, convenient, safe, reliable, and affordable cooking energy.[1] Traditional cooking fuels used mainly in developing countries coupled with the slow adoption rate of efficient technologies present diverse challenges that are discussed in the subsequent sub-sections.

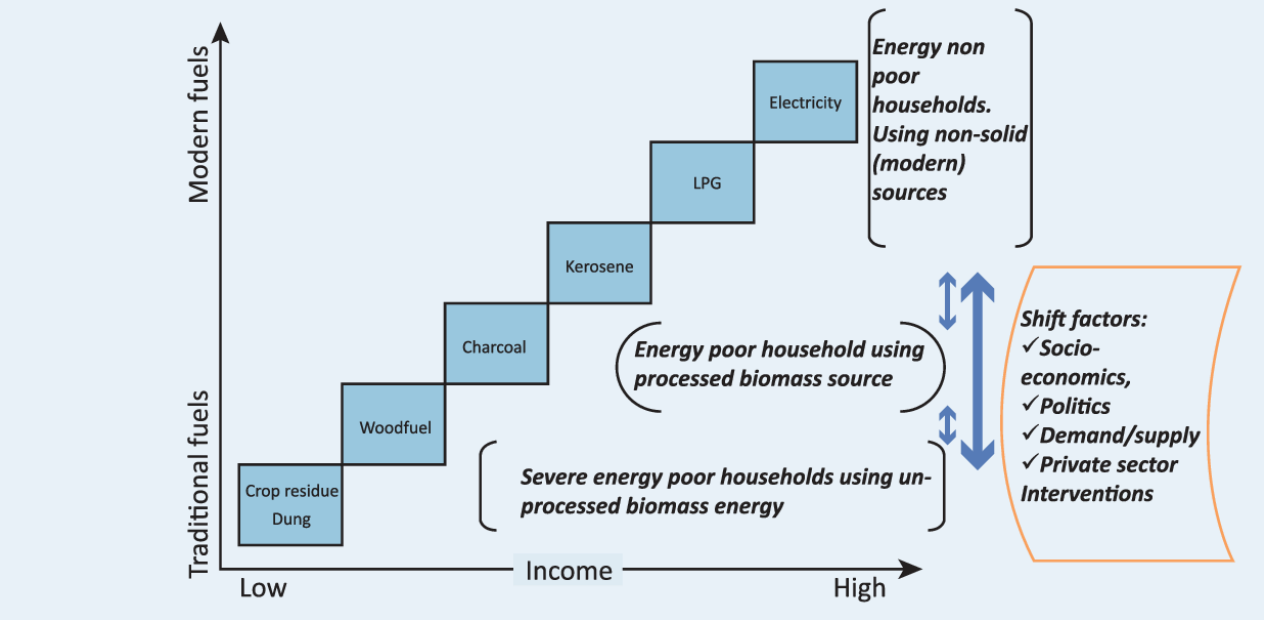
3.3 Cooking fuels and vulnerable groups

Vulnerability in the household is strongly correlated with forms of energy used by the household. The less vulnerable are thought to consume more modern fuels while the more vulnerable groups depend much more on traditional fuels, encapsulated by the energy transition theory or energy ladder framework (Figure 3.1). The energy ladder framework hypothesises that as the economic status of households improve, they tend to consume more sophisticated fuels (Hiemstra-Van der Horst & Hovorka, 2008; Hosier & Dowd 1987). Following this framework therefore, households will shift from the use of crop residue and animal dung to woodfuel, charcoal, kerosene, LPG and finally electricity as their income increases. Continuously, poor households are therefore left with little or no choice of shifting up the ladder to modern fuels like LPG and electricity. Instead, they continually use traditional solid fuels such as woodfuel and charcoal by necessity rather than by choice (Hiemstra-Van der Horst & Hovorka, 2008; Barnes, Krutilla & Hyde, 2005).

Several research findings have been consistent with the hypothesis thus far, with the general revelation suggesting that household switch to the consumption of LPG and electricity for cooking as they become economically prosperous. But more importantly, not only economic characteristics but social, government and private sector interventions, demand and supply dynamics all play significant roles in shaping households' movements along the cooking fuel ladder (Mwaura, Okoboi & Ahaibwe, 2014; Hiemstra-Van der Horst & Hovorka, 2008).

[1] https://www.esmap.org/the-state-of-access-to-modern-energy-cooking-services

Figure 3.1 Fuel transition conceptual framework



Source: Hiemstra-Van der Horst and Hovorka (2008)

Other vulnerable groups that are affected by the energy decisions and the forms of energy consumed by the households especially, in the developing world are women and children. These vulnerable groups bear the heaviest brunt of polluting and inefficient cooking systems because they are the backbone of the households' cooking system and end up breathing in smoke from these systems (Das, Pradhan & Nonhebel, 2019; WHO, 2016). In developing countries where 60% of the population depend on solid fuels, women and girls play significant roles in cooking fuel decision making because they make or collect most of the fuel (Shailaja, 2000). Their ultimate preference is woodfuel for cooking especially in the rural areas since it is easily accessible with nearly zero economic cost. The penultimate is charcoal whose production heavily requires men. Based on the risks associated with gathering the solid fuels and cooking, most of them face hazards including burns, injuries, poisoning, cataracts to chronic headaches and respiratory diseases. Particularly for the girl-child these risks significantly constraint her in terms of her available time for education, rest and productive ventures for income generation. National time-use survey report from three ECOWAS member countries reveal that women from poor households spend between 2-35 minutes more on cooking per day.[2]

3.4 Cooking fuels and health

The World Health Organization (WHO) assessed that cooking end-use has become a source of global health crisis in the home. By 2016, the WHO estimated that nearly half of humanity (about 3 billion people) depended on solid fuels like charcoal and woodfuel they have gathered from their immediate environment or purchased with scarce income (WHO, 2016). Fast forward to 2020, four billion

[2] https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/ECOWAS_Policy_for_Gender_Mainstreaming_in_Energy_Access.pdf

people worldwide are reported to lack access to clean, efficient, convenient, safe, reliable, and affordable cooking energy according to the World Bank, ESMAP and MECS (Energy Sector Management Assistance Program –ESMAP-, 2020). The solid fuels, which are often burnt in inefficient stoves for cooking and heating purposes have turned the home, which is supposed to be a place of safety and refuge, into one of the most health-damaging environments (WHO, 2016).

The burning of solid fuels like biomass and coal for cooking and heating purposes in traditional cooking stoves and open fires produce large quantities of dangerous pollutants ranging from carbon monoxide (CO) and particulate matter (PM) to volatile organic compounds. In dwellings with poor ventilation, emissions of these pollutants can reach 100 times the levels recommended as safe by the WHO 'Indoor Air Quality guidelines' (WHO, 2014). This singular act of pollution termed household air pollution (HAP) in the literature is the single largest environmental risk factor for health worldwide and, this is thought to have been responsible for about 3.8 million premature deaths in 2018.[3] For many of the people continuously exposed to HAP, the consumption of these solid fuels is by necessity as it is a means to survival rather than preference based on the availability of choices. The consumption of these traditional polluting fuels using the inefficient stoves also perpetuates the incidence of poverty amongst these households as it creates unsustainable health burdens on the households. As mentioned in the preceding sub-section, women and children are the most vulnerable when it comes to the burdens exerted by the widespread dependence on these polluting fuels in the developing world.

3.5 Cooking fuels and the environment

Household fuel combustion is a significant source of carbon emissions into the atmosphere that adds to the greenhouse gases responsible for climate change extreme events that disrupt regional environmental systems critical to human welfare. For this reason, measures to reduce household air pollution present an unrivalled opportunity to realise climate and health co-benefits.

Household cooking fuel combustion is thought to produce 25% of global emissions of black carbon, the second largest contributor to climate change after carbon dioxide (CO_2) (WHO, 2016). Black carbon absorbs a million times more energy per unit mass than CO_2 but exerts its impacts over a shorter period relatively and these impacts are especially magnified on a regional scale in areas close to the source of emissions (WHO, 2016). Because of its short lifespan in the atmosphere, reducing black carbon emissions can lead to immediate slowing of global warming. More than 80% of all black carbon emissions from household combustion come from developing countries (WHO, 2016).

In addition to the emissions, household cooking fuels also cause further environmental damage that exacerbates the global climate change menace. According to the International Energy Agency (IEA), more than half of all wood harvested globally is used for fuel (IEA, 2019). Generally, woodfuels are harvested from nearby non-forest areas by rural folks at almost zero cost. Out of the rural areas towards peri-urban and urban areas, collecting and selling of woodfuel is an economic livelihood activity for a significant proportion of people. Aside gathering deadwoods, this category of woodfuel dependent people cut down trees from shrub and woodlands to forest areas for sale in local markets. These activities certainly contribute to global widespread deforestation particularly, in woodfuel

[3] https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health

dependent regions like Asia and Africa. Consequently, many ecosystems and wildlife habitats are disrupted on a large scale around the globe.

Charcoal is an important fuel in the household's cooking fuel mix in most developing countries because it features prominently in the cooking fuels used in the urban areas. Its production, however, presents a far greater environmental risk than woodfuel because it involves a grossly inefficient production process. It is produced through the chemical transformation of biomass in a process called pyrolysis or carbonization. This chemical transformation is carried out in the absence of air, thereby breaking down the biomass into its elemental components rather than burning it completely. Because the common raw material often used is wood harvested through clear felling, selective cutting or from grown plantation, unsustainable charcoal production process contributes significantly to deforestation (NL Agency, 2010). As of now, the charcoal production technology in most developing countries especially, in SSA is raw and crude mostly in the form of earthly mound kilns. These technologies have efficiency rates of around 13% to 15% (FAO, 2017). Based on these low recovery rates, Naughtons-Treves et al. (2007) estimated that the production of 50 tonnes of charcoal from hardwood may require the clearance of 1 square kilometre of forest cover.

3.6 Section Summary

Energy is fundamental to all activities and sectors in every economy globally. The household sector has particularly attracted attention in recent times due to the types of fuel and the impacts on the users and the environment. Lots of poor households in developing countries are trapped in energy poverty confined to the consumption of solid biomass like crop residue and animal dung, woodfuel and charcoal. While their economic status influences these fuel choices, the fuel types consumed in turn contribute highly to their economic status. The heaviest burdens are borne by women and girls who spend considerable amount of time and efforts in the production, use and management of these solid fuels.

Cooking fuels present health and environmental issues that concern the world. Household air pollution is the single largest environmental risk factor for health worldwide, as it is responsible for nearly 5% of the global disease burden. Household cooking fuel combustion is also responsible for 25% of global emissions of black carbon, the second largest contributor to climate change after carbon dioxide. Additionally, the unsustainable harvesting, production and consumption of solid fuels especially in developing countries have caused considerable loss to the world's natural forest cover in an alarming rate over the past couple of decades.

4 GHANA'S ENERGY POLICY LANDSCAPE: THE PLACE OF THE HOUSEHOLD, GENDER, HEALTH AND THE ENVIRONMENT

Section Objectives: This section seeks to provide evidence on

- The importance of energy to all demand sectors including the household sector
- The contextualization of how energy affects household production and productivity (bringing issues of gender into perspective)
- Global, SSA and Ghana shares of energy consumed by the household sector and specifically, the share of total final energy consumed by cooking end-use
- How Goal 7 of the Sustainable Development Goals (SDGs) is linked to other SDGs
- How other local contents with respect to energy serve the cooking needs of Ghanaian households.

4.1 Introduction

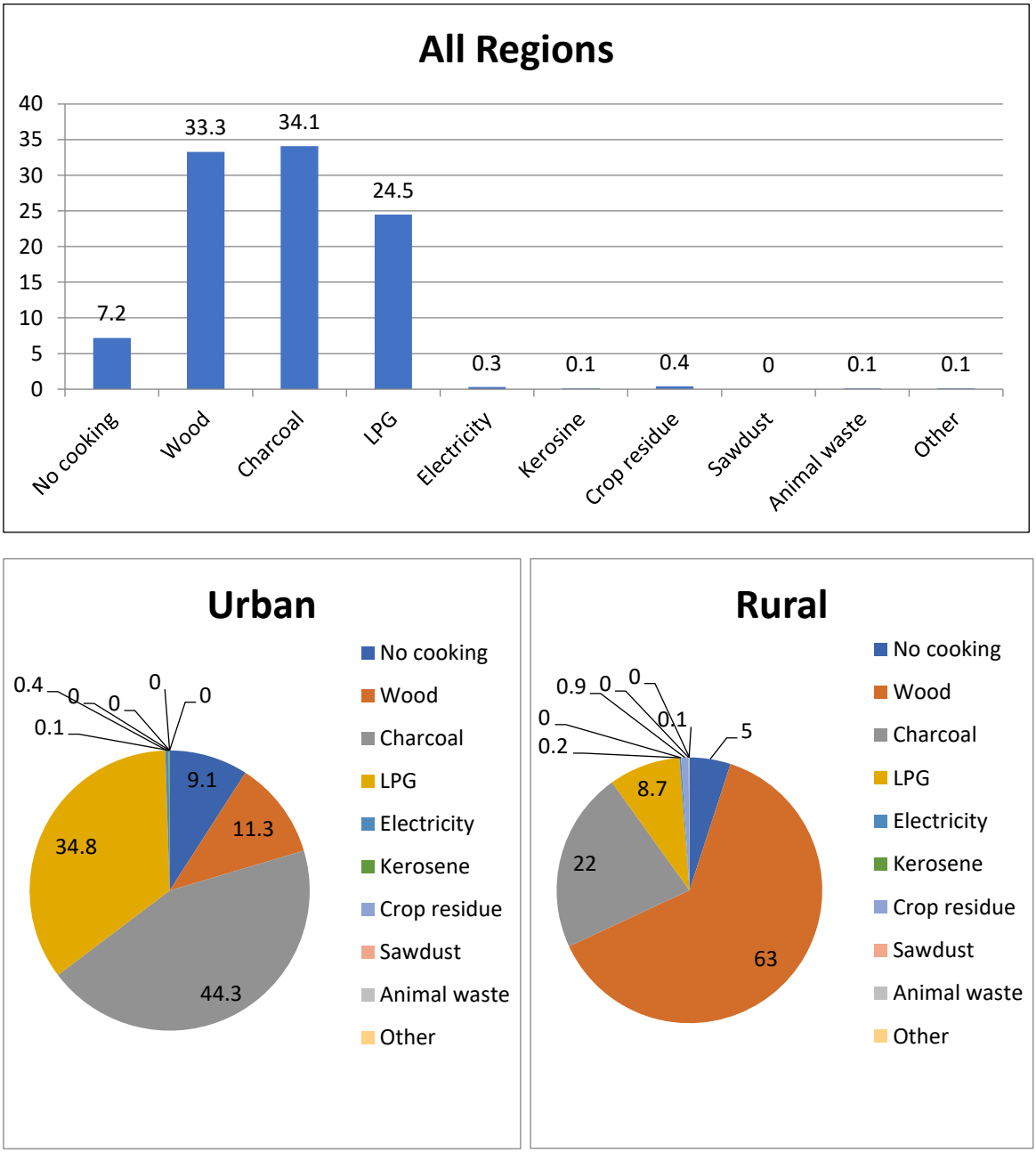
This section reviews the various energy policies and related policies in Ghana in relation to energy cooking services. Policies generally drive actions and activities of an intended sector towards the achievement of a set of goals and objectives. The focus of this section is to review energy and environmental policies in Ghana looking specifically at the policy targets and strategies on cooking energy in the household. The review assesses how extensively cooking energy issues have featured in the national energy and environmental policies over the years and how effectively the strategies have been implemented to meet the set goals. The review therefore proceeds by looking at the general state of demand and supply of cooking fuels in Ghana before critically assessing the cooking energy services in the various energy and environmental policies in Ghana. Gender perspectives and sustainability issues captured in the policies are also discussed in addition to the various initiatives undertaken in relation to the policies, their implementations and successes. Finally, action gaps in sustainable energy transitions are identified and discussed.

4.2 Demand and supply of cooking fuels in Ghana

Biomass constitutes the second largest (37.4%) final energy consumed in Ghana as at 2019 after petroleum products (47.6%), with electricity placing third (15%) (Energy Commission, 2020). However, biomass i.e. firewood and charcoal are the most utilised sources of cooking fuel by the household sector in Ghana (Energy Commission, 2019b). Firewood dominates the cooking fuel landscape of Ghana followed by charcoal, and Liquefied Petroleum Gas (LPG). The consumption of woodfuels alone in Ghana amounts to about 20 million tonnes annually. Accordingly, 67.4% of households in both urban and rural Ghana depend on biomass as their main fuel for cooking (GSS, 2019). An estimated 63% of households in rural Ghana rely on fuelwood for cooking whereas 44.3% of households in urban Ghana also rely on charcoal for cooking, with traditional woodfuel and charcoal cookstoves being the main stoves in use (GSS, 2019 ; Energy Commission, 2019b). The use of LPG dominates in urban households, with 34.8% of urban households using LPG for cooking compared to 8.7% of rural households that use LPG for cooking. Electricity, however, is the least

utilised form of cooking fuel, with less than 1 percent of Ghanaian households using electricity for cooking (GSS, 2019).

Figure 4.1 Main fuel used by the household for cooking in Ghana (percent)



Source: GSS (2019)

According to a report by the Energy Commission of Ghana, about 90% of woodfuels are supplied from the natural forests in the transition and savannah zones of Ghana and mainly from Kintampo, Nkoranza, Wenchi, Afram Plains, and Damongo districts whereas, the other 10% are obtained from wood waste from logging, sawmill residue and planted forests (Energy Commission, 2012). LPG is sourced locally and internationally. The Tema Oil Refinery (TOR) and Atuabo Gas Processing Plant are responsible for the local production of LPG and kerosene, which is supplied throughout the country through the various filling stations. Imported LPG accounts for 77% of the total LPG consumed in Ghana whereas Atuabo Gas Processing Plant and Tema Oil Refinery produce 20% and 3% respectively as of 2018 (Energy Commission, 2019a). As of 2019, a total of 18,189 GWh of electricity was generated by the various installed power generation plants (Energy Commission,

2020). This is a 12% increment from the 2018 power generation of 16,246 GWh and 58% increment from the 2015 power generation of 11,491 GWh. The bulk of the electricity (59.8%) generated in 2019 is sourced from various thermal plants in the country, namely Takoradi Power Company (TAPCO), Takoradi International Company (TICO), Tema Thermal 1 Power Plant (TT1PP), CENIT Energy Ltd., Sunon-Asogli Power (Ghana) Ltd., Tema Thermal 2 Power Plant (TT2PP), Kpone Thermal Power Plant, AMERI Plant, Karpowership, Trojan, Genser, Amandi, AKSA and Cenpower thermal plant. The Akosombo, Bui and Kpong hydro power plants operated by the Volta River Authority (VRA) supplement the energy needs of the country with a production of 39.9% of electricity supply. Renewables share in the power generation mix remains lowest at 0.3% (Energy Commission, 2020).

4.3 Policy strategies on modern energy cooking services

Ghana has over the years rolled out energy policies that have captured cooking fuels consumption by households. Dedicated sections in the policies detail household energy use with set targets and strategies to be addressed. Some of the national policies that have strategised for household cooking energy in Ghana are: The National Energy Policy (2010), Energy Sector Strategy and Development Plan (2010), Strategic National Energy Plan (SNEP 2006-2020), Renewable Energy Act 2011 (Act 832), Renewable Energy Masterplan (2019), Ghana Shared Growth and Development Agenda I & II (GSGDA I, II) and Sustainable Energy for All Ghana Action Plan (Energy Commission, 2015). Household energy sources such as electricity, LPG, and biomass (charcoal and firewood) are covered in the policy documents and instruments. Targeted cooking fuels with set goals and specific strategies as well as the states of implementation are outlined in Table 4.1 below.

Table 4.1 Policy instruments targeting cooking energies and implementations

Policy Instrument	Fuel	Target/Goal	Measures/Strategies	Implementation
2010 National Energy Policy	Biomass (Woodfuels)	The goal of the renewable sub-sector is to increase the proportion of renewable energy, particularly solar, wind, mini hydro and waste-to-energy in the national energy supply mix and to contribute to the mitigation of climate change.	• Support sustained regeneration of woody biomass resources through legislation, fiscal incentives, and attractive pricing • Promote the establishment of dedicated woodlots for wood fuel production • Promote the production and use of improved and more efficient biomass utilisation technologies • Promote the use of alternative fuels such as LPG as substitute for fuel wood and charcoal by addressing the institutional and market constraints that hamper increasing access of LPG in Ghana • Prices based on market forces • Taxes and levies on woodfuels being regulated by the appropriate national agencies or local authorities, as may be necessary	• Introduction of Improved cookstoves such as the Gyapa by governmental agencies, NGOs and Research institutions
2010 Energy Sector Strategy and Development Plan	Petroleum Product (Kerosene)	Increase access to petroleum (Kerosene) in rural areas	• Continuing to finance the development of the Rural Kerosene Promotion Programme nationwide • Expanding the petroleum products storage capacity nationwide	Establishment of the Kerosene Promotion Fund (KPF)

			• Expanding marine related facilities on the Volta Lake for bulk transportation to ensure year-round supply of petroleum products to Northern Ghana • Facilitating the availability of more petroleum product distribution outlets in deprived areas to increase access density (number of persons per sale outlet). • Promoting a more efficient licensing regime for sales outlets to ensure optimal economic benefits to both investors and consumers • Supporting the rehabilitation and expansion of rail infrastructure to enhance the transportation of petroleum products	
	Petroleum Product (Liquefied Petroleum Gas)	Increase access of LPG from 6% as at 2010 to 50% by 2015	• Speed up the establishment of a Natural Gas Processing Plant to produce LPG from the associated gas to be produced from the Jubilee Oil and Gas Field • Re-capitalise Ghana Cylinder Manufacturing Company (GCMC) to expand production capacity	• LPG cylinder/bottle recirculation model • Introduction of subsidies on LPG

			• Construct LPG Storage and supply infrastructure in all regional and district capitals in the long term • Increase the LPG distribution margin.	
	Biomass	Increase RE in the total national energy mix and ensure its efficient production and use	• Support sustained regeneration of woody biomass resources through legislation and fiscal incentive • Promote the establishment of dedicated woodlots for wood fuel production • Promote the production and use of improved and more efficient woodfuel utilization technologies • Promote the use of alternative fuels such as LPG as substitute for fuel wood and charcoal • Promote the production and use of other woodfuel energy resources (waste, biofuels)	
Ghana Shared Growth and Development Agenda II	Biomass	Ensure that energy is produced and utilized in an environmentally sound manner	• Promote the use of energy efficient end use devices (such as improved wood fuel stoves, etc)	Production of improved cookstoves

Strategic National Energy Plan (2006-2020)	Electricity	To achieve 100% universal electrification by 2020. The present level of access to electricity for households is estimated to be over 50%.	• To achieve 30% penetration of rural electrification via renewable energy technologies by 2020. • To reduce the average electricity intensity per urban household by 50% by 2020.	
	Biomass	To ensure that the energy share of traditional biomass (woodfuels) in the national final energy mix is reduced from about 60 percent at present to at least 50 percent by 2015 and eventually to 40 percent by 2020.	• Expanding forest plantation cover. • Promoting fuel substitution in households and commercial cooking • Setting up a national agency dedicated solely to woodfuel production and marketing issues along the same lines as VRA and ECG for Electricity, and GNPC and GOIL for petroleum issues.	
	Liquefied Petroleum Gas	To increase LPG penetration for cooking by 20% by 2015 and 30% by 2020.	• Government improves access to LPG in the country by supporting measures aim at widening LPG distribution network to increase access for rural dwellers. • Government reduces subsidy on LPG and redirect it to subsidize LPG-related appliances for the poor. • Government ensures that LPG is fairly accessible throughout the country.	

Sustainable Energy for ALL Action Agenda 2015	Biomass	To ensure that all households using charcoal or firewood for cooking will use improved energy saving cook stoves by 2020. Woodfuel stoves in Ghana should have a minimum efficiency of 30%.	• Cookstove design are based on needs and preferences of users • Ensure durability and performance of devices • Facilitate access to finance for SME manufactures • Ensure active stakeholder participation • Public awareness to accelerate adoption • Market-based programme design and implementation for commercialization and scaling up	National Improved Woodstove for Household Challenge
	LPG	To transition 50% of households to the use of LPG as their primary cooking fuel by 2020	• To promote the manufacture of smaller sized cylinder bottles (eg 6kg) to make it affordable to low income earners • To increase LPG storage infrastructure in the localities and to ensure supply of both the cylinders and the gas to meet demand • By the year 2016, LPG stoves will be added to the list of end-use devises that will have standards and labels which will indicate their consumptions and efficiency levels.	• Targets have not been met as of 2020 since only 22.3% of households were using LPG as their primary cooking fuel by 2017

			• A public campaign will be mounted to create public awareness on the benefits of using LPG by 2016.	

Source: Authors' construct

Electricity for household cooking is the least represented type of cooking fuels in the policies reviewed. The policy goals on electricity focus mainly on lighting of households. The Strategic National Energy Policy (2006-2020) however, acknowledges that electricity is the cleanest option in combating indoor pollution although the generation of electricity through thermal sources is not global warming friendly. Since there has been sufficient generation of electricity in the country in the post-2012-2016 power crisis, there should be increased discussion and promotion of electricity for cooking as an alternative cooking fuel to biomass. Similarly, little attention is placed on biogas for cooking in the energy policies despite the enormous potentials and benefits. Charcoal, firewood and LPG fuels have received the most coverage in the energy policies with specific strategies outlined to meet set goals and targets. The implementations have however not met up to the goals. Production of charcoal is solely by private individuals who supply for the market for household use with little role of the government. The policy strategies on biomass in the areas such as the establishment of dedicated woodlots for production and regulation of taxes and levies on woodfuels by appropriate agencies are still yet to be embarked upon. The National Environmental Policy has no clear-cut goals and measures laid out to promote the production and consumption of cooking fuels although there is an acknowledgement of the effects on forests due to increased consumption of woodfuels.

4.4 Gender inclusiveness and sustainability in energy policies

The role of gender in the energy mix of Ghana is an area of significant importance necessary for shaping the energy policies in the country. The Strategic National Energy Plan (2006-2020) and The National Energy Policy (2010) recognise the importance of women and children, and the effect of energy pollution on their health and productivity. Both policies address the need to promote the use of modern energy fuels, support the capacity development of women in the energy sector and involve women in the formulation and implementation of energy interventions (Ministry of Energy, 2010). The SNEP also reiterates the differences in the socio-cultural and traditional roles of men and women whereby women are burdened with cooking, fuelwood collection and charcoal production. The representation of women in energy-related issues and decision making is emphasized in order to create a gender balanced human resource development (Energy Commission, 2006). The 2010 Energy Sector Strategy and Development Plan further outlines strategies in mainstreaming women in the energy mix. These are the women in LPG promotion programme, women in energy efficiency and conservation programmes, capacity building for women in energy and establishment of gender desk in the ministry of energy.

Similarly, the Ghana Shared Growth and Development Agenda I, acknowledges the traditional role of women within households, which contributes to the high risks of suffering the effects of using solid fuels and biomass for cooking. Women and children in the rural areas especially are burdened with the task of collecting fuelwood and charcoal. Also, high exposure to indoor pollution and limited involvement of women in the planning and management of energy services are urgent issues that needs to be addressed. The goal of the policy is to ensure that the gender concerns are mainstreamed and aligned with proper health, safety and environmental standards (Government of Ghana, 2010).

The GSGDA II emphasized the importance of sustainability in the energy mix. The policy objective on sustainability is targeted at ensuring the production and utilisation of energy in an environmentally sound manner. In terms of household cooking energy services, the promotion of improved woodfuels burning cookstove is highlighted. Similarly, the Ghana Climate Change policy acknowledges the pressure and effects on savannah woodlands due to the heavy dependence on charcoal and fuelwood for cooking in Ghana. The Reducing Emissions from Deforestation and Forest Degradation in

Developing Countries programme (REDD+) seeks to address the preservation of our natural forests. The need to improve the efficiency of production, harvesting, conversion and use of woodfuels through improved utilization of cookstoves is one of the policy actions directed towards ensuring sustainability of our forests. Also, alternative sources of cooking fuel such as LPG is encouraged especially in rural Ghana to reduce the use of woodfuels (Republic of Ghana, 2013).

4.5 Household energy cooking initiatives and implementations in Ghana

One area in household modern energy cooking that has received considerable attention is improved cookstoves. The heavy dependence on biomass for cooking coupled with the health implications on consumers especially women necessitated the need to find better and sustainable means of consuming woodfuels. The production of charcoal and charcoal stoves are largely informal activities, though improved cookstoves promotions have been undertaken by some NGOs and various development projects. Industry and commercial sectors also use biomass energy in their operations (Energy Commission, 2015).

Reputable international and local non-governmental organizations (NGOs) have contributed to the development of modern energy technologies in Ghana. Several projects targeting the promotion and supply of improved cookstoves have been undertaken by the NGOs. The Netherlands Development Organization (SNV), the Kumasi Institute of Technology and Energy and Environment (KITE) have both collaborated with the Ministry of Power to implement energy related initiatives and projects including improved cookstoves. New Energy, also a local NGO has been fundamental in the promotion of modern energy services to the northern part of Ghana (Energy Commission, 2015). The Technology Consultancy Centre (TCC) at the Kwame Nkrumah University of Science and Technology (KNUST) is a cookstove testing laboratory provided by the United Nations Development Programme (UNDP) and Energy Commission of Ghana to assess and verify claims by cookstove manufacturing and marketing promotion organizations in line with the Sustainable Energy for All Action Agenda (Akolgo et al., 2018).

Strides have been made in the promotion of improved cookstoves notably the introduction of the National Woodstove Energy Challenge by the energy commission where eight (8) new woodstoves were developed for households. Among the prototypes presented were the *Obahemaa*, *Donago* and *EJA* stoves (Ghana SE4ALL Secretariat, 2019). However, the lack of a national policy with specific goals and strategies is a setback. Also, there is the lack of incentives in the promotion of cookstoves in relation to import duties, taxes on technologies and regulation of raw materials. Finally, the perceived poor quality and durability of cookstoves produced as well as poor performance has resulted in the low adoption of cookstoves amongst households (Energy Commission, 2012).

The promotion of LPG has been done over the years with the introduction of the Ghana LPG Promotion Programme. Educational campaigns on LPG adoption have been carried out. The setting up of the Ghana Cylinder Gas Manufacturing Company (GCMC) and LPG refilling stations across the country through private sector participation are some of the initiatives that have been undertaken under the programme (Broni-bediako & Amorin, 2018b). Also, there was the introduction of subsidies on purchases of LPG introduced in 2010 in order to encourage usage by households. However, these subsidies were withdrawn in 2013 due to the increasing drain on the government's fiscal account (Global LPG Partnership, 2018). The Government of Ghana also introduced the cylinder recirculation model as both a safety measure (after the gas explosion incidence in 2017) and a means to increase household LPG access.

The SE4ALL Ghana Action Plan summarizes the bottlenecks in the implementation of various modern energy strategies. Regarding LPG, the supply of LPG over the years has been inadequate compared to the demand. The number of storage, filling and distribution facilities in the country are inadequate and mostly centered around regional capitals and urban centers mostly in southern Ghana. The existing model of distribution is regarded as outmoded and needs to be revised. Increasing safety concerns in the use of LPG is also a factor that can be attributed to the inefficient management and lack of standards of cylinders and cookers. As a response, the Government of Ghana directed the National Petroleum Authority (NPA) to plan, facilitate and implement the Cylinder Recirculation Model (CRM). The model dictates that the LPG bottling plants will be sited away from congested commercial and population centres, while empty cylinders will be filled and distributed to various consumers and households through retail outlets (GLPGP, 2018). The NPA was to partner the GLPGP in the execution of this model.

4.6 Policy action gaps in sustainable cooking energy transitions

The relevance of modern energy cooking services is evident in the major energy policies of Ghana as cooking is central for human sustenance. However, the emphasis on cooking energy have centered mainly on the reduction of biomass and promotion of LPG. Less emphasis has been placed on the use of electricity as an alternative fuel for cooking due to the low generation and supply of electricity in the country and high generation of electricity through thermal energy during the time of the formulation of policies. Also, the policy gap in support of the use of improved biomass cookstoves contributes to the low adoption of cookstoves by households that have no means to access or afford cleaner cooking alternatives. Most of the strategies and measures outlined in achieving the promotion of sustainable household cooking energy transitions have not taken off leading to the non-achievement of set goals and targets.

4.7 Section Summary and Conclusion

Biomass is the most utilized cooking fuel in Ghana with demand taking a toll on the natural forests and raising concerns of deforestation. LPG demand is steadily increasing with supply coming from both international and local markets while electricity is supplied locally. However, the demand and adoption of electricity for cooking is quite insignificant. Energy policies such as the National Energy Policy, Energy Sector Strategy and Development Plan, Ghana Shared Growth and Development Agenda I &II, Renewable Energy Masterplan, and many more have strategized for the promotion of sustainable cooking fuels for households. The introduction of improved biomass cookstoves, LPG cylinder recirculation programme, LPG promotion programme, expansion in storage and distribution centers, and rural LPG programme are some of the measures undertaken by various governments over time to ensure sustainable cooking energy transitions by households. Despites the efforts put out, these programmes and policies have encountered several bottlenecks that impede the success of the programmes. The bottlenecks and policy gaps identified are important for ensuring the complete success of the goals and targets set by the policies in Ghana.

5 COOKING IN THE GHANAIAN HOUSEHOLD: UNDERSTANDING THE RELATED NATIONAL MARKETS OF FUELS AND COOKING TECHNOLOGIES

Section Objectives: This section seeks to find empirical answers to the following

- What are the main cooking fuels in the Ghanaian household?
- What are the supporting fuels in the Ghanaian household?
- What is the structure of the supply chain of the main cooking fuels in Ghana?
- What are the clean cooking fuels used in Ghanaian households?
- What is the structure of the supply chain of the clean cooking fuels in Ghana?
- What is the documented consumption gap of the clean cooking fuels in Ghana (expected versus actual consumption rates)?
- What are the main cookstoves and electrical appliances used for cooking in the Ghanaian household?
- What are the supplies and services networks of these cookstoves (appliances)?
- What is the structure of the supply chain of these cookstoves (appliances) in Ghana?
- What initiatives are being undertaken to produce and distribute clean and improved cookstoves (appliances) to households in Ghana?
- What is the adoption rate of these clean and improved cookstoves (appliances)?
- What challenges do these clean and improved cookstoves (appliances) face in terms of acceptance and adoption?
- What are the documented reasons for the low adoption of clean and improved cookstoves (appliances)?

5.1 Introduction

After this introduction, the section discusses four main issues. First, cooking fuels and cookstoves as well as electrical appliances used in Ghanaian households are discussed. This is followed by the supply and marketing of these cooking technologies in Ghana. The third sub-section looks at the acceptance and adoption of improved and clean cooking technologies (cookstoves and appliances) in Ghana, whiles the last sub-section provides a summary to the chapter.

5.2 Cooking fuels and cookstoves used in Ghanaian households

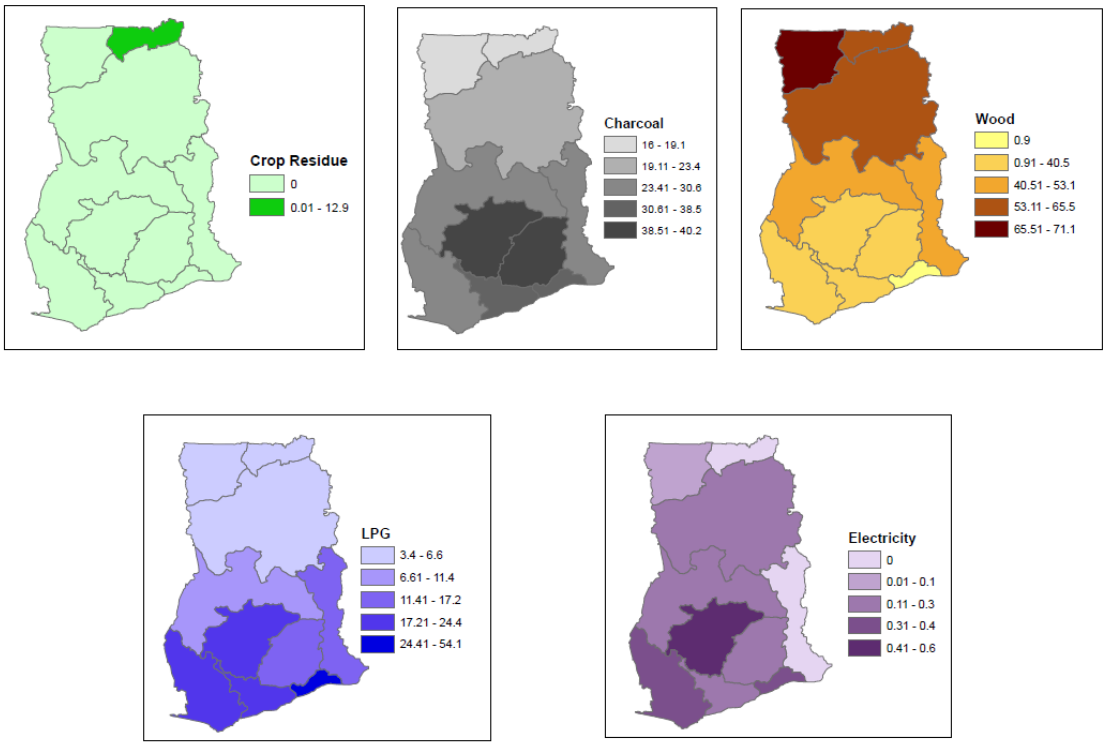
Solid fuels remain the main cooking fuels used in Ghanaian households. In Accra, which is the most urbanised city of Ghana, the dominant fuel for cooking is LPG, used in 51% of households followed by charcoal used by nearly 40% (GSS, 2019). In other urban areas excluding Accra, charcoal dominates as the main fuel used by the household for cooking. Additionally, only 0.3% of households in Ghana use electricity as their main cooking fuel as of 2017 (GSS, 2019). Figures 4.1 and 5.1 provide a summary of the primary cooking fuels used by households in Ghana. According to the literature, the modern fuels that are available to the Ghanaian household are electricity and LPG. Only 24.8% of households in Ghana use these modern fuels as their main cooking fuels (Figures 4.1 and

5.1). Unsurprisingly, the proportion is higher in the urban areas (35.2%) favoured by economic factors and availability of the fuels compared to rural areas where only 8.9% use modern fuels as their main cooking fuels (GSS, 2019).

Beyond the urban - rural distributions of the main fuels used by households for cooking, there are also observed geographical variations across Ghana. Biomass and agricultural residues are used mostly in the northern regions, whereas charcoal and LPG dominate in the southern coastal regions. Figure 5.1 provides a pictorial representation of this distribution. In the Ghanaian household, combinations of fuels are used in different ways for different reasons for cooking. This phenomenon is generally known as "fuel stacking". From the information embedded in Figures 5.1, all the fuels are also used as secondary or supporting fuels one way or the other by the households. According to a report by the World Health Organization, there are variations in the mix of fuels used by households due to geography and the availability of resources including income and energy resources available to the household (WHO, 2018).

Consumers are familiar with a broad range of cooking technologies for each fuel type. The woodstove segment is still largely dominated by the 3-stone fire hearths, although some alternatives exist including, car tire-rims and clay stoves and the improved wood stoves like Philips and *Envirofit* wood stoves (see Figure 5.2). The charcoal cookstove market is dominated by traditional coal pots and '*Gyapa'*, an energy-efficient stove. While the '*Gyapa'* cookstove (see Figure 5.2) has convinced a broad segment of consumers, others that are also popular in the market are the '*Toyola'* stove and '*Kenya Jiko'* stoves. The 4-burner stove with oven is very popular among the users of LPG (Akolgo et al., 2018). Households also complement the use of LPG with other electric heating and cooking technologies such as rice cookers, hot stoves, microwaves, kettles among others (Copenhagen Census Centre, N.D.). Cooking areas in the Ghanaian settings also tend to differ, depending on the location of the household, the household size and its economic status. Cooking areas could be indoors or outdoors, under sheds or in verandas, and in shared or separate spaces (WHO, 2018).

Figure 5.1 Regional distribution of cooking fuels in Ghana.



Source: Author's construction based on GSS, 2019 data.

Figure 5.2 Examples of improved charcoal and wood fuel stoves in the Ghanaian market

Source: Ahiekpor, Bensah, and Kemausuor (2017)

5.3 Supply and marketing of cooking fuels and heat conversion technologies in Ghana

The marketing of cooking fuels in Ghana takes two major forms depending on the type of fuel under consideration. First of all, whiles clean cooking fuels such as LPG normally have a more formalized way of marketing, traditional or non-clean cooking fuels are usually sold informally with no coordinated arrangement (EC and GACC, n.d.). A typical example is the charcoal production and sales. Charcoal production in Ghana, as in most SSA countries, remains an unorganized and informal activity, which is undertaken by various groups of people including, landless labourers who produce an average of 10-15 bags in a week. The produced charcoals are conveyed by a first layer of middlemen to accessible roads and later transported by the second layer of middlemen who are mostly truck drivers to urban areas. Wholesalers then purchase the charcoal in bulk and redistribute/retail in smaller quantities (UNDP, n.d.). The Brong-Ahafo and Eastern Regions produce over half of all the charcoal produced in Ghana. Whiles all the regions bordered by the sea are net consumers of charcoal the other regions that are inland are net charcoal producers. The Greater Accra and Ashanti Regions, which have the two largest cities in Ghana, account for half of the country's consumption of charcoal (UNDP, n.d.).

With regard to the marketing of fuelwood, producers and transporters normally sell it in bundles or cylindrical block pieces. The bundles may consist of splits of wood or smaller diameter logs or saplings tied, while the blocks are larger diameter pieces of wood purchased for further splitting by the trader or the fish smoker before use. The bundle is the most common unit of sale. The mean farm gate price per bundle of variable weight and quantity of pieces is GHC2.50 ($0.54) [range: GHC2 ($0.44) in Central – GHC 3.5 ($0.76) in Western) while the retail price is GHC 8 ($1.74) on average

[range: GHC5 ($1.9) in Central-GHC12 ($2.61)[4] in Volta] (Darko, 2018). The value addition is the transformation process from the standing tree to the splits or pieces of wood used by the consumer. This entails mainly labour for harvesting, cleaning, sizing into shorter length, splitting, bundling and packing. Overall, producers earn the least price (15.4%) and profit (20%) share across regions while traders earn the highest shares of 49% of the price spread and 50% profit along the chain for a bundle of fuelwood. Transporters may earn the least profit per bundle in some cases, hence, tend to overload trucks to maximize profit (Darko et al., 2015).

According to the Energy Commission (2019), LPG supplied to the country in 2018 rose to almost 397,000 tonnes from around 359,000 tonnes, representing 15.5%. In 2018, about 4,800 tonnes (3% of supply) of LPG was exported, a drop from about 40,000 tonnes exported in 2017; 11% of total supply that year. To achieve a 50% nationwide LPG use, Energy Commission of Ghana estimates at least 450,000 tonnes of LPG will be required by 2020 based on an estimated population of 31–32 million (Energy Commission, 2017a), but it is not likely to be achieved if limited distribution outlets nationwide remain the same and its price continues to remain high (Energy Commission, 2019).

By the end of 2017, about 152 companies were licenced as Oil or LPG Marketing Companies. Out of this number, 81 reported to have sold LPG and only 39 were pure LPG Marketing Companies (GLPGP, 2018). These companies distributed gas to about 645 gas filling stations across the country (GLPGP, 2018). These refilling stations serve customers who carry their empty cylinders to the gas refilling stations to get them refilled (IMANI, 2017). In 2018, local LPG supply virtually came from Atuabo Gas (20%) due to the shutting down of the Tema Oil Refinery. The Refinery has performed below capacity for decades, reportedly due to underinvestment, lack of maintenance and debt. There are proposals to restart the plant after reconfiguration through a second furnace, but with reduced capacity (WHO, 2018).

There have been efforts over the past two decades to introduce and promote the adoption of improved and energy efficient firewood and charcoal stoves in Ghana. The initiatives started in the 1990s by the Government of Ghana with the introduction of the first improved and energy efficient charcoal stove, called '*Ahibenso*' stove. This stove was reported to have fuel saving efficiency of about 35-40 per cent compared to the traditional coal pot which is known to have less than 18% fuel efficiency (Ahiekpor et al., 2016). Other past initiatives also include the Council for Scientific and Industrial Research's (CSIR) improved woodstove project and the Volta River Authority's (VRA) climate stove initiative that resulted in the introduction of 'improved' firewood stoves in households across the country. The improved cookstove (IC) market of Ghana is currently dominated by ceramic lined charcoal stove products (*Gyapa, Toyola and Holy Cook Stove*) and non-ceramic lined charcoal stove products (*Cookclean stove and Envirofit stoves*) which are used mostly in urban centres (Bensah et al., 2015). Local fabrication and distribution of ICs are tilted in favour of charcoal stoves in contrast to fuelwood stoves because market for fuelwood stoves is limited at the household level. However, few artisans and enterprises have been building and promoting institutional woodstoves in educational institutions and agro-based companies such as cassava processing (gari making) and fish smoking. Figure 5.3 provides some of the examples of ICs in Ghana.

Apart from the private sector that has taken the production of clean cooking technologies up as a form of business, several efforts are also being made by governments, international organizations and NGOs amongst others to ensure the adoption of clean cooking technologies and fuels in Ghana. For

[4] Using the 2018 exchange rate (Cedi/USD) of 4.59

example, the government since 1989 has implemented a number of LPG promotion programmes. The main LPG promotion programme, initiated in 1989, distributed 14.5 kg and 5 kg LPG cylinders to households in urban areas (Acharibasam and Apatinga 2014; Asante et al., 2018). The Ministry of Energy, in its drive to ensure a sustained supply of LPG to consumers, adopted a delivery strategy that involved supplying trucks to registered LPG retailers who then provided on-the-spot cylinder refilling at consumers' houses. This delivery model was abandoned in the 1990s due to safety concerns (Asante et al., 2018). The known count of LPG cylinders in circulation in Ghana stood at 600,000 as of 1997. In 2013, this number was estimated at 2.5 million and 4.8 million in 2017(G LPGP, 2018). The 2017 estimate is a 92% increment from the 2013 estimate.

Another endeavour by the government to promote access to LPG was the establishment of the Ghana Cylinder Manufacturing Company and Sigma Gas Ghana, as well as three refilling stations in the coastal and northern areas around the 2000s. Later, the Ministry of Energy, through the Energy Sector Strategy and Development Plan, supplied several new cylinders to the Ghanaian market and gave price incentives to consumers in order to expand LPG access and use in rural areas (Biscoff et al., 2012; Asante et al., 2018). In 2013, when the LPG subsidy was removed, the government initiated a rural LPG promotion program (RLP) to distribute small-size cylinders (e.g. 6kg) to rural communities free of charge. By the end of 2017, about 149,500 cylinders had been distributed in 108 of Ghana's 217 districts (Asante et al., 2018).

Although charcoal and fuel wood are not clean cooking fuels, there have been several attempts to reduce the quantity of these fuels use through the promotion of improved cookstoves. These actions have been led by the government agencies, NGOs and international organizations. For instance, SNV worked with the Ghana Fisheries Commission and Ghana Standards Authority to develop a new low heat, low smoke oven called the Ahotor oven. The Ahotor is user friendly in that it emits far less and cleaner smoke, operates at a lower temperature, and produces high-quality smoked fish using 32% less fuelwood. It is more comfortable and safer for fish processors to use (due to reduced smoke), it is safer for consumers, and it is better for the environment. In 2013, the Council for Scientific and Industrial Research (CSIR), through sponsorship from the Clean Cooking Alliance (CCA), established a cookstove laboratory. Around the same time, CSIR, in partnership with the Energy Commission, led a biogas and cookstove technology transfer from China to Ghana. Also, within the government sector, the Ministry of Energy and a private Korean company signed a deal in 2018 for the annual distribution of at least 500,000 ICs in Ghana for the following five years, based on a carbon credit arrangement. Under the agreement, the Korean company is required to deploy 5 million ICs to end users in Ghana between 2018 and 2022 to help close the access gap for millions of Ghanaians without access to clean cookstoves (Bawakyillenuo, 2020). As social enterprises, private stove companies have access to carbon funds, which give them the opportunity to sell ICs at subsidized rates to end users. For example, Relief International, a private company, is able to sell 'Gyapa' ICs at a subsidised rate of USD 3.77 (GHS 20) per unit compared to the unsubsidised market price of USD 15 (GHS 80) and in turn receives carbon credit for avoided emissions due to improved cooking conditions. As of June 2019, the company had sold about 200,000 cookstoves (Bawakyillenuo, 2020).

Biogas technology is also another source of fuel for cooking in Ghana, although not very popular. Interest in biogas technology in Ghana began in the late 1960s but it was not until the middle 1980s did biogas technology receive the needed attention from government (Bensah, 2010). Over the years, there have been government programmes that have supported the building of biogas digesters for various purposes. One of such initiatives is the Appollonia Integrated Rural Energy project in 1992. However, government involvement in the biogas sector has been underwhelming hence a number of

private biogas companies have marketed the technology on purely business grounds (Bensah et al., 2008). The two leading companies are Biogas Technology West Africa Limited and Beta Civil Engineering.

According to SNV (2007), Ghana has the potential to realize the dissemination of about 270 thousand domestic biogas plants. This is contained in the Biogas for Better Life (B4BL) initiative for Africa – an ambitious programme conceived by developing partners of Africa and launched in Nairobi in May 2007. The major aim is to combat poverty by providing over two million households in Africa with biogas plants, with collateral benefits of improved family health through reduction of indoor pollution and drudgery involved in firewood collection and usage (SNV, 2007). In a study to assess domestic biogas potential from cow dung in the three northern regions and Ashanti Region, KITE (2008) estimated a technical potential of 80,000 household biogas installations and a market potential (estimated based on the ability and willingness of users to pay) of about 8,000 (8% of 80,000) plants. According to KITE (2008), households have not shown much interest in using biogas in their kitchen thus, biogas technology has been disseminated mostly in institutions such as schools, hospitals, prisons, and slaughterhouses.

The sale of electric stoves and equipment for cooking in Ghana has largely been private sector led. Most of the electric equipment used for cooking in Ghana are imported and private businesspeople normally lead the charge. Electric stoves can be purchased in smaller shops in marketplaces as well as in supermarkets. The popular shops for the purchase of electric stoves in Ghana include Melcom, Shoprite, GAME among others.

5.4 Acceptance and adoption of improved and clean cooking technologies in Ghana

Several factors have been attributed to the acceptance and adoption of clean cooking technologies in Ghana. Although most of these factors are linked to the demand side of clean cooking, some have been associated with the supply side of clean cooking energy and technology.

The continuous production of charcoal which farmers regard as a form of insurance for crop failure contributes to the low patronage of clean cooking fuels in Ghana. Therefore, the provision of alternative livelihoods to charcoal producers could lead to a significant drop in charcoal production, which in turn could enhance the adoption of cooking clean fuels and technologies (WHO, 2018). Cost is also another factor that affects the adoption of clean cooking fuels and technologies. This is mainly associated with the segments of the population in both the rural and urban areas that have low incomes. Given that cheaper alternatives like biomass are readily available for use, people will save themselves the time and money to maintain these unclean sources (Bawakyillenuo, 2020; Agbokey, 2019; WHO, 2018).

According to Agbokey *et al*. (2019), factors such as safety, non-availability of spare parts on the open market to replace faulty stove accessories, stove size and household size are the potential barriers to the adoption of clean cookstove for instance, in Ghana. Also, the lack of awareness on the health benefits of using clean cooking fuels affects its adoption in Ghana. There is limited awareness of the health risk of solid fuels used in homes, thus, people do not see the need to change the use of these fuels (Bawakyillenuo, 2020; WHO, 2018).

5.5 Section summary

This section discussed the types of cooking fuels and heating technologies available in Ghanaian households, as well as the marketing and adoption of these cooking fuels. The most widely used cooking fuels in Ghana are firewood and charcoal followed by LPG with electricity as the least. The percentage of households in Ghana that use clean energy cooking fuels such as LPG are relatively lower in the rural areas compared to the urban centres.

With respect to the marketing of cooking fuels in Ghana, the clean cooking fuel such as LPG is more formalised compared to the non-clean cooking fuel as biomass which is largely informal. Charcoal is mostly produced from the Brong Ahafo and Eastern Regions with the Ashanti and Greater Accra Regions consuming more than half of the charcoal produced in Ghana. Due to environmental and health concerns, the government of Ghana through its departments and agencies have undertaken several initiatives to provide clean cookstoves and fuels to households through several programmes. Other NGOs and international organizations have also taken up initiatives to supply clean cooking technologies. The private sector is also actively involved in the marketing of clean cookstoves and fuels in Ghana. However, several factors affect the adoption of improved and clean cooking technologies in Ghana, some of which include financial constraints, lack of awareness, safety concerns and non-availability of spare parts to replace faulty stoves.

6 COOKING PRACTICES IN GHANA: UNDERSTANDING THE CHOICES OF DIFFERENT CLASSES OF HOUSEHOLDS

Section Objectives: This section seeks to provide evidence on

- The general perception of cooking fuels and cooking practices by households in Ghana
- The choices of staple foods consumed by different classes of households in Ghana and the factors influencing these choices
- The share of household income spent on food and cooking fuel
- The practice of fuel stacking by households
- The costs and benefits associated with the types of cooking fuels used by households.

6.1 Introduction

This section presents a review of relevant literature covering cooking practices in Ghana. Specifically, the general perception of households on cooking fuels and cooking practices in Ghana is first reviewed. Also, the choices of staple foods consumed by different households as well as the factors influencing these choices are discussed. The share of households' income spent on food and cooking fuels, the practice of fuel stacking in Ghana, and the cost and benefits of cooking fuels consumed in Ghana are also looked at. Finally, documented gender perspectives of the costs and benefits of different fuel types are discussed.

6.2 Staple foods consumed by households in Ghana

Households in Ghana consume varieties of staple foods. Most of the staple foods prepared by households contain starchy roots, fruits and cereals (FAO, 2009). Maize is the most important and consumed staple food in Ghana (Suleman & Sarpong, 2012). Over the years, the consumption of rice has increased rapidly and is now the second most important staple food after maize in Ghana, consumed by both rural and urban households (Anang et al., 2011). Other staple foods consumed in Ghana include yam, cocoyam, plantain, cassava, millet and sorghum.

Wide varieties of Ghanaian local foods and cuisine are prepared from the staples consumed throughout the country. Some of the most popular meals consumed in Ghana include *banku* (cooked fermented maize and cassava dough), *tuo zaafi* (cooked unfermented maize/millet flour), *kenkey* (cooked fermented maize dough), *kokonte* (cooked cassava flour), *rice*, *fufu* (cooked and pounded cassava, plantain, yam or cocoyam), *jollof* rice (boiled rice and stew), and *waakye* (boiled rice and beans/cowpeas). These dishes are usually served with side dishes such as soups and stews (Diehl et al., 2019). Rice is used for cooking a variety of dishes by households notably, *jollof* rice, plain rice, rice porridge, rice balls, and fried rice consumed by all classes of households (ibid). Dishes like *kenkey*, *banku*, *kokonte*, *gari* (roasted cassava grits) and *tuo zafi* are prepared from maize. Roots and tubers like cocoyam, plantain, and cassava are also used to prepare local Ghanaian dishes like *ampesi* and *fufu*. Some of the side dishes eaten with these are palm oil soup, groundnut soup, light soup, okra soup, fried or roasted fish, and grinded pepper, tomatoes and onions (Komatsu & Kitanishi, 2015).

Patterns of food consumption in Ghana vary across regions and geographical areas despite the similarities in food consumption of some popular foods throughout the country. Some staple foods are associated with specific groups of people, communities and regions in the country (Annor, Debrah, & Essen, 2016). These foods have cultural significance attached to those areas and best prepared by the indigenes of such areas. *Tubaani* (cooked beans flour), *waakye* and *tuo zafi* are food preferences of the people in the northern part of Ghana, whiles rice, *banku*, *fufu* and *ampesi* and *apem* (boiled yam and boiled plantain) are also food preferences of the people in the southern part of the country (Meng & Chinnan, 2018). Ethnic compositions of a group of people also serve as a determinant of food consumption of households. The main staple food of the Akan is *fufu* and soup and *ampesi* with *kontomire* (cocoyam leaf) ; the Ewes' have *banku/akple* and *okro* soup; while the Nzemas' have *akyeke* as their main staple foods (Laryea, Akoto, & Oduro, 2016; Codjoe & Owusu, 2011).

Similarly, the type of food crop cultivated by the people in a particular ecological zone also influences their consumption of certain staple foods and dishes. The dominant staple cultivated in the Northern Region of Ghana is millet (Dickinson et al., 2015) as such *hausa-kooko* (porridge) is one of the popular dishes consumed mostly in the morning. Cultivation of maize and rice is also common in the northern regions, hence, their preference of *tuo zaafi* over other dishes in the regions (Shiratori, 2019).

Traditions also influence the choice of staple food consumption by households in Ghana. There are certain dishes that are rarely cooked, and are only prepared for the celebration of traditional and cultural activities. Therefore, such dishes are mainly consumed during such occasions. The Ga tribe in the Greater Accra region uses *kpokpoi*, a meal prepared from maize, for the celebration of their Homowo festival. Similar cooking practices are evident among other cultures in the country whereby the indigenes cook varieties of traditional dishes and display for visitors to see and taste during various special occasions. Whereas some communities seem to be losing touch with such cultural heritages, others are preserving them (Laryea et al., 2016).

6.3 Household Income vis-à-vis staple food and cooking fuel

Income has proven to influence the decision regarding the choices of food and cooking fuel by households in Ghana (Martey, 2019; Mensah & Adu, 2015; Karimu, 2015). The Ghana Living Standards Survey Round 6 (GLSS6) and Round 7 (GLSS7) reports show that expenditure on food is the highest amongst all household's expenditures in Ghana. Food accounts for 46.7% of the total annual household expenditure between 2012 and 2013 (GSS, 2014) and 42.9% between 2016 and 2017 (GSS, 2019). Urban household expenditure on food accounts for 39.2% of total household expenditure, whereas rural household expenditure on food accounts for 50.6%. Similarly, Zereyesus et al. (2017) also observed that households within the Brong Ahafo, Northern, Upper West, and Upper East Regions of Ghana had 66% of their total expenditure going to food.

Donkoh et al. (2014), noted in their study on food expenditure and household welfare in Ghana that, rich households tend to spend a smaller share of their income on food while poor households spend a larger share of their income on food. As household income increases, investment into other household expenses also increases for the provision of quality goods and services. This is confirmed by Mensah, Aidoo, and Teye (2013) in a study conducted in Kumasi as well as in the work undertaken by Gershon et al. (2020).

On the other hand, total annual household expenditure on electricity and other cooking fuels is lower than food in Ghana. Households spend 4.9% of their annual expenditure budget on cooking fuels

(GSS, 2019). A study by Ankrah, Jiang, & Ameyaw (2020) in four regions in Ghana reveals that about 45% of households using modern cooking fuels, spend averagely about GH¢225.00 ($43.27) per year on modern cooking fuels. Evidence on households' expenditure on traditional cooking fuels is however limited.

6.4 Fuel Stacking in Ghana

As stated above, 33% of households in Ghana use fuelwood as their main cooking fuel, 34% use charcoal as their main cooking fuel and nearly 25% also use LPG as their main cooking fuel. This implies that households in Ghana practice fuel stacking as all the fuels also serve as secondary cooking fuel sources. This is more predominant in the northern part of Ghana mainly where various studies on cooking fuels have been conducted. This has been shown in studies by Dalaba et al. (2018), Wiedinmyer et al. (2017), Piedrahita et al. (2016), Dickinson et al. (2015), and Kankam & Boon (2009). Households in rural communities in the Northern region of Ghana - Nwodua, Langa, Bognayili, and Changnayili confirmed using multiple fuels in cooking though the majority of them only used fuelwood (Kankam & Boon, 2009).

The type of food cooked is a determinant of the type of cooking fuel utilized (Karimu, Tei, & Adu, 2016). Piedrahita et al., (2016) in their study noted that rural households in the Northern Region prefer to use the three-stone fire stove that uses fuelwood to cook their traditional *tuo zaafi* meal while using charcoal stoves to prepare soups and rice. The preparation of *tuo zaafi* involves vigorous stirring, and involves cooking in large quantities and large pots because of the large households, hence, the preference of fuelwood over other fuel types. Rice and soups, on the other hand, do not need large fires for preparation and as such, charcoal stoves are preferred for such meals. Urban households, on the other hand, use charcoal to prepare *tuo zaafi* and *banku* while rice dishes like *jollof* and plain rice are cooked using LPG (Wiedinmyer et al., 2017). This is because the dominant fuel used in urban households is charcoal while LPG is the secondary cooking fuel. Secondly, urban dwellers tend to have small family sizes.

Similarly, Moro et al. (2020) noted that different cooking activities and seasons also influenced the type of fuel used for cooking. Households prefer cooking large meals for occasions such as funerals with fuelwood using the three-stone open fire stove. Comparatively, fuelwood is affordable among all the other cooking fuels used by households especially with staple foods cooked in large quantities.

Taste is also a determinant of the choice of fuel used in cooking different cuisines (Karimu et al., 2016). Traditional cuisines passed on over generations require techniques that involve the use of specific types of cooking fuel. It is believed that, a change in the type of fuel used affects the original taste of the cuisine.

6.5 Costs and Benefits of Cooking Fuels

An assessment of both the costs and benefits associated with the use of the various cooking fuels is necessary for the determination of the choices made by households. The perceived costs and benefits associated with different cooking fuels could affect households' decisions regarding the adoption of different cooking fuels. Although there have been studies documenting the costs and benefits associated with the use of fuelwood, charcoal, and LPG, little or no work has been done on other cooking fuels such as kerosene, biogas and electricity as alternative clean fuels. More so, the studies conducted were focused on only the costs and benefits of fuel types in general without necessarily relating to the types of food consumed by households.

6.5.1 Fuelwood

Fuelwood is among the most typical type of cooking fuels used throughout Ghana, especially in the savannah zones and by the rural households (Akpalu et al., 2011). Due to the abundance of fuelwood, especially in rural communities, collection and utilization of fuelwood are associated with almost no monetary cost, rendering it the preferable and least cost cooking fuel. The responsibility of picking fuelwood for cooking is mostly laid on women and children. In areas where woodfuels are not easily collected from nearby woodlands, for instance in most urban and peri-urban communities, fuelwood is often purchased in small quantities at varied prices depending on the locality (Diehl et al., 2019). Despite this benefit, picking of fuelwood poses an inconvenience to users taking into consideration the time and physical energy spent in the search for fuelwood. The time involved in picking it, when channeled into other productive and economic ventures can increase the household's wealth. Also, the quantity of fuel consumed per each cooking session is high, cooking is time demanding and pots are darkened from soot requiring extra energy in cleaning unlike modern cooking fuels (Karimu, 2015).

The initial cost for the installation of fuelwood cookstoves is zero. Construction of the three-stone open fire cookstoves are from materials freely available such as mud and stones and require no professional skills. Either three stones are arranged together or mud moulded to serve as support for pots, thus earning the popular name three-stone open fire stove. The stove can also be set up conveniently in any space available, either indoor or outdoor in the household without necessarily building an enclosed kitchen. Households therefore, usually use these stoves in open spaces in the compound. Cooking in open spaces, however, poses a challenge and inconvenience during rainy seasons where much cooking is done using wood stoves. In some cases, cooking is stopped abruptly whenever weather conditions deteriorate (Wiedinmyer et al., 2017).

The health hazard from the use of fuelwood has been largely documented (Adusah-poku & Takeuchi, 2019a). The smoke produced from fuelwood causes indoor pollution which is dangerous to one's health. Exposure to particulate matter and carbon monoxide has accounted for lots of respiratory illness such as lung cancer, cardiovascular diseases, carbon monoxide poisoning, and childhood deaths in some cases (Karakara & Dasmani, 2019; Burwen & Levine, 2012). In addition, fires from fuelwood when not properly controlled have a high probability of causing domestic accidents in the cooking process. Despite these, the large flames from wood are preferred over other cooking fuels for cooking for vast numbers of people with specific cooking pots explicitly designed for such cooking.

6.5.2 Charcoal

In Ghana, charcoal is considered as the main cooking fuel used in urban communities and households, due to its superior qualities over fuelwood whereas being the secondary fuel in rural communities and households (Wiedinmyer et al., 2017; Afrane & Ntiamoah, 2011). Charcoal, unlike fuelwood, burns cleaner and longer, has high heat content and produces less smoke. As such, it is generally preferred over fuelwood in urban areas. Also, it does not necessarily need to be used in large spaces or kitchens as the cookstoves are portable and easy to handle (Van Vliet et al., 2013). The design of charcoal cookstoves allows it to be moved around, and therefore, there is the flexibility in using it both indoors and outdoors.

A study by Akolgo et al. (2018), reveals that the durability of cookstoves is a factor contributing to the increased adoption of charcoal cookstoves by a majority of urban households. Stoves lasts long

and used for years without needing either repairs or replacements; therefore, relieving households from the financial burden of periodic maintenance and replacement of cookstoves. Whereas the price of charcoal is relatively less expensive in comparison to modern cooking fuels, with traditional cooking fuels, charcoal is not affordable to all rural households. Fuelwood is instead, considered as the cheaper fuel in comparison (Afrane & Ntiamoah, 2011).

Additionally, charcoal can be purchased in small quantities as and when needed due to its accessibility and availability. The fuel is always readily available on the market and sometimes sold at designated parts of the communities (more like small market areas within the communities). Shortage and scarcity in supply are not issues often associated with the production of charcoal. Moreover, charcoal is more comfortable to carry and transport from the market to homes, last for years without deteriorating, and is resistant to insects attack (Dickinson et al., 2015). This finding together with those of Akolgo et al. (2018) and Afrane & Ntiamoah (2011) corroborate the average marginal costs of cooking with different fuels by households estimated by the Global LPG Partnership (Table 6.1). Accordingly, the estimated average cost of cooking is highest for charcoal fuel per day, month and annually relative to LPG, which came second highest and firewood which costs the least (GLPGP, 2018).

Table 6.1 Average maginal cost of cooking per household across different fuels (per day, month and annual)

Fuel	Estimated cost of cooking per household per day in GHS (Euro)	Estimated monthly cost of cooking for a household in GHS (Euro)	Estimated annual cost of cooking for a household in GHS (Euro)
LPG	GHS 2.24 (€0.40)	GHS 68.25 (€12.29)	GHS 819 (€147)
Charcoal	GHS 2.88 (€0.52)	GHS 87.50 (€15.75)	GHS 1,050 (€189)
Firewood	GHS 1.83 (€0.33)	GHS 55.57 (€10.00)	GHS 667 (€120)

Source: GLPGP (2018)

The use of charcoal cookstoves has immensely increased since the introduction of the Gyapa improved cookstoves. The improved cookstoves are light in weight and works more efficiently compared to the traditional coal pot contributing to the increase in uptake. Both rural and urban households in Ghana mainly use charcoal. However, it is used in urban areas mainly to support the cooking needs of households when there are shortages in the supply of LPG (Mensah & Adu, 2015). Even though charcoal burns cleaner than wood, it cannot be compared to modern cooking fuels like LPG and electricity as it pollutes more and thus capable of causing health complications with frequent use (Akpalu et al., 2011). In a survey conducted by Wiafe (2013) in six regions in Ghana, majority of the respondents (54.1%) raised concerns about the inability to use charcoal when wet as one of the disadvantages in using charcoal.

6.5.3 Liquefied Petroleum Gas

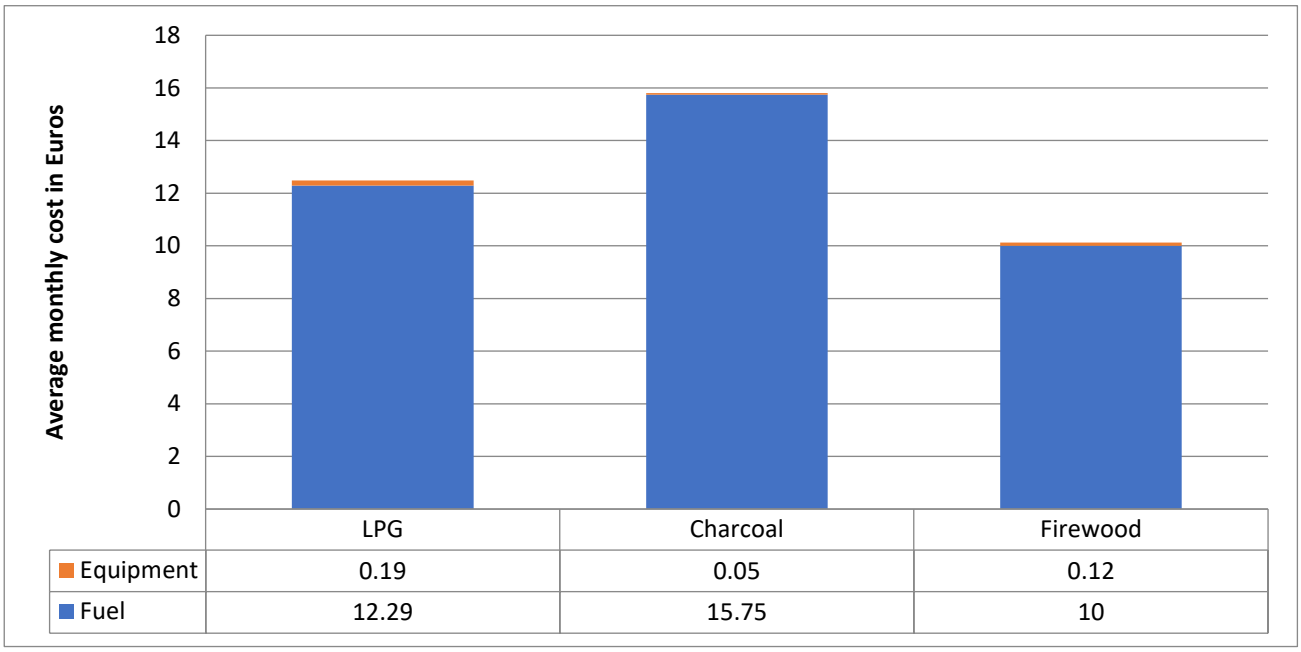
LPG was introduced as cooking fuel by the government to the Ghanaian communities in 1989 to encourage households shift from the use of biomass to cleaner cooking fuels (Serwaa et al., 2015). LPG as a clean energy source is beneficial as it is void of all the health hazards posed by traditional cooking fuels. Besides, it is convenient to use and works efficiently. Despite its benefits, adoption of LPG by rural households for cooking has been very low, unlike the urban households. Its uptake has, however been high in the coastal zones than the savannah zones (Akpalu et al., 2011).

According to Dalaba et al., (2018), in the Kassena-Nankana District of Upper East Region, less than 10% of rural households use LPG stoves compared to over half of the population of urban households that use LPG. Accessibility of the gas to users is one of the main reasons that account for the low uptake of LPG. Across the country, it is evident that urban communities are preferred for situating LPG filling stations. Rural household members commute over long distances with gas cylinders in order to locate the closest LPG filling station to purchase the fuel. The cost of transportation and long queues mostly characterising filling stations deter people from filling their empty cylinders on time (Serwaa et al., 2015). Poor road connectivity from rural to urban areas for the refilling of LPG cylinders is also a factor contributing to the low adoption of LPG (Broni-bediako & Amorin, 2018a).

In addition, the supply of LPG does not meet the demand. Since the introduction of subsidies by the government over the years, some commercial and private vehicle owners changed their fuel type of vehicles from petrol and diesel to LPG (Martey, 2019). Commercial vehicle by taking advantage of the subsidy programmes increased the demand for LPG, especially in urban communities. Queuing as well as packing of commercial vehicles for days at filling stations waiting to purchase during periods of LPG shortages quickly became a norm (Serwaa et al., 2015). Households, therefore, have to compete with the commercial vehicles during periods when stations are restocked with LPG. These struggles and competitions amongst LPG consumers would be minimized if the CRM would be fully implemented and enforced. Removal of the subsidy programmes, on the other hand, also led to increased fuel prices, thus, further discouraging the adoption of LPG by households.

Generally, LPG stoves and appliances are expensive compared to wood and charcoal stoves. Poor and rural household therefore hardly invest in these appliances as well as the other components like cylinder, hose, regulator, and safety valves (Zhou et al., 2011). This finding lends support to the finding on the average costs of equipment across different fuels used by households in Ghana (GLPGP, 2018) as shown in Figure 6.1. Another concern related to LPG usage is safety. Worn out valves and faulty cylinders, which are not regularly inspected, also pose dangers to users. Reports of LPG leakages in households that have caused fire outbreaks leading to the destruction of properties, injuries and even death discourage the adoption of LPG. Between the year 2000 and 2013, 41% of fire outbreaks in Ghana were domestic fires (Addai et al., 2016). A study by Dalaba et al., (2018) also reveals that majority of households in both rural (80%) and urban (85%) household were worried about the safety of using LPG in their homes and seen as dangerous.

Figure 6.1 Amortized average cost of cooking per household across different fuels and amortized average cooking equipment cost (per month)



Source: GLPGP (2018)

6.5.4 Electricity

The use of electricity for cooking by households is still very low in Ghana despite the benefits associated with using this clean cooking fuel. Karakara & Dasmani (2019), in a study on domestic fuel consumption using the Ghana Demographic and Health Survey (GDHSVI) data for 2014 noted that less than 1 per cent of households use electricity for cooking in Ghana. Some of the reasons attributed to the low uptake of electricity as a cooking fuel included the unreliability of electricity and high cost due to large family sizes. Also, households prefer to cook staple foods such as *banku*, *tuo zaafi* and *akple* traditionally by using either fuelwood or charcoal. Again, the frequency of power outages in the country contributed to the unattractiveness in electricity use for cooking (Kwakwa et al., 2013).

6.6 Gender perspectives and cooking fuels

In rural Ghana, women and children are mostly the ones tasked with the collection of fuelwood for cooking in the homes. This also applies to the minority of households in the urban communities that still use fuelwood for cooking. As such, studies have shown that, the number of hours invested in the collection of fuelwood affect the educational and labour outcomes of women and children (Karimu et al., 2016). In addition, women face the direct impact of fuelwood emissions, causing severe health hazards (Afrane & Ntiamoah, 2012). Therefore, households headed by females have a high probability of choosing modern cooking fuels than their male counterparts who do not go through the stress of cooking in the local setting (Adusah-poku & Takeuchi, 2019; Mensah & Adu, 2015). Unfortunately, most of the households headed by females fall within the poor bracket of households, which hinders their financial ability to switch onto modern cooking fuels (Kroon et al., 2013).

6.7 Gaps in literature

The literature provides evidence on cooking fuels and cooking practices by households in Ghana. However, despite the extensive work that has been conducted in the area in Ghana, there are limitations in specific areas. On the perceptions of males and females on cooking fuels and cooking practices, not much had been documented on the differences that males or females attribute to the topic but rather the general perception from the field. Further research is necessary in the area of fuel stacking and food choices to ascertain the specific staple foods that contribute to the practice of fuel stacking by households. With household expenditure on food and cooking fuel, it emerged that the data available is limited. Evidence on the expenditure on different fuel types is limited unlike the data on food expenditure that has been documented in the various Ghana Living Standards Survey reports that have been conducted over the years.

6.8 Conclusion

Food and energy are part of the essentials needed in life. Cooking practices and cooking fuels consumed differ across households in Ghana. Generally, most of the staple foods in Ghana are consumed throughout the country although certain staples are associated to specific communities, tribes and ethnic groups. The types of cooking fuels and stoves used by households in Ghana also differ. Households in Ghana consume both traditional and modern cooking fuels, but most importantly, households in Ghana practice fuel stacking. Majority of rural households consume traditional fuels whereas urban households consume both traditional and modern cooking fuels. The type of staple food consumed by households may be influenced by the regional and geographical location, the type of crop cultivated in a geographical location, and the traditional and cultural practices of a group of people.

Ghanaian households spend more on food than all other household expenses including cooking fuels. The cost and benefits of the types of cooking fuels determine households' choice of cooking fuels. Majority of households use biomass in the form of fuelwood and charcoal because it is cheaper compared to other cooking fuels; and available and easily accessible despite the hazardous effects on the health of the users. LPG is the most used of the modern fuels whereas electricity is the least used (1%) by households in Ghana mainly because of availability and affordability issues.

7 SECTION SEVEN: OPPORTUNITIES FOR COOKING WITH ELECTRICITY

- This section looks at the current landscape and the resources available to address the heavy dependence on biomass for cooking, considering the appreciable electricity access and supply surplus in Ghana.
- It acknowledges the minimal focus on electricity for cooking in the past and present policy and interventions.
- It makes a case for increased focus on e-cooking for addressing the biomass challenge.

7.1 Introduction

The earlier chapters examining the landscape on energy for cooking in Ghana have underscored that past and current interventions, like in many other African countries, have focused on improving biomass options and promoting LPG for cooking more recently. As such, electric cooking initiatives are absent in the many policy documents and initiatives examined. Justifiably, in times past, this seemed impractical to consider due to the electricity supply and reliability challenges (dubbed "*dumsor*", meaning off/on in Twi).

The "*dumsor*" times (2013-2016) resulted in power disruption to households, businesses, and industry resulting in devastating economic consequences, pressuring the government to increase power generation rapidly (Acheampong, 2014). Although a stable and reliable supply of electricity made "*dumsor*" a thing of the past, the last few months (beginning January 2021) has seen a resurgence of power outages not caused by supply constraints but by transmission challenges requiring maintenance and repair work on transmission infrastructure. [5] Nevertheless, the political costs of unreliable power supply in Ghana suggests that the current challenge will be dealt with swiftly to restore reliability.

Cooking with electricity is the cleanest way to cook (at point of use), considering the minimal negative impact on the cook's health and household air pollution. Additionally, it offers the opportunity to increase environmental sustainability as more renewable sources of electricity are integrated into the grid, and fewer trees are cut. In countries like Ghana, where electricity access is already appreciable, an extensive grid infrastructure reduces the efforts and resources to build alternative infrastructure for other fuel types like LPG, making it a ready alternative for transitioning urban and peri-urban households with careful load and demand planning.

7.2 Overview of the Power Sector

Ghana operates an unbundled electricity market with separate entities in charge of power generation, transmission, and distribution. This unbundling introduced private participation and competition primarily on the generation side, thereby ushering in several independent power producers (IPPs). Transmission is designated to a single entity to prevent discrimination to market participants. On the distribution side, licensed entities operate different concession areas across the country.

[5] See https://citinewsroom.com/2021/04/the-2021-dumsor-crisis-what-we-know-so-far/

Generation: Power is generated from hydropower, thermal (crude oil, natural gas and diesel) and renewables (solar and biogas). The share of hydro in the electricity generation mix has been reducing since 2000, representing 39% in 2019. Conversely, thermal capacity increased, representing 59.8% in 2019. According to the Energy Commission (2020), the power generated from renewable energy, excluding hydro, is 0.3% of the total generation.[6] This is made of VRA Solar (2.5MW), Meinergy (20MW), BXC (20MW) and Safiana biogas plant(100KW).

As shown in Table 7.1, the total installed capacity sits at 5171MW while the dependable capacity is 4695MW. The peak load on the transmission grid is 2612.6 MW and 2803.7 MW when exports to neighbouring countries are considered. With a total dependable grid capacity at 4580.0MW, an excess of 1776.3 MW dependable capacity power remains, as shown in Table 7.1.

Transmission: The Ghana Grid Company (GRIDCO) is the sole entity responsible for transmitting power.

Distribution: Electricity distribution in Ghana is handled by three utilities: two state-owned and one private utility. Electricity Company of Ghana (ECG) is the largest entity responsible for power distribution for the southern part of the country covering six regions: Greater Accra, Ashanti, Central, Eastern, Western and Volta region. The Northern Electricity Distribution Company (NEDCo) distributes electricity to Brong Ahafo, Northern and Upper East and West regions. Enclave power serves the Tema Free Zone Enclave consisting of about 50 industrial customers as the sole private entity.

7.3 Institutional Energy Actors

The Ministry of Energy is responsible for energy policy formulation, implementation, monitoring, and evaluation. It also supervises and coordinates the work of energy sector agencies. In line with its responsibility for policy formulation and implementation, it is also in charge of the National Electrification Scheme (NES), which seeks to extend electricity to all parts of the country.

The Energy Commission (EC) is the technical regulator and mandated to manage Ghana's energy resources development and utilisation. The scope of its work covers electricity, natural gas, and renewable energy industries and granting licenses for operations. It also serves as the Government's energy policy adviser, working closely with the Minister of Energy.

The Public Utilities Regulatory Commission (PURC) is an independent multisectoral regulator mandated to regulate utility services for electricity and water sectors. Among its functions is the provision of guideline rates for the utility services, specifically water and electricity rates.

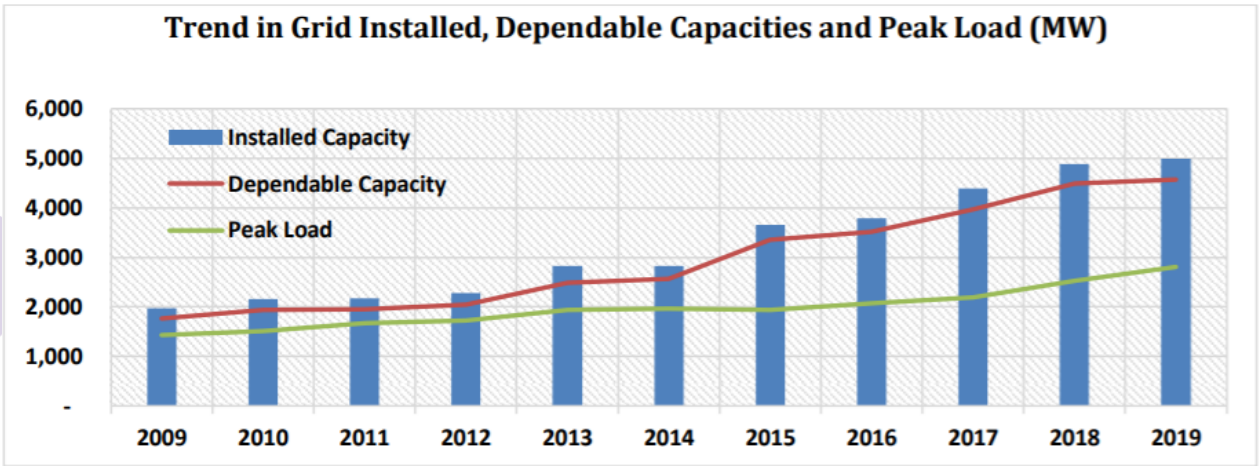
[6] The policy position is to increase non-hydro renewable energy forming part of the electricity mix to 10% by 2030.

Table 7.1 Power Generation Sources and Capacity

Plant	Installed Capacity (MW)	Dependable Capacity (MW)
Hydro		
Akosombo	1,020	900
Kpong	160	105
Bui	400	360
Total	**1,580**	**1,365**
Thermal		
Takoradi Power Company (TAPCO)	330	300
Takoradi International Company (TICO)	340	320
Tema Thermal 1 Power Plant (TT1PP)	110	100
Cenit Energy Ltd	110	100
Sunon Asogli Power (Ghana) Limited	560	520
Tema Thermal 2 Power Plant (TT2PP)	87	71.5
Kpone Thermal Power Plant	220	200
Karpowership	470	450
Ameri Plant	250	230
Trojan*	44	39.6
Genser*	95	85
Amandi	203	190
AKSA	370	350
Cenpower	360	340
Total	**3,549**	**3,296.1**
Renewables		
Safisana Biogas*	0.1	0.1
VRA Solar*	2.5	2
BXC Solar*	20	16
Meinergy*	20	16
Total	**42.6**	**34.1**
Grand Total	**5,171.6**	**4,695.2**

Source: Energy Commission (2020: pg. 20)

Figure 7.1 Trend in grid installed dependable capacities and Peak-load.



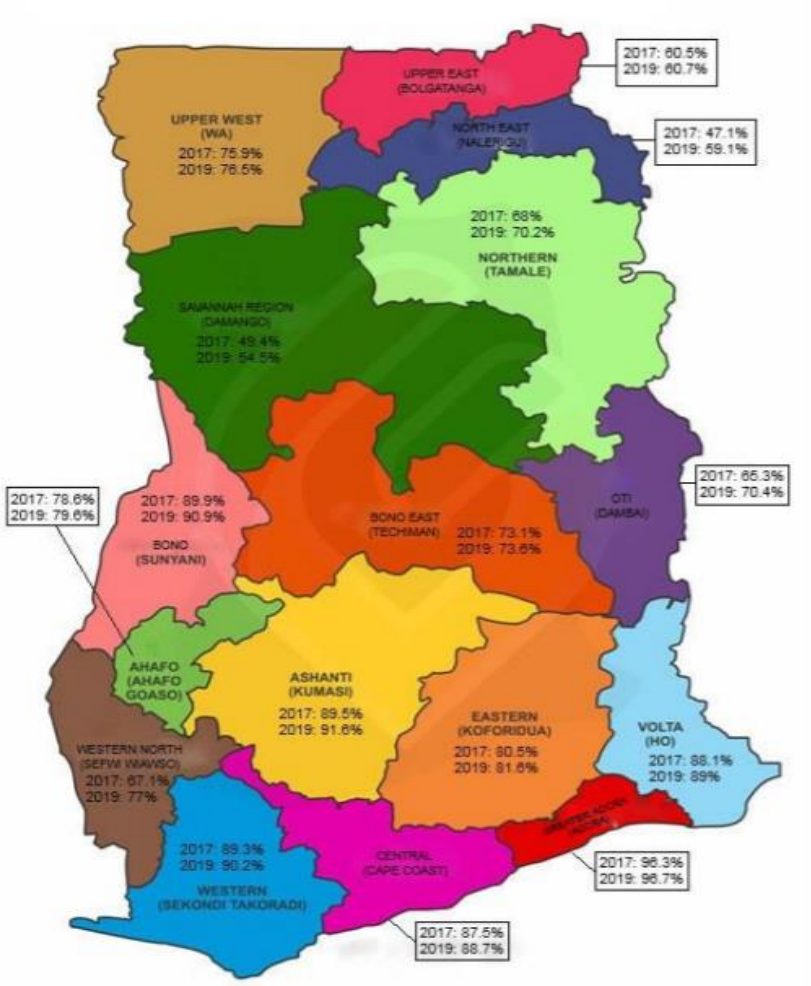
Source: Energy Commission (2020: pg. 36)

7.4 State of Grid and Off-grid Sectors

7.4.1 State of electricity access

Ghana has made significant progress in electrification over the last two decades, underpinned by successful electrification planning. According to the statistics from the Energy Commission (2020), the proportion of the population with access to electricity in 2019 stood at 85%: aggregated from urban (100%) and rural (70.5%). This translates into 92.6% (urban) and 70.4% (rural) at the household level. The regional distribution for electricity access is depicted in Figure 7.2 below.

Figure 7.2 The regional distribution for electricity access.



Source: Ghana Energy Commission (2020: pg.1)

The current electrification levels can be argued to be the commitment to extend reliable electricity supply to all parts, as detailed in the 1989 National Electrification Scheme document. This document laid down the initial plan for universal access. Since then, the development of National Energy Strategy (2003), National Energy Policy (2010), Energy Sector Strategy and Development Plan (2010), Renewable Energy Act, 2011 (Act 832), SEforALL Action Plan (2012) and Mini-Grid Electrification Policy (2016) and others have all contributed to the development and growth in electricity access across the country.

Nevertheless, the target of universal access by 2020 has not been achieved. Efforts to connect the remaining communities remain a priority, especially communities on islands in Lake Volta and isolated lakeside locations. According to the Ghana Renewable Energy Master Plan (2019), mini/microgrids from renewable energy sources will provide electricity access to remote and island communities; targets for implementation are 200 to 300 mini-grids by 2025 to 2030.

7.4.2 State of off-grid electrification sectors

As discussed above, governments have successfully provided grid electricity for many rural communities through the rural electrification programme. However, some communities present several constraints (economic, financial, social, environmental and technical) for traditional grid expansion due to their geographical location. For non-island communities, such as communities in the northern part of Ghana, the strategy is to extend the national grid to those areas. For more remote island communities, mini-grids are planned for electrification. It is estimated that out of the 5 million people identified as not having access in 2015, 2.9 million reside in the lakeside and island communities around the Volta Lake (Government of Ghana, 2015), and successful electrification of these island communities will bring the country towards 94% electricity access (Mossi Reyes, 2017).

Mini-grids

The Minigrid Electrification Policy (MEP) (2016), as mentioned in the Ghana Renewable Energy Masterplan (2019), highlights the role of mini grids/microgrids in complementing grid expansion efforts in the National Electrification Scheme. In the MEP, mini-grids are public sector-led investments with state entities such as the VRA, ECG/NEDCo. There is a limited role for the private sector, which mainly involves contracts for construction services. Although mini-grids can be expensive to construct, especially considering the remote locations and low demand for power by households, the policy regarding electricity pricing follows the Uniform National Tariff (UNT), the same price for grid customers (ESMAP, 2017). Although private sector involvement could increase implementation, there is no licensing regime or framework for private mini-grids (PAOP, 2019). According to the renewable energy master Plan (REMP, 2019), mini-grids will be based on solar, wind, biomass, biofuels, hydro depending on the target community; as of 2015, 13 mini-grids were in operation with planned targets of 86 by 2020, 200 by 2025, and 300 by 2030.

Stand-Alone Systems

In areas where mini-grids are absent, some communities have benefited from using solar lighting and home systems primarily provided by private companies, both local and international. These include Azuri technologies, PEG Ghana, Burro, GTEC Solar, Zola, Northlite Solar, Suka Solar, Sunhut enterprise and Wilkins engineering. Companies mainly offer lighting solutions and systems to support appliances like radio and televisions. Others are also active in the productive use of energy sector, providing products for small and medium scale enterprises, health centres and water pumping for irrigation. However, little or no evidence exists in the literature to show the availability of products that support cooking. In addition, companies use different payment and distribution models, which is summarised in Table 7.2 below.

The market continues to dwindle for private companies due to increasing electrification rates year on year, although solar lanterns still have policy support to provide some access to isolated communities (REMP, 2019). However, despite this support, companies face many challenges, including 1. last-

mile distribution issues around inadequate mobile coverage and underdeveloped transport infrastructure 2. inconsistent import duties 3. Local content and licensing regulations that impact the cost of business and 4. Poor mobile network connectivity which affect the ability to deploy PAYGO models in some settings (PAOP, 2019). Addressing these issues are critical to ensure that remaining communities can have some access until the grid arrives.

Table 7.2 Different payment and distribution models are used by companies

COMPANY	PRODUCTS	DISTRIBUTION MODELS	PAYMENT MODELS
Burro Brands	Solar lanterns and SHS (Greenlight Planet)	Direct sales through agents	Cash and carry, as well as a PAYGO pilot
GTEC	Solar lanterns and SHS (Greenlight Planet)	Direct sales through agents and NGOs	Cash and carry
NorthLite Solar Ltd.	Solar lanterns and SHS	Distribution through MFIs	Cash and carry, as well as MFIs
PEG Ghana	SHS, televisions, (d. light), and solar water pumps	Direct sales through agents, NGOs, and associations	PAYGO, cash and carry (customer or partner), and company payroll deductions
Suka Wind and Solar Energy Ghana Ltd.	Solar lanterns and SHS	Retail outlets and agents	Cash and carry
Sunhut Enterprise–Villageboom	SHS	Kiosk outlets in off-grid communities, VSLAs, and community leaders as sales agents and payment collectors	Cash and carry, as well as rent to own
Wilkins Engineering Ltd.	Solar lanterns and SHS (Greenlight Planet)	Direct sales through agents	Cash and carry, as well as a PAYGO pilot
ZOLA Electric	SHS, televisions, and radios	Direct sales through agents	PAYGO and cash and carry

Source: Power Africa Off-grid Project (2019: pg. 13)

7.5 Power Reliability

One component of electricity access worth discussing is the reliability of power. In many countries in the sub-region, poor supply reliability remains a challenge often brought about by the inability to cope with generation constraints (Kojima and Trimble, 2016). The reliability of electricity supply is a function of two factors: frequency and duration of the disruption or outage (Bhatia and Angelou, 2015). The System Average Interruption Duration Index (**SAIDI**) and System Average Interruption Frequency Index (**SAIFI**) serve as international standards to evaluate the reliability of electricity distribution across countries and aid in consistent reporting. In some instances, the Customer Average Interruption Duration Index (**CAIDI**) is also reported.

Table 7.3 details the SAIFI, SAIFI and CAIDI indices for 2015 to 2018 categorized by the performance of ECG and NEDCO (the two-state distribution utilities) against the regulatory benchmark. SAIDI indices for ECG in 2018 fall within the regulatory benchmark, whiles NEDCo shows a worsening over the years. CAIDI scores are, however, are within limits set by the regulatory benchmark. Much of the challenges with power reliability has been blamed on ageing grid infrastructure, which is a common issue in many African countries. For example, a PwC survey of

senior power industry players in 15 African countries found that two-thirds (67%) of those we interviewed cited ageing or badly maintained infrastructure as a high or very high concern (PwC, 2015).

Table 7.3 Grid Electricity Distribution Reliability Indices

RELIABILITY INDEX	OPERATIONAL AREA	REGULATORY BENCHMARK (Per L.I 1935)	2015		2016		2017		2018	
			ECG	NEDCo	ECG	NEDCo	ECG	NEDCo	ECG	NEDCo
System Average Interruption Frequency Index $SAIFI\ (Interuptions/customer) = \frac{Sum\ of\ all\ customer\ interuptions}{Total\ number\ of\ customers\ served}$ *This is a measure of the number of times that a customer is interrupted during an operational year.*		Maximum number of outages permitted per year								
	METRO	6	74	N.A	60	42	48	132	28	146
	URBAN	6	74		89		88		57	
	RURAL	6	109		108		104		61	
System Average Interruption Duration Index $SAIDI\ (Hours/customer) = \frac{Sum\ of\ all\ customer\ interuption\ durations}{Total\ number\ of\ customers\ served}$ *This is a measures of the average duration of interruptions recorded for the distribution system during an operational year.*		Maximum average duration of outage permitted per year								
	METRO	48 Hours	161	N.A	130	41	77	117	44	123
	URBAN	72 Hours	13		146		115		71	
	RURAL	144 Hours	203		156		135		76	
Cumulative Average Interruption Duration Index $CAIDI\ (Hours) = \frac{SAIDI}{SAIFI} = \frac{Sum\ of\ all\ customer\ interuption\ duration}{Total\ number\ of\ customer\ interuptions}$ *This is a measure of the average duration of interruptions for customers interrupted during an operational year.*		Average duration of outages permitted per year for customers interrupted only								
	METRO	8 Hours	2	N.A	2	1	2	1	2	1
	URBAN	12 Hours	2		2		1		1	
	RURAL	24 Hours	2		2		1		1	

Source: Ghana Energy Commission (2019: pg. 22)

7.6 Electricity Tariff Structure

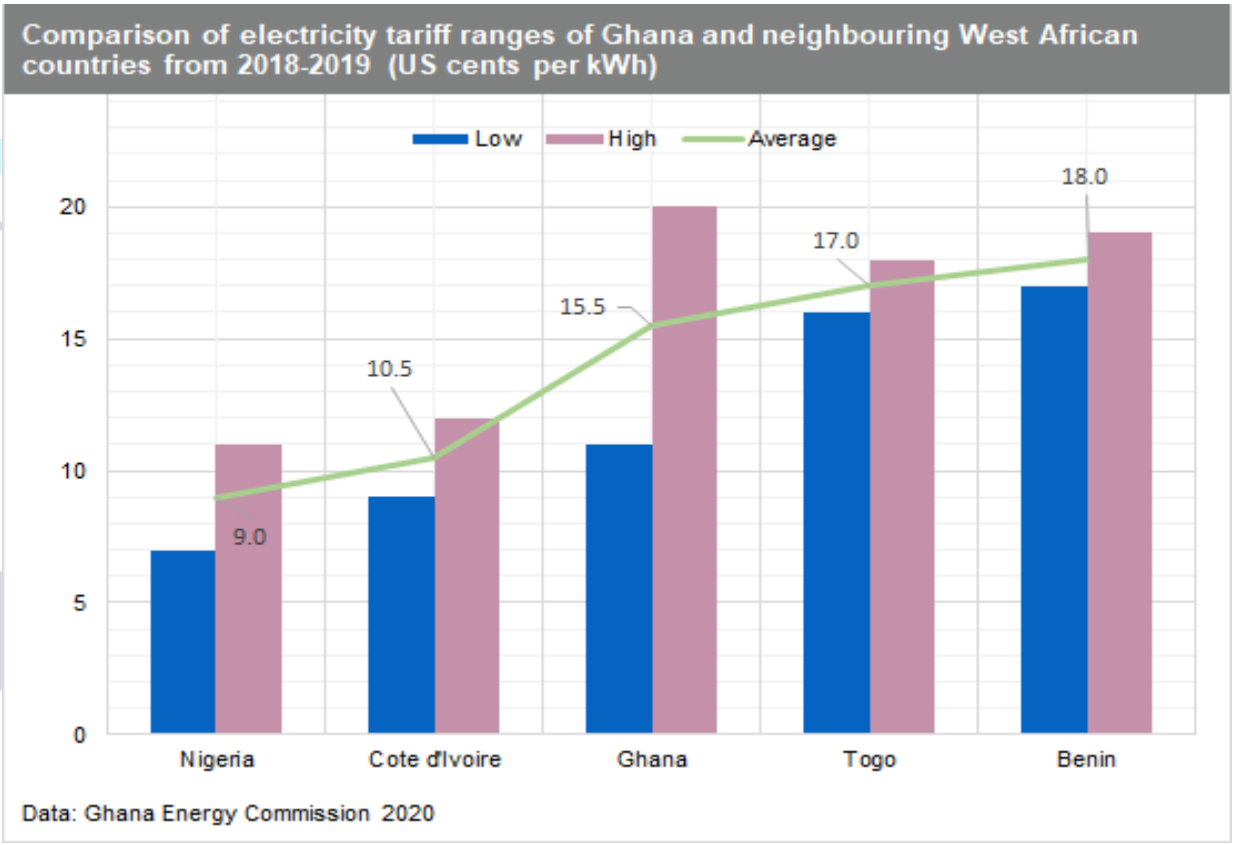
The price for electricity shown in Table 7.4 below varies by consumption class and category of user. Residential customers pay the least (13-18 US cents/kWh) while industries pay the most (20-51 US cents/kWh). The PURC has a lifeline tariff of 50 kWh per month for all consumers to provide affordable electricity to the poor, in line with the Government's commitment to electricity access and poverty reduction (GPRS) (Kumi, 2017). According to the data from the Energy Commission, the average tariff in Ghana is less expensive than neighbouring Togo and Benin but more expensive than Nigeria and Cote d'Ivoire. However, this is cheaper than East African countries like Kenya and Uganda, with a tariff of 23 US cents/kWh and 20 cents/kWh (ESMAP, 2020)

Table 7.4 Electricity Tariff Classification

CONSUMPTION CLASS	RESIDENTIAL (Domestic usage)			NON-RESIDENTIAL (Commercial usage less than 100 kVA)			INDUSTRIES (SLT usage)*		
	Ghp/ kWh		US cents/kWh	Ghp/kWh		US cents/kWh	Ghp/kWh		US cents/kWh
	Oct-18	Oct-19		Oct-18	Oct-19		Oct-18	Oct-19	
51-300	55.54	65.42	13	67.75	79.79	15			
301-600	72.09	84.90	16	72.10	84.91	16			
601+	80.10	94.33	18	113.76	133.98	26			
SLT – L V							75.66	104.73	20
SLT – MV							58.57	79.52	15
SLT – HV							53.82	83.46	16
SLT – HV Mines							102.57	263.97	51

Source: Ghana Energy Commission (2020: pg.34). Special load tariff (SLT) – low voltage, special load tariff (SLT) – medium voltage, special load tariff (SLT) – high voltage and special load tariff (SLT) – high voltage – mines

Figure 7.3 Electricity Price Comparisons in Neighboring Countries



Source: Acheampong et al. (2021: pg. 22)

7.7 Cooking with Electricity – Cost Comparisons with Other Fuels

As elaborated in previous sections, firewood, charcoal, and LPG are the main cooking fuels used by households in Ghana. Rural communities are known to use a combination of firewood and charcoal, with the former sometimes gathered for free. However, the pressure on forest resources and population growth suggests that paying for firewood would become a growing phenomenon.

With cost being one of the most cited reasons for avoiding cooking with electricity, fuel cost comparisons serve as a helpful starting point to address the affordability question. Recently, a report by ESMAP (2020) examining cost perspectives for cooking with electricity and other fuels finds that cooking with AC grid electricity using energy-efficient appliances can be the cheapest for many people costing between ($3–$17/month) if access and reliability challenges are absent. Ghana presents an excellent case to transition from biomass cooking to a cleaner fuel stack comprising electricity and LPG in terms of access and reliability.

To obtain preliminary insights into how much cooking with electricity may cost for a typical household (4 persons), some comparisons are made below with charcoal and LPG. The prevailing market prices for a 50 kg bag of charcoal and LPG were obtained in April 2021. A bag sold for GHS 40 and LPG price per kg for 6.30 GHS. The price for the 14.5 kg retailing for 91.40 GHS. A report by SNV (2020) states that a four-person household is estimated to consume 14.5 kg of gas per month or two (2) 50 kg bags of charcoal if they are not used in conjunction with other fuels. Cooking diaries conducted by MECS in Kenya, Myanmar, Tanzania, and Zambia using various e-cooking appliances like the electric pressure cooker (EPC), rice cooker, hotplate, infra-red stove, and kettle show that a typical household of 4 persons with 100% e-cooking consumes between 1 – 2 kWh per day. Using a 2kWh per day for 30 days for pricing, Table 7.6 below shows that electricity could be cheaper than charcoal and LPG.

Table 7.5 Fuel Cost Comparison for Cooking

Fuel Type	Use Estimate for 4person HH per month	Cost
Charcoal	Two (50kg bags)	GHS 80 (USD 14.03)
LPG	14.5 kg	GHS 91.40 (USD 16.03)
Electricity	60kWh (2kWh per day)	GHS 55 (USD 9.6)

Conversion with 1USD = 5.7 GHS (Bank of Ghana on 13th March 2021)

7.8 Implications for Cooking with Electricity in Ghana

Based on this preliminary analysis, cooking with electricity could be about 40% less expensive than charcoal and LPG. Evidence emerging from other countries in the region belies the common perception that cooking with electricity is expensive. This is without pricing in the additional health benefits, convenience and time savings associated with electric cooking. Looking at electricity access, supply, and demand data, Ghana is a good case for promoting e-cook interventions. This will complement the current commitment to increase LPG use to 50% of the population by 2020, which currently faces some implementation challenges. Undoubtedly, more evidence regarding the feasibility of cooking with electricity in Ghana is needed. Studies like cooking diary studies which gather data on country-specific cooking energy consumption and local cuisines' compatibility have

been found helpful in many countries in changing perceptions about e-cooking and hence worth exploring. At present, household and market assessments are ongoing to understand household cooking patterns and energy use and the availability of e-cooking appliances in the market, considering that a robust supply chain is essential to promote adoption and sustain interest in e-cooking.

8 SUMMARY AND CONCLUSION

8.1 Introduction

This section summarises the review by highlighting the salient empirical findings that were investigated by other researchers, governments and non-governmental institutions on the subject matter and concludes the review. The summary is be followed by concluding remarks based on the findings from the reviewed literature.

8.2 Summary of the review

The energy sector has caught the world's attention over a couple of decades because of its instrumental role in growth and development, industrialization, climate change issues, health issues and the performance of household activities. The household is a major consumer of energy for varied end-uses, including cooling, heating, lighting and cooking. Due to the supply and demand dynamics of the different fuels used in the household sector coupled with the socio-economic as well as environmental implications of the use of such fuels, the household energy landscape has become a heavily researched field over the past three decades.

Alternative sources of electric power have received the most attention in terms of research and investment in the past few decades because of their climate change mitigation potentials. However, it is cooking fuels that the world has often been concerned about. Nearly 3 billion of the world's poorest people rely heavily on solid fuels like wood, charcoal, crop wastes and animal dung for their cooking and heating needs according to the World Health Organization. These fuels present environmental and health challenges particularly to economies in the developing regions and the WHO assessed that, women and children are particularly exposed to these risks. This review therefore sought to unearth the realities regarding the dynamics of cooking fuels and the choices of households in the urban areas in terms of fuels and food types consumed. To achieve this broad objective, desktop review methods were employed.

Cooking energy services have been lightly, rather than heavily planned for in Ghana's energy policy landscape. The policies mainly focused on the reduction of biomass and promotion of LPG. The National Energy Policy and the 2010 Energy Sector Strategy and Development Plan are the main policies that have clear targets and strategies for cooking services. Some of the key measures include promoting the establishment of dedicated woodlots for fuel production; promote the production and use of improved and more efficient biomass utilization technologies; promote the use of LPG as substitute for woodfuel; increase the LPG distribution margin; and promote the production and use of other woodfuel energy resources like waste-to-energy and biofuels). There has not been enough coverage on electricity as cooking fuel in the energy policy instruments and the National Environmental Policy does not have clear-cut targets and strategies for household cooking services in Ghana. The energy policies have recognized the importance of women and children and their exposure to household air pollution. The policies strategized for modern energy fuels as risk mitigation as well as environmental sustainability measures.

Approximately 76% of households in Ghana use polluting fuels such as firewood and charcoal to cook. While firewood is more popular in the rural areas, charcoal and LPG are more popular in the urban areas. Less than 1% of households in Ghana use electricity for cooking. Many households use multiple fuels or technologies for cooking (a phenomenon termed "fuel stacking"). The particular

mix of fuels and technologies used differs based on geography and the available resources. The woodstove segment is largely dominated by 3-stone fires although some alternatives such as tire-rims and clay stoves exist. The charcoal cookstove market is dominated by traditional coal pots and 'Gyapas', an energy efficient cookstove. The 4-burner stove with oven is very popular among the users of LPG. The biomass market is dominated by private players in the supply chain while the LPG market has the national bulk distributor working jointly with private LPG sales points. The production and distribution of the cooking technologies are largely controlled by private players.

Ghanaians consume wide varieties of staple foods. Even though identifiable similarities are evident in the consumption of different staple foods and cuisine throughout the country, some particular foods are associated with specific groups of people, tribes and ethnicities as their main staple food. Some of the popular staple foods and cuisines consumed across the country include but not limited to *jollof rice, tuo zaafi (tz), banku, fufu, akple, emo tuo, kenkey*. Most of these cuisines are prepared from locally cultivated food crops in the country. Ghanaians generally consume three meals daily and employ several methods in cooking. Some of the most popular methods include boiling, steaming, frying, simmering, baking, roasting, stewing, and pounding. Type of food cultivated, ethnicity, culture and traditions influence the choice of staple foods consumption by households in Ghana.

According to the literature, expenditure on food is the highest amongst all household's expenditures in Ghana. Additionally, rich households tend to spend a smaller share of their income on food while poor households spend a larger share of their income on food. With fuels, households spend 4.9% of annual expenditure budget on cooking fuels. Further evidence reveals that about 45% of households using modern cooking fuels averagely spend about GH₵225.00 ($43.27) per year on modern cooking fuels. In rural Ghana women and children are mostly the ones tasked with the collection of fuelwood for cooking in the homes. As such, the number of hours invested in the collection of fuelwood affects the educational and labour outcomes of women and children. They also face the direct impact of fuelwood emissions, causing severe health hazards. Households headed by females are therefore more likely to choose modern cooking fuels but most of them fall within poor bracket of households, hindering their financial ability to switch onto modern cooking fuels.

8.3 Conclusion and implications

The market for modern energy cooking services in Ghana is not a matured one yet, but a developing one. The various policies reviewed concentrated on promoting sustainable consumption of the solid fuels rather than a pragmatic transition towards modern cooking fuels. LPG had been well planned for in the policy documents but electricity for cooking is largely anonymous in the policy documents. Achieving the Sustainable Development Goal 7 target of ensuring universal access to affordable, reliable and modern energy services by 2030 will require a conscious effort from government to develop sustainable strategies for electricity and biogas to be used for cooking in addition to LPG.

There has been little to zero documentation on the potentials and benefits of using electricity for cooking in the Ghanaian household. The main fuels covered in the literature are charcoal, fuelwood and LPG with no attention paid to how electricity could actually help lift many households up the energy ladder. This presents an opportunity to investigate the dynamics around this fuel, what people think and believe about electricity for cooking, the misconceptions and the unverifiable views and opinions about this fuel.

It was evident from the literature that many consumers or households are unaware of the benefits of modern cooking fuels. This lack of awareness coupled with affordability issues, design issues and the

continuous support given to traditional fuel systems have inhibited the development and adoption of modern cooking fuel services in Ghana. It is imperative that attention is paid to future designs of modern cooking fuel combustion technologies to suit local needs coupled with some subsidies measures to incite acceptance and adoption. Additionally, and crucially, interested stakeholders including the government should endeavour to create more awareness amongst the wider household population across the country as that can motivate some households to take the initiative.

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