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What Drives Clean Cooking Solutions in Africa? An Empirical Study in Kenya and Nigeria

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ABSTRACT

Improved cookstoves and clean cooking solutions have been garnering increasing attention in Africa owing to their carbon credits. The energy ladder theory indicates that the utilisation rate of clean cooking solutions increases when the Gross Domestic Product (GDP) per capita increases. This study analyses other factors that may influence the utilisation rate of clean cooking solutions, such as population, women household heads, electricity utilisation, and improved water. The results show that GDP per capita correlated more highly with clean cooking solutions than with other factors. This study also determined that higher electricity access rates did not lead to high utilisation of electric cookstoves in Africa, likely due to the greater influence of traditional cooking methodologies and government policies. Through interviews, the study found that certain policies influence Kenya's high adaptability and Nigeria's low adaptability to clean cooking solutions.

Keywords: Improved Cookstoves, Clean Cooking, Energy Ladder Theory
JEL Classifications: D10, D12

1. INTRODUCTION

In 2022, the world population was estimated to reach 8 billion (United Nations, 2022). Approximately 2.6 billion people, 35% from Sub-Saharan Africa, 25% from India, and 15% from China, have limited options for energy sources and rely primarily on traditional solid biomass (International Energy Agency [IEA], 2021:167). Solid biomass includes firewood, charcoal, food waste, and coal. People, generally women, spend an average of 1.4 h a day collecting kindling, and 4 h a day cooking, and are forced to endure smoke from their cooking stoves that utilise biomass fuels (IEA, 2017:3). Since the 1970s, projects to promote improved cookstoves (ICS) have mainly targeted women from rural areas (Wang and Corson, 2015). Older cookstove systems include triple-stone or tripod stoves, traditional cookstoves made of stone or firewood, and earthen or clay outdoor cookstoves.

Nearly 3.2 million deaths annually are associated with diseases caused by indoor air pollution due to inefficient cooking methods (World Health Organization [WHO], 2021). In addition, the use of wood and charcoal to fuel old-fashioned cookstoves can destroy forests. According to the Clean Cooking Alliance[1], approximately four million people suffer severe illnesses annually and one million die from smoke inhalation from cookstoves, with 50% of these deaths comprising children under five. To address this problem, various projects have been launched using ICSs, which generally cost as little as $10 per unit, although some are more expensive depending on their performance. In addition to wood and charcoal, clean cooking fuels, including electric cooking stoves, liquefied petroleum gas (LPG), biogas, natural gas, methanol, and ethanol, play an essential role. Each country has a different utilisation rate of clean cooking fuels. Moreover, the WHO has divided emission rate targets for cooking fuels into six tiers[2]. Cooking stoves at all

1 Webpage of the Clean Cooking Alliance: https://cleancooking.org/the-value-of-clean-cooking/ (Accessed 6 November 2022)

2 Webpage of the WHO: https://www.who.int/tools/clean-household-energy-solutions-toolkit/module-7-defining-clean (Accessed 4 June 2023)

tiers reduce the cooking time by increasing combustion efficiency and reducing smoke emissions.

In Africa, the aforementioned fuels are used in cooking stoves. However, what factors determine the energy used? Why do these factors influence cookstove fuel options? This study proposes the following hypotheses. The first factor to influences clean cooking fuel utilisation is a country's population size. As many African countries lack adequate infrastructure, fuel costs could be higher in countries with larger populations. Based on personal observations of the author, infrastructure development and logistics systems have become obstacles in some sub-Saharan countries. If the fuel price increases, the adoption rate of clean cooking fuels should decrease. A large population would also increase the charcoal and firewood use ratio. Second, the proportion of women household heads influences the utilisation of clean cooking fuels. Women take major roles in daily cooking (Gill-Wiehl et al., 2021), especially in Africa (Kapfudzaruwa et al., 2017). Therefore, the higher proportion of women household heads may be a factor in the prioritisation of cleaner cooking solutions. Third, the electricity access rate could have a significant impact because the utilisation rate of electric cooking stoves would naturally increase if electricity were widely available. Conversely, if electricity is not widely available in an area, the utilisation rate of electric cooking stoves cannot increase. Fourth, improved water[3] access could also have a meaningful impact, as cooking is almost always associated with clean water. Therefore, the utilisation of ICS would naturally increase when the access to improved water increases.

Upon visiting 28 cookstove companies in 14 African countries over the past year and examining the cooking stove business, the author noticed significant differences in the adoption of ICS and clean cooking fuels in each country. Although the energy ladder theory (Horst and Hovorka, 2008; Burke, 2013; Kroon et al., 2013) states that increasing Gross Domestic Product (GDP) per capita would increase the use of clean cooking fuel, the visits confirmed that real-world situations do not ideally follow the theory. Notably, Nigeria has been slow to adopt clean cooking solutions, whereas Kenya's rapid adoption is evident. Using Demographic Health Survey (DHS) data from 18 countries and conducting a correlation analysis, this study aims to determine why Nigeria experiences difficulties in increasing its usage ratio of clean cooking fuels and why Kenya has the opposite experience. Although both countries have a similar GDP per capita, their adaptation rates to clean cooking fuels differ. To confirm the proposed hypotheses, representatives of both countries were interviewed.

2. LITERATURE REVIEW

2.1. Carbon Credit Markets

According to the World Bank (2022:12), carbon pricing is "a cost-effective policy tool that governments can use as part of their broader climate strategies. A price is placed on greenhouse gas (GHG)[4] emissions, which creates a financial incentive to reduce these emissions or enhance their removal." The three direct carbon pricing mechanisms are the carbon tax, emission trading system (ETS), and carbon crediting mechanism. Carbon tax is a policy instrument through which the government levies a fee for GHG emissions. ETS markets exist as regional[5] or national[6] cap-and-trade schemes[7]. The carbon crediting mechanism refers to "a system in which tradable credits (typically representing a metric ton of carbon dioxide equivalent) are generated through voluntarily implemented emission reduction or removal activities" (The World Bank, 2022:13). According to the Carbon Offset Guide[8], carbon credit markets exist under compliance schemes and voluntary programmes. For example, the United Nations developed the Clean Development Mechanism (CDM)[9] as a compliance scheme, and some non-governmental organisations[10] have developed similar voluntary programmes.

2.2. Existing Studies on Cookstoves

Numerous researchers have studied cookstoves from multiple angles. One of the most important events in this area of research is the recognition of cookstove projects as a mechanism for offsetting carbon emissions from climate change challenges by creating emission credits. According to Donofrio et al. (2021), the carbon credits from household devices were dominated by cookstoves, equating to 6 million CO_2 tons in 2019 and 3.5 million CO_2 tons in 2020.

The production of improved cooking stoves has attracted global attention. Lewis and Pattanayak (2012) conducted 146 analyses from 32 studies conducted in 22 countries. This is because the ICS business has become a means of generating emissions credits (Bumpus, 2011; Freeman and Zerriffi, 2012; 2014; Simon et al., 2012). According to the Clean Cooking Alliance, 4.6 million tons of CO_2 were produced by cookstoves between 2014 and 2015. Lovell and Liverman (2010) considered cookstove-derived methodologies as a recognised mechanism in the Compliance Market, particularly the CDM, and showed that the offset mechanism was complex and argumentative. Freeman and Zerriffi (2012) reported that although the contribution of cookstove-derived carbon finance to climate change is practical, its contribution to health hazards is unknown, emphasising the need to clarify project objectives before their development. Lambe et al. (2015a; 2015b) also stated the uncertainties in carbon finance projects and inherent business risks from cooking stoves.

Some scholars have discussed how cookstoves and water filters influence human behaviour. Thomas et al. (2013) developed a

3 Forms of "improved water" are piped, public tap, tube well, borehole, protected dug well, and bottled water.

4 Greenhouse gases include not only CO_2 but also methane (CH_4), Nitrous Oxide (N_2O), and Fluorinated gases.

5 An example of the regional ETS market exists in the EU as the EUETS. The US and Japan also have state- and prefecture-level ETS markets, respectively.

6 Examples of national ETS markets exist in China, Kazakhstan, and New Zealand. Some countries are also under consideration to introduce an ETS market like Japan.

7 Webpage of CarbonCredit.com: https://carboncredits.com/carbon-prices-today/ (Accessed 3 October 2022). As of October 3rd, 2022, the price of 1 CO_2 ton is valued at approximately €66 in the EUETS.

8 Webpage of Carbon Offset Guide: https://www.offsetguide.org/understanding-carbon-offsets/carbon-offset-programs/compliance-offset-programs/ (Accessed 28 August 2022)

9 CDM is no longer working after 2021.

10 Examples include The Gold Standard in Switzerland and VERRA in the USA.

project using remotely reported electronic sensors to assess the use of water filters and cookstoves in Rwanda, confirming that their use was significantly lower than that reported in surveys. In a pilot project in Rwanda, Barstow et al. (2014) distributed cookstoves and water filters to 1943 households across 15 villages and confirmed positive behavioural changes among its end users. Nagel et al. (2016) expanded the study to larger-scale programmatic cookstoves and household water filters, informing global efforts to reduce childhood morbidity and mortality caused by diarrhoeal diseases and pneumonia. Purdon (2015) examined the carbon finance business environment in Tanzania, Uganda, and Moldova, and found that the state's political economy preferences were necessary to incentivise carbon finance projects, while the price of carbon was insufficient. Simon et al. (2014) discussed the need for future research to consider domestically produced versus imported cookstoves, whether government subsidies should be direct or indirect, and projects with or without emissions credits. Shankar et al. (2014) emphasised that almost everywhere, cooking has been a woman's job and that purchasing and procuring an ICS differs from applying it. Parker et al. (2015) and Beyene et al. (2015) discussed the use of cooking stoves and deforestation and forest degradation, known as "REDD"; both identified the challenges and limited effects of carbon dioxide reduction. Rosenthal et al. (2018) discussed the importance of cookstove improvement, as this can target several of the 17 Sustainable Development Goals, including women's empowerment.

Studies of cookstoves by region were also considered. Gadgil et al. (2013) studied a case in Sudan and found that women were victimised, including sexual assault, when they left to collect firewood. Shan et al. (2017) determined not only stove safety and performance but also local cooking practices and community economic structures from a user's perspective. Pailman et al. (2018) conducted 126 surveys in South Africa, Mozambique, Malawi, and Zambia to investigate ICS effectiveness. Based on empirical studies, Jürisoo et al. (2018) attempted to elucidate the circumstances that changed the use of cookstoves in Kenya and Zambia. Agbokey et al. (2019) found that introducing cookstoves in rural Ghana reduced fuel costs and health hazards and improved the taste of foods.

Problems concerning ICS can be addressed by focusing on the economic burden of its adoption. Hsu et al. (2021) suggested that promoting LPG in rural areas of Kenya through microloans for equipment was commercially viable and beneficial for health because it decreased biomass fuel pollution. Jewitt et al. (2020) highlighted the impact of fuel costs on cookstove selection in Nigeria. Onyekuru et al. (2021) conducted an economic analysis of fuels and fertilisers and stated that education, agricultural engagement, family size, location, and income contributed to household heads' reluctance to pay for ICS adoption in Nigeria. Kapfudzaruwa et al. (2017) considered ICS adoption patterns in Africa and noted a correlation between GDP per capita and illiteracy rates. Gill-Wiehl et al. (2021) noted that the lack of a comparable matrix by fuel type used in cookstoves made the formation of cooking programmes difficult. Kapfudzaruwa et al. (2017) also determined the usefulness of microfinance, the so-called pay-as-you-go type, in which you only pay in advance for your use. Negash et al. (2021) examined the economic factors affecting cookstove biomass, fuel, and fertiliser in Ethiopia.

3. COUNTRY DATA SUMMARY

Figure 1 shows the utilisation of clean cooking fuels and GDP per capita of some African countries. These 18 countries from the African continent were selected as the sample because their updated data (2015 onwards) were available on the Demographic and Health Data website; older data may not accurately reflect the current situation. The relationship between the population of each country and the use of clean cooking fuels is shown in Figure 2. Clean cooking fuel usage tends to be lower in countries with larger populations; however, this does not necessarily imply that its use remains high in countries with smaller populations. Notably, Nigeria has the highest population among the selected countries.

Figure 3 shows the relationship between the women household head of each country and the use of clean cooking fuels. Countries with higher numbers of women household heads tend to have higher access to clean cooking solutions. However, this does not indicate that the use of clean cooking fuels remains high in countries with fewer women household heads, with the R^2 being merely 0.3051 (Figure 3).

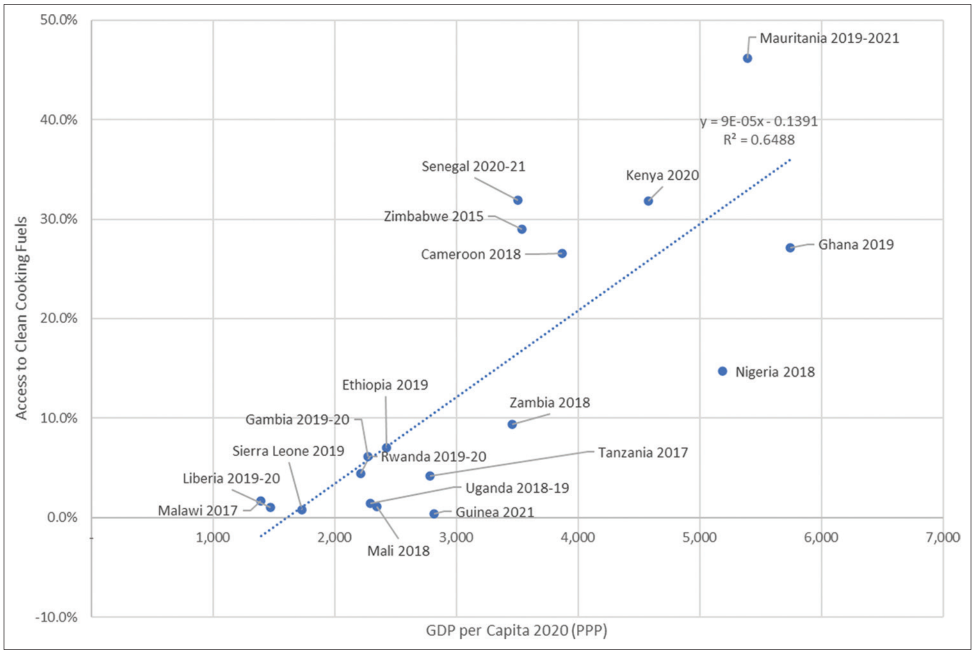
Figure 4 shows the results for the electricity access rate and GDP per capita with an R^2 of 0.4303, which is lower than that in Figure 1 (0.6488). This implies that the GDP per capita is more highly correlated with the utilisation rate of clean cooking fuels than with electricity among the 18 African countries. The utilisation of ICS and the access rate for power increase when GDP per capita increases (Figures 1 and 4). Notably, in Figure 1, Kenya has a high utilisation of clean cooking fuels, and Nigeria has a low utilisation despite having the same level of GDP per capita.

Table 1 lists the utilisation rates of the major factors that influence clean cooking solutions usage. The results show that even in countries with high electricity access, the utilisation rate of electric cookstoves has not increased. A striking example in Table 1 is Ghana, where the use of electric cookstoves has not increased even though the electricity access rate is >80%. This indicates that cooking traditions influence cooking fuel selection. In addition, the utilisation rates of electric cooking stoves in Nigeria and Kenya were low, even though both countries have electricity access rates >50%.

Figure 5 shows the electric cookstove utilisation in the sampled African countries in terms of GDP per capita and power access. A notable example is Zimbabwe's adaptation of electric cookstoves resulting from the government's prohibition on illegal charcoal utilisation. In this instance, government policy, instead of GDP per capita or the access rate to electricity, determines the utilisation of electric cookstoves.

Figure 6 shows the access to improved water and utilisation rate of ICSs. Unlike the electricity and energy ladder theories, improved water and ICS are not well correlated ($R^2 = 0.042$). Because the access rate of improved water is influenced by the locations of

Figure 1: Clean cooking fuels vs. GDP per capita in 18 African countries



Source: Cameroon Demographic and Health Survey (DHS) (2018), Ethiopia Mini-DHS (2019), The Gambia DHS (2019-2020), Ghana Malaria Indicator Survey (MIS) (2019), Guinea MIS (2021), Kenya MIS (2020), Liberia DHS (2019-2020), Malawi MIS (2017), Mali DHS (2018), Mauritania DHS (2019-2021), Nigeria DHS (2018), Rwanda DHS (2019-2020), Senegal MIS (2020-2021), Sierra Leone DHS (2019), Tanzania MIS (2017), Uganda MIS (2018-2019), Zambia DHS (2018), Zimbabwe DHS (2015), The World Bank[11]

water sources, which include underground water aquifers, rivers, ponds, and oceans, the utilisation rate of ICSs may not necessarily coincide with improved water.

4. KENYA AND NIGERIA

The energy ladder theory for Africa is shown in Figure 1. The utilisation rates of clean cooking fuels differed between Kenya and Nigeria despite these countries having a similar GDP per capita. Table 2 shows the consumer demographics of Kenya and Nigeria. Sesan (2014) also investigated Kenya and Nigeria in terms of cooking fuels, comparing the projects in Kenya, where schemes are structured from the bottom up to meet community needs, with projects in Nigeria, which are led by experts from top to bottom. Sesan (2014) stated that the results for Nigeria were inferior to those for Kenya. In this report, the author examined the historical trends in clean cooking fuel utilisation rates to highlight the policy aspects of cooking stove installation in Kenya and Nigeria. Moreover, stakeholders from both countries were interviewed to understand the reasons for these differences.

4.1. Policies and Trends in Clean Cooking Fuel Utilisation

In terms of policies related to ICSs in Kenya, the Kenyan government has supported LPG promotion with a policy of 0% value-added tax (VAT) on LPG since 2016, intending to increase each household's clean energy access to 100% by 2028. However, in July 2021, the government changed its policy by increasing VAT by 16%. Table 3 compares the 2014 and 2020 data for Kenya. The use of clean cooking fuels in urban areas increased by approximately 40%, whereas the use of kerosene and charcoal decreased. The use of LPG increased among clean cooking fuels owing to the above policies. In rural areas, the use of charcoal and firewood decreased, while the use of clean cooking fuels increased. As the VAT rate only increased to 16% in 2021, Table 3 was not significantly affected by VAT.

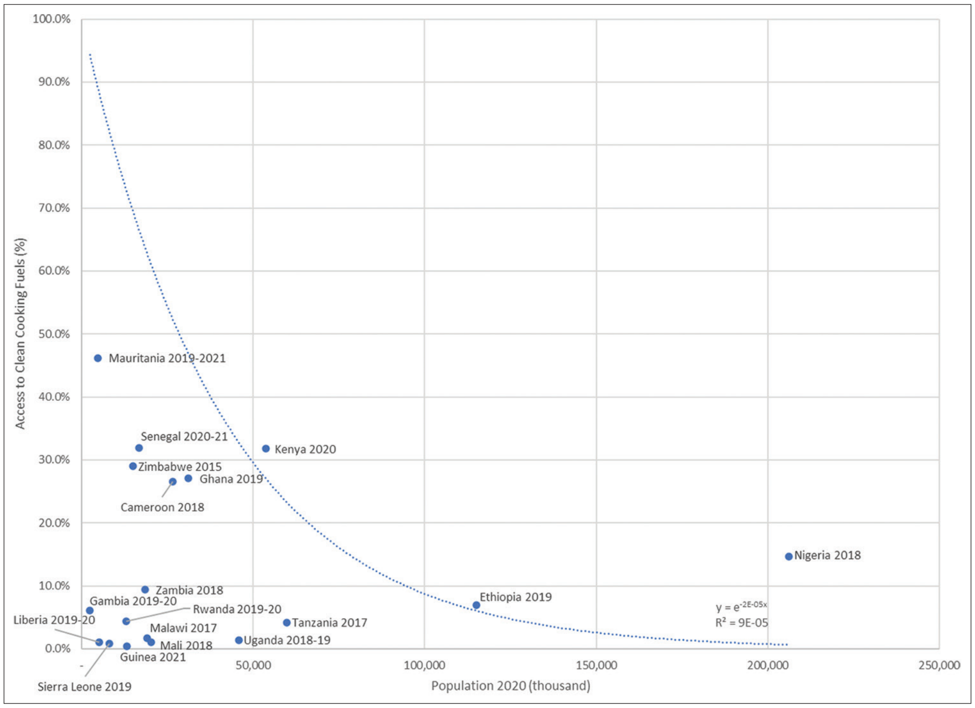
Sesan (2021) stated that in Nigeria in November 2014, during the campaign for the 2015 general elections, the then-Jonathan administration suddenly announced a 9.2 B Naira (US$ 57.5 M at the then currency rate) ICS distribution programme for rural poor women as a national policy. The goal of the Nigerian government was to provide 10 million households with cooking stoves fuelled by clean cooking fuels under the leadership of the Federal Ministry of Environment by 2025. Table 4 compares the use of clean cooking fuels in Nigeria from 2015 to 2018. The use of kerosene in urban areas decreased, while the use of clean cooking fuels other than electricity (LPG, biogas, natural gas, and ethanol) increased. However, in rural areas, where a large segment of the population lives, the use of firewood remained high (>80%). Thus, adopting clean cooking fuels takes longer in rural areas than in urban areas.

4.2. Interviews with Specialists in Nigeria and Kenya

Representatives with sufficient knowledge and experience of the ICS business and the use of clean cooking fuels in both countries were interviewed. The first interview was conducted in April 2022 with an official from an industry association and a researcher in Nigeria. The official holds a management position in this trade association, which comprises cookstove manufacturers and distributors, briquette manufacturers and distributors, and

11 Webpage of The World Bank: https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?most_recent_year_desc=true&msclkid=ac20b4bed06b11ec9e8139602ac37b7d (Accessed 11 July 2022)

Figure 2: Access to clean cooking fuels versus population in 2020 in 18 African counties



Source: Cameroon DHS (2018), Ethiopia Mini-DHS (2019), The Gambia DHS (2019-2020), Ghana MIS (2019), Guinea MIS (2021), Kenya MIS (2020), Liberia DHS (2019-2020), Malawi MIS (2017), Mali DHS (2018), Mauritania DHS (2019-2021), Nigeria DHS (2018), Rwanda DHS (2019-2020), Senegal MIS (2020-2021), Sierra Leone DHS (2019), Tanzania MIS (2017), Uganda MIS (2018-2019), Zambia DHS (2018), Zimbabwe DHS (2015), The World Bank[12]

Table 1: GDP per capita and utilisation rates of clean cooking fuels, electric cookstoves, and hypothesised influencing factors in 18 African countries

Country Data Year	Clean cooking fuels (%)	GDP per capita 2020	Women household head (%)	Electricity access (%)	Improved water (%)	Electric cookstoves (%)
Ethiopia 2019	7.0	2,423	22.1	35	68.7	6.7
Gambia 2019-2020	6.1	2,275	22.0	65.6	94.9	0.2
Ghana 2019	27.1	5,744	34.8	83.50	93.1	0.4
Kenya 2020	31.8	4,578	31.0	55	69.8	0.6
Liberia 2019-2020	1.1	1,468	33.7	23.90	84.0	0.6
Malawi 2017	1.7	1,392	25.6	12.60	86.2	1.7
Nigeria 2018	14.7	5,186	18.0	59.40	65.7	0.7
Rwanda 2019-2020	4.4	2,214	31.9	45.70	80.4	0.2
Sierra Leone 2019	0.8	1,727	27.4	22.70	67.0	0.1
Tanzania 2017	4.2	2,780	20.6	25.80	63.3	0.1
Uganda 2018-2019	1.4	2,294	28.3	41.30	76.2	0.7
Zambia 2018	9.4	3,458	26.8	34.20	72.3	9.2
Zimbabwe 2015	29.0	3,537	40.6	33.70	78.1	25.7
Guinea 2021	0.5	2,817	17.1	51.90	79	0.2
Mali 2018	1.1	2,348	17.4	48.60	69.3	0.5
Senegal 2020-2021	31.9	3,503	24.5	67.30	88.7	0.1
Mauritania 2019-2021	46.2	5,390	39.0	45.90	79.9	1.7
Cameroon 2018	26.6	3,868	26.0	62.20	78.8	0.8

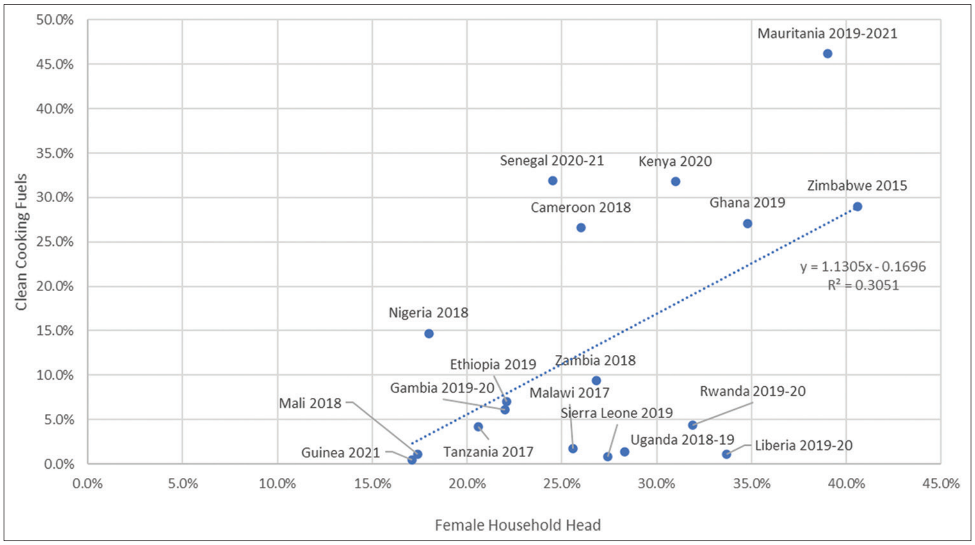
Source: Cameroon DHS (2018), Ethiopia Mini-DHS (2019), The Gambia DHS (2019-20), Ghana MIS (2019), Guinea MIS (2021), Kenya MIS (2020), Liberia DHS (2019-20), Malawi MIS (2017), Mali DHS (2018), Mauritania DHS (2019-21), Nigeria DHS (2018), Rwanda DHS (2019-20), Senegal MIS (2020-21), Sierra Leone DHS (2019), Tanzania MIS (2017), Uganda MIS (2018-19), Zambia DHS (2018), Zimbabwe DHS (2015), The World Bank

consultants, and has more than 30 years of industry experience. The researcher is a professional with 25 years of experience in sociology and social policies.

According to the industry association, poverty has been the main reason for Nigeria's low ICS utilisation. The World Bank identified Nigeria as one of the largest countries in terms of the absolute number of poor people. The official noted that residents must have more knowledge and experience in emission credit projects and that support in this area is needed. The official also believed

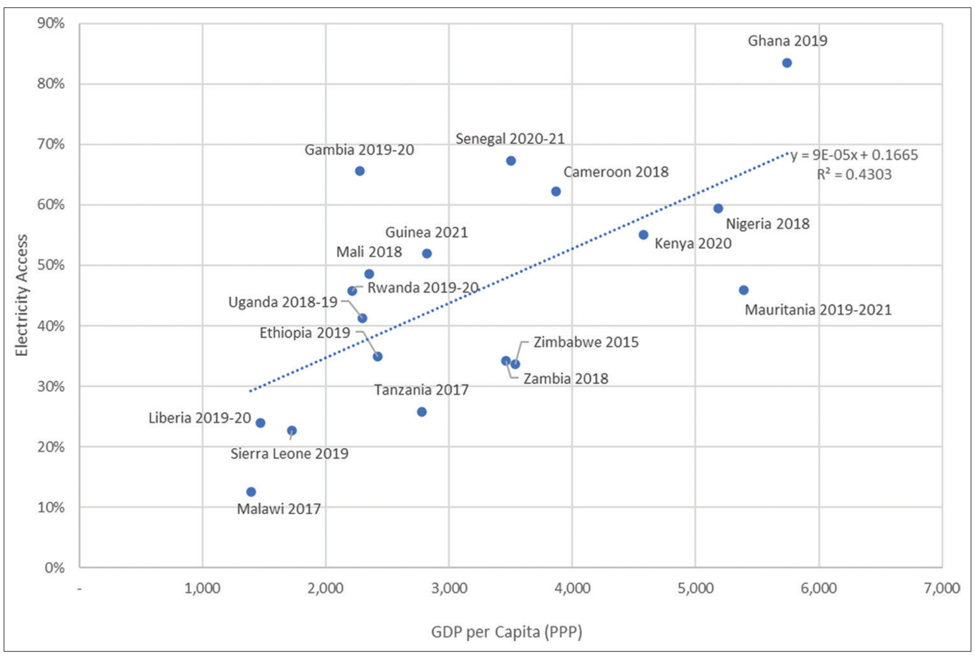
12 Webpage of The World Bank: https://data.worldbank.org/indicator/SP.POP.TOTL (Accessed 11 June 2022)

Figure 3: Access to clean cooking fuels versus women household heads in 18 African countries



Source: Cameroon DHS (2018), Ethiopia Mini-DHS (2019), The Gambia DHS (2019-2020), Ghana MIS (2019), Guinea MIS (2021), Kenya MIS (2020), Liberia DHS (2019-2020), Malawi MIS (2017), Mali DHS (2018), Mauritania DHS (2019-2021), Nigeria DHS (2018), Rwanda DHS (2019-2020), Senegal MIS (2020-2021), Sierra Leone DHS (2019), Tanzania MIS (2017), Uganda MIS (2018-2019), Zambia DHS (2018), Zimbabwe DHS (2015), The World Bank[13]

Figure 4: Power access versus GDP per capita of 18 African countries



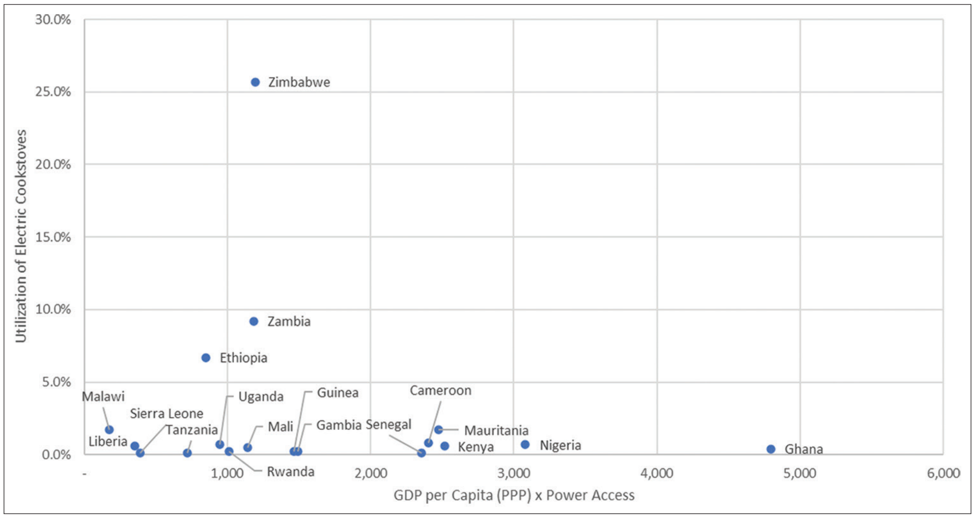
Source: Cameroon DHS (2018), Ethiopia Mini-DHS (2019), The Gambia DHS (2019-20), Ghana MIS (2019), Guinea MIS (2021), Kenya MIS (2020), Liberia DHS (2019-2020), Malawi MIS (2017), Mali DHS (2018), Mauritania DHS (2019-2021), Nigeria DHS (2018), Rwanda DHS (2019-2020), Senegal MIS (2020-2021), Sierra Leone DHS (2019), Tanzania MIS (2017), Uganda MIS (2018-2019), Zambia DHS (2018), Zimbabwe DHS (2015), The World Bank

that promoting foreign investment and creating an environment in which investment returns generate further investments is necessary. Meanwhile, the researcher acknowledged the causes of poverty, especially in rural areas, and stated that adequate planning was essential for the national gas policy in Nigeria. Nigeria's national gas policy involves creating regulatory, institutional, and legal infrastructures to attract significant private sector investment to mainly promote the use of homegrown LPG. However, this business-as-usual approach requires improved infrastructure to allow the widespread use of LPG for cooking. In particular, increasing delivery capacity, known as the "last mile," is essential.

Another interview was conducted in Kenya in June 2022 with a manager in an industry association with cookstove manufacturers and distributors, briquette manufacturers and distributors, and

13 Webpage of The World Bank: https://data.worldbank.org/indicator/SP.POP.TOTL (Accessed 11 June 2022)

Figure 5: Electric cookstove utilisation versus GDP per capita and power access in 18 African countries



Source: Cameroon DHS (2018), Ethiopia Mini-DHS (2019), The Gambia DHS (2019-20), Ghana MIS (2019), Guinea MIS (2021), Kenya MIS (2020), Liberia DHS (2019-2020), Malawi MIS (2017), Mali DHS (2018), Mauritania DHS (2019-2021), Nigeria DHS (2018), Rwanda DHS (2019-2020), Senegal MIS (2020-2021), Sierra Leone DHS (2019), Tanzania MIS (2017), Uganda MIS (2018-2019), Zambia DHS (2018), Zimbabwe DHS (2015), The World Bank

Table 2: Consumer demographics of Kenya and Nigeria

Consumer demographics	Kenya	Nigeria
A. Population (million people)	54[14]	219[15]
B. Number of households (million households) (= a/c)	14.6	46
C. Mean size of households (persons)	3.7	4.7
D1. Household headship (Women) (%)	31	18
D2. Household headship (Men) (%)	69	82
E. Electricity (%)	55	59.4
F. Improved Water (%)	69.8	65.7
G1. Time to obtain drinking water – Water on the premises (%)	50.6	41.6
G2. Time to obtain drinking water – 30 min or less (%)	37.2	52.2
G3. Time to obtain drinking water – More than 30 min (%)	11.9	6.1
G4. Time to obtain drinking water – Don't know (%)	0.3	0.1
Total (%)	100	100

Source: Kenya MIS (2020), Nigeria DHS (2018)

Table 3: Comparison of 2014 and 2020 cooking fuel usage in Kenya

Kenya	2014			2020			Difference		
Unit (%)	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
CCF	25.4	2.1	11.9	63.5	12.1	31.8	+38.1	+10	+19.9
Kerosine	26.6	1.3	11.9	8.1	1.4	4	▲18.5	+0.1	▲7.9
Charcoal	27.6	9.7	17.2	12.2	5.3	7.9	▲15.4	▲4.4	▲9.3
Wood	17.2	84.2	56.1	15.1	79	54.5	▲2.1	▲5.2	▲1.6
Others	3.2	2.7	2.9	1.1	2.2	1.8	▲2.1	▲0.5	+3.9
Total	100	100	100	100	100	100	0	0	0

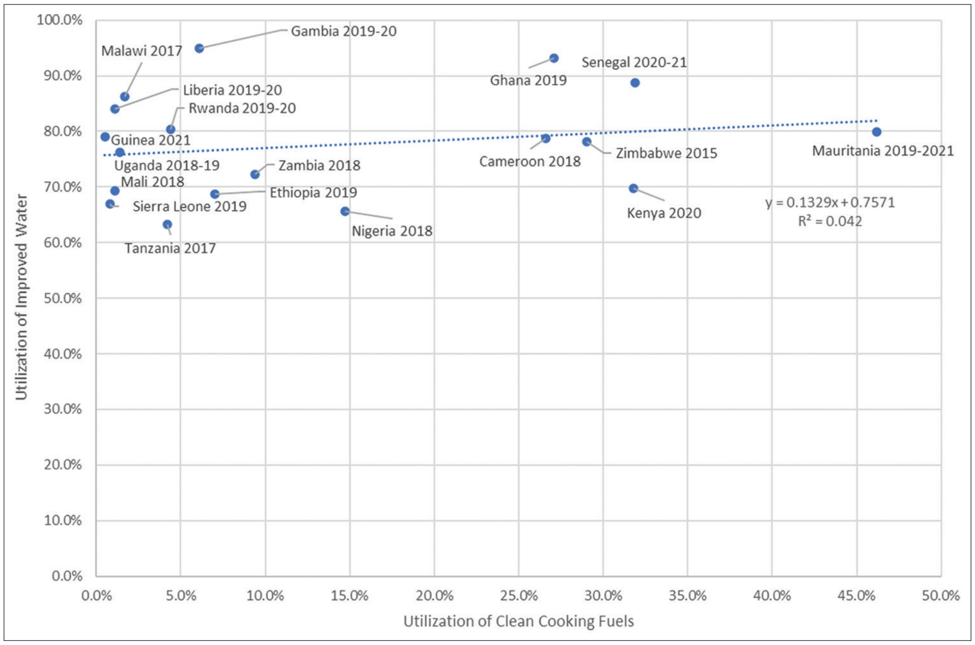
CCF: Clean cooking fuel, Source: Kenya DHS (2014), Kenya MIS (2020)

consultants, among others. Interviewees noted that although the Kenyan government's elimination of the value-added tax (VAT) to promote LPG was effective, the growth rate of LPG use was likely to be impacted in the future because the Kenyan government reinstated the 16% VAT in July 2021. However, a representative mentioned that active lobbying to lower the restored VAT was ongoing. The same person also suggested that there may be room to reconsider cooking stoves that were not exempt from VAT because other fuels are VAT-free. Regarding the situation in Kenya and Nigeria, despite not knowing the situation in Nigeria in-depth, the person emphasised that, for better or worse, Kenya had to concentrate on its policy regarding energy imports. Nigeria is an energy exporter and an energy powerhouse that exports crude oil and imports gasoline, making its energy policy complex and challenging. The same person also suggested that Kenya's long history of not being an energy exporter has forced it to focus its

14 Webpage of World Population Review (Kenya): https://worldpopulationreview.com/countries/kenya-population (Accessed 7 November 2022)

15 Webpage of World Population Review (Nigeria): https://worldpopulationreview.com/countries/nigeria-population (Accessed 7 November 2022)

Figure 6: Access to improved water versus utilisation of clean cooking fuels in 18 African countries



Source: Cameroon DHS (2018), Ethiopia Mini-DHS (2019), The Gambia DHS (2019-2020), Ghana MIS (2019), Guinea MIS (2021), Kenya MIS (2020), Liberia DHS (2019-2020), Malawi MIS (2017), Mali DHS (2018), Mauritania DHS (2019-2021), Nigeria DHS (2018), Rwanda DHS (2019-2020), Senegal MIS (2020-2021), Sierra Leone DHS (2019), Tanzania MIS (2017), Uganda MIS (2018-2019), Zambia DHS (2018), Zimbabwe DHS (2015), The World Bank

Table 4: Comparison of 2015 and 2018 cooking fuel usage in Nigeria

Nigeria	2015			2018			Difference		
Unit (%)	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Electricity	1.2	0.3	0.6	1.1	0.3	0.7	▲0.1	0	+0.1
Other CCF[16]	9.6	1.5	4.7	25.7	3.7	14	+16.1	2.2	+9.3
Kerosine	43.9	10.5	23.8	24.3	6.8	15	▲19.6	▲3.7	▲8.8
Charcoal	6.3	1.2	3.3	9.3	2.6	5.8	+3	+1.4	+2.5
Wood	37.3	83.3	65	36.8	82.6	61.1	▲0.5	▲0.7	▲3.9
Others	1.7	3.2	2.6	2.8	4	3.4	+1.1	+0.8	+0.8
Total	100	100	100	100	100	100	0	0	0

CCF: Clean cooking fuel, Source: Nigeria MIS (2015), Nigeria DHS (2018)

policies on importing and using energy efficiently, which may have led to the successful adoption of clean cooking fuel.

5. CONCLUSION

Based on the post-2015 data from the 18 African countries sampled, no significant relationship was found between each country's population and the use of clean cooking fuels. Countries with larger populations tended to have lower utilisation of clean cooking fuels; however, this does not mean that scattered countries with smaller populations remain stagnant in their utilisation. In addition, no definite relationship was found between electricity access and the use of electric cooking stoves. This implies that even if people had access to electricity, users did not find it convenient to change the cooking method they were already familiar with. Moreover, no definite relationship was observed between access to improved water and ICS use. This implies that the only accessible water may still come from underground water aquifers, rivers, and ponds. In contrast, the relationship between GDP per capita and clean cooking fuel use showed a tendency for clean cooking fuels to increase as GDP per capita increased. In addition, a correlation between GDP per capita and electricity access was observed. However, considering the example of Zimbabwe, government policy rather than the power utilisation rate may influence the utilisation of electric cookstoves.

Kenya and Nigeria, countries with a similar GDP per capita, both use VAT as a policy inducement. The interviews revealed that poverty alleviation and infrastructure development measures are necessary to improve clean cooking fuel usage in Nigeria. These discussions highlight the difficulties in formulating Nigeria's energy export and import policies. It also suggests concerns about a future slowdown in the growth rate of LPG usage in Kenya because the government abolished 0% VAT on LPG.

Adaptations of clean cooking solutions and ICS are sometimes discussed from the perspective of the energy ladder theory. However, this study revealed other factors underlying the

16 This category includes LPG, cylinder gas, natural gas, and biogas.

theory, particularly the influence of the policies imposed by the governments. Moreover, this study found that GDP per capita is not the only factor determining the utilisation level of clean cooking solutions implemented in African countries. This analysis can help policymakers increase the rate of clean cooking solutions to achieve climate change targets. It can also help the private sector to strategise the implementation of cookstove carbon credit projects in Africa.

5.1. Study Limitations

Travelling to African countries and discussing cookstoves revealed that many people depended on multiple cookstove fuels; that is, both ICS and clean cooking solutions such as LPG and charcoal. Utilising several options is common depending on the type of food cooked. Having a backup cooking solution was also common, for example, in preparation for power outages, which is common in some African countries. If people have multiple types of cookstoves, both ICS and clean cooking solutions may influence the utilisation ratio of cookstoves.

The information presented in this paper used available data from 2015 to 2021, while the information on population and GDP per capita for each country was from the year 2020. This discrepancy in data periods could have influenced the analysis. In addition, because of the author's limited language skills, the French and Portuguese data from some African countries were not fully utilised. These points should be considered in future studies.

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