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LPG Utilization in Nigerian Households – A Review and Forecast 2022

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Abstract: *This paper examines how (Liquefied Petroleum and Natural Gas (LPG) gas is used in Nigerian households. The World Bank and Nigeria National Petroleum Corporation (NNPC) Statistical Bulletin were used to gather yearly data regarding the level of LPG produced and consumed including kerosene for a period of 36 years (1986 to 2022). Results from the study showed that LPG was high (6.903 million barrels), but consumption was lower (3.18 million barrels). On the other side, after 36 years, kerosene consumption in Nigeria (6.2030 mbbls) outpaces its production (4.0532 mbbls).Therefore, LPG consumption will inevitably rise over time. Consequently, it is expedient for the domestic energy market of Nigeria to enact policies to ensure that every Nigerian home use LPG. If consumers switched to LPG, the government wouldn't have to spend as much money subsidizing the price of kerosene for the domestic energy market in Nigeria. To increase the use of LPG as a domestic fuel in Nigeria, this paper is important for both the Nigerian government and investors. The outcome of this study would furnish clarifications to help the government make policy decisions and informs investors about the demand and consumption structure of the domestic energy market in Nigeria.*

Keywords: *LPG, Utilization, Review, Forecast, Nigerian-Homes, Consumption and Production.*

1. INTRODUCTION

With a population of about 218 million (World Bank, 2022), located on the western coast along the Gulf of Guinea and domiciled in Africa, Nigeria refers to the OPEC nation that has the biggest populace. The natural gas reserves in Nigeria have risen from 202 trillion cubic feet (tcf) to 209.16 trillion cubic feet (tcf) between 2019 and 2022, respectively (NPURC, 2022), with an export capacity of 28.6256 million cubic meters and is anticipated to rise in the next years (OPEC, 2019). This suggests that, literally, Nigeria stands on a wealth of reserves that, if properly utilized, can act as a catalyst for the economic growth and prosperity of Nigeria (GECF, 2020).

LPG is a net export for Nigeria, which produces an average of 3 million tonnes per year (MTPA) and consumes only 400,000 tonnes (MT) yearly (FY 2016), or 15% of production (Abdul-Kabir, 2015). According to conservative estimates, domestic cooking accounts for between 85 and 95 percent of LPG consumption in Nigeria (Badmus et al., 2021). In Nigeria, refineries and a few gas processing facilities are the main sources of LPG production. LPG is created as a light byproduct of the oil refining process in the refineries in Warri and Port Harcourt (Abdul-Kadir, 2015). The largest gas processing facility in Nigeria is called Nigerian Liquified Natural gas (NLNG). According to Abdullahi (2014), the center converts wet gas obtained from a few nearby oil sources into natural gas liquids and natural gas (liquefied for export).

The Mobil Oso facility in Bonny and the Chevron Escravos facility are two other significant gas processing facilities in the nation. Both facilities generate LPG primarily for the export market (Amadi et al, 2021). LPG is sold ex-gate on bulk trucks with a 20–25MT capacity from the nearby refineries. Many businesses, including Shell, Total, BP, Agip, and others, have been producing these

gases for many years. As a result, the abundance of natural gas reserves makes the gas industry profitable (Chikezie et al, 2020).

LPG is a fuel utilized in homes. LPG consist of combination gases such as hydrogen and carbon utilized as fuel for the purpose of home warming appliances or gas used for cooking including industries (WLPGA, 2023). Nigeria is a nation that is developing, this is traceable to the increasing rate of the populace and as such fuel utilized for other domestic use is greater than that of LPG utilized home as well as industries. LPG serves a fuel that is used in homes, it has the capability of offering cleaner burning as well as providing safety alongside minimal emissions (Nwokocha, 2010). The recent need for energy transition has made natural gas utilization a cleaner option among fossil-based energy sources. Nigeria is said to be country with abundant natural gas sources and pockets of hydrocarbon. One of the ways to utilizing Natural gas is as domestic gas for cooking.

LPG is becoming more and more popular among both retail and industrial consumers due to its clean, adaptable, and secure nature. Even though it emits fewer greenhouse emissions than other energy sources, it is still a better energy source than others due to its accessibility and availability. Annual consumption data from NLNG Company continues to indicate rise in LPG usage, which grew recently from 50,000 Tons in 2001 to 140,000 Tons in 2013. To fully satisfy this rising demand, Total Energies has invested in five cutting-edge LPG bottling facilities in Nigeria, which are located in the states of Lagos, Edo, Anambra, Kaduna, and Kano. Our facilities have received certification for their quality management systems under ISO 9001:2008. The average storage and filling capacities of these plants are 2,150 M3 and 700 LPG cylinders respectively(Total Energies, 2022). From the foregoing, it is imperative to review and forecast the production and consumption of LPG and kerosene in Nigerian homes to aid policy makers in decision making or economic planning.

2. STATEMENT OF THE PROBLEM

Nigeria is endowed with a wealth of natural gas resources, however the challenge of effectively maximizing natural gas utilization, especially LPG, is currently a concern (Garside, 2020; GECF, 2020). Of the four main cooking fuels—Firewood, Kerosene, Charcoal, and Gas—LP Gas is the least used. Nigeria has a per capita consumption of just over 1 kg, which is considerably less than that of other West African nations like Ghana (4.7 kg) and Senegal (9 kg) and significantly less than that of other developing nations like Egypt (25 kg), Indonesia (85 kg), and South Africa (8.5 kg) (EIA and Population Reference Bureau, 2016). Over 50% of households in Nigeria still use firewood as their primary source of cooking fuel, contributing to the country's ongoing environmental problems (Abdul-Kadir, 2015). The frequent use of kerosene for cooking at home and the subsequent frequent burning of charcoal have made the issue worse (Chikezie et al., 2020). According to the Developmental Association of Renewable Energy, kerosene (27%), charcoal (6%), and firewood (56%) are used as residential fuels more frequently than LP (5%). Others include sawdust (2%), electricity (4%), and others. Nigeria must therefore make the most of the natural resources obtained from natural gas to meet the four criteria for global energy security: affordability, accessibility, availability, and acceptability. Therefore, to examine the factors influencing supply and demand in the Nigerian energy market, this article examines times series analysis of LPG as a home fuel and Kerosene, it would establish the LPG and kerosene domestic market's underlying energy demand trend (UEDT), which would help stakeholders make forecasts and decisions and the government formulate policies.

3. OBJECTIVES OF THE STUDIES

The purpose of this study is to assess and forecast the use of LPG gas in Nigerian households and based on the results, to analyze the variables influencing supply and demand in the Nigerian energy market. The study specifically identified trend associated with the demand for energy for kerosene cum LPG relating to the domestic market of Nigeria, it is anticipated to provide support prediction as well as making of choices by collaborators as well as government policymaking. In addition to informing investors relating to the rate at which demand and patterns of consumption as it affects the Nigerian domestic energy market. This study is important to the government of Nigeria as well as shareholders. This will increase the rate at which LPG is used as a domestic fuel in Nigeria. Although there are various methods for determining the trend in energy demand. This study is limited by

spreadsheet program utilized for modelling (stochastic) of trend relating to the demand of energy as well as producing a particular direction of flow with the help of curve fitting which will help in the estimation of Nigerian LPG consumption behavior.

4. LITERATURE REVIEW

There are several previous research on LPG and kerosene production and use in the literature, however they all have different restrictions. According to a recent literature review, the relative growth in LPG demand between 1986 and the present can be attributed to government initiatives to stimulate LPG consumption. Due to the badly refined kerosene fuel that has increased domestic mishaps in Nigerian households, kerosene demand has been on the decline. In Nigeria, LPG is still the residential fuel that is most affordable, cleanest, and safest.

4.1. Liquified Petroleum Gas as a Domestic Fuel

As a byproduct of the methods used to refine oil, liquefied petroleum gas (LPG) is created. Propane makes up LPG, a mixture of light hydrocarbons that may also comprise isobutene, regular butane, and butylenes. These substances both at room temperature as well as atmospheric pressure are deemed gaseous, meanwhile, they can liquefy at room temperature, when pressure is being applied. LPG is delivered in pressurized steel bottles, which are normally filled in the range of eighty percent to eighty five percent respectively of their size to permit for enlargement of the liquid inside. In pressure vessels, LPG is kept for ease of handling. For pure butane at 20 °C (68 °F), a given quantity of LPG fills 250 times its volume when it vaporizes, and for pure propane at 55 °C (131 °F), it is roughly 2.2 mega Pascals (22 bar). A strong detergent, such as ethanethiol or melchaptane, is included for the purpose of detecting possible leakages. Because then gas is described as odorless with heavier capacity than than air, what it does is to replace air and consequently settle in the basement, and as such may lead to choking. Propane and butane are combined in LPG in a 60:40 ratio. 2010 (Nwokocha). In their study, Amadi et al. (2021) used Choba as a deliberate case study to analyze the distribution of LPG to households. The findings demonstrated that investing in the pipeline option will boost national security, employment opportunities, services, and technological advancements. With the help of a detailed environmental impact assessment carried for the goal of sustainable development, the authors further uncovered the fundamental criteria to limit the harmful effects of LPG distribution on the environment. In addition to the current Lagos outlet, Ihemtuge et al. (2020) created a new, cost-effective distribution network for LPG delivery to cities throughout Nigeria using the projected Port Harcourt and Calabar outlets. The study also found that using the proposed Port Harcourt and Calabar outlets for LPG distribution might reduce trucking costs throughout cities in the nation by up to 25% on average. Time series analysis was used by Abdullahi (2014) to model the demand for petroleum products. The authors discovered that all products arising from petroleum, including LPG, fuel utilized for oil, petrol, diesel, kerosene appears inelastic in terms of both price and income. LPG, however, has the highest inelasticity, meaning that the market's supply of the fuel has been depleted.

4.2. Kerosene Utilized for Household Cooking

The term kerosene refers to a burnable hydrocarbon liquid made via crude oil that is utilizedas jet fuel, stove fuel, and in lamps. In Nigeria, it is a typical domestic fuel. Kerosene produced in Nigeria must meet specifications from the Nigerian Upstream Petroleum Regulatory Commission (NUPRC), unlike LPG. Unfortunately, most of the kerosene sold in Nigeria does not meet the requirements set forth by the Department of Petroleum Resources (DPR). LPG refers to the best and safest cooking fuel for homes in Nigeria because of the numerous domestic mishaps and fire outbreaks that have occurred. A study on the energy, environmental, and energy compatibility evaluations of HHK and LPG use as home fuels in Nigeria for more than 40 years was conducted by Badmus et al. in 2021.The outcome demonstrated that using HHK for lighting and coking fuel is significantly less efficient. As a result, LPG needs to make up a larger share of the cooking fuel mix because it is more ecologically friendly, energy efficient, and effective. According to Chikezie et al. (2020), who identified and analyzed the amounts of domestic energy used, as well as the issues and future implications of indiscriminate deforestation for energy use, the rate at which wood energy is being consumed in Imo is on the increase, and they recommended increasing LPG use to lower the region's rate of charcoal burning. Although their results varied, as is typical, Adagunoda and Abdullahi (2014) both used times

series analysis and a random trend model to model the demand for petroleum products. While Abdullahi (2014) examined LP gas, fuel oil, diesel, kerosene, and fuel. Only three petroleum products—gasoline, diesel, and kerosene—were examined by Adagunoda (2014). They did not, however, include a time/trend analysis of domestic fuel demand in Nigeria from the standpoint of residential and industrial utilization. The literature that is currently available does not mention the growing pattern of demand or consumption in Nigeria. From the aforementioned, it is clear that a clean, readily available, and reasonably priced fuel used for cooking in Nigerian homes is the current clamor. The clean, adaptable, and safe character of liquefied petroleum gas (LPG) has contributed to its rising popularity among both retail and industrial consumers. LPG has established itself as a revolutionary residential fuel.

5. METHODOLOGY

For this analysis, data from an annual time series covering the years 1986 to 2022 were gathered from the World Bank and the NNPC Annual Statistical Bulletin (now known as Nigeria National Petroleum Limited (NNPL)). Figures 3 and 4 provide respective graphical representations of how LPG and kerosene are being produced and consumed as plotted on a Microsoft Excel spreadsheet using data from the World Bank and NNPC Annual Statistical Bulletin. Linear regression was performed using the excel function on the plotted graph for both LPG alongside kerosene, and a straight regression statement was produced to reveal the connections between the energy production/consumption trend as well as the time involved. The methodological procedure for this study is shown in Figure 1. To accomplish its goals, this study used time series analysis. Time series evaluation technique which is performed for a variety of rationalealongsideintentions that are beneficial as well as suitable for various goals. Time series or trend analysis is helpful for pattern recognition, predicting, abnormality observation, and other processes. Numerous techniques and computer programs are used to conduct time series/trend analysis (Harvey, 1989).The simplest and clearest method for performing a time series/trend analysis is stated to be exploratory analysis. The variables could be plotted in a spreadsheet to accomplish this. In this approach, the reliance of a serial occurrence on another could be investigated using autocorrelation or linear regression.

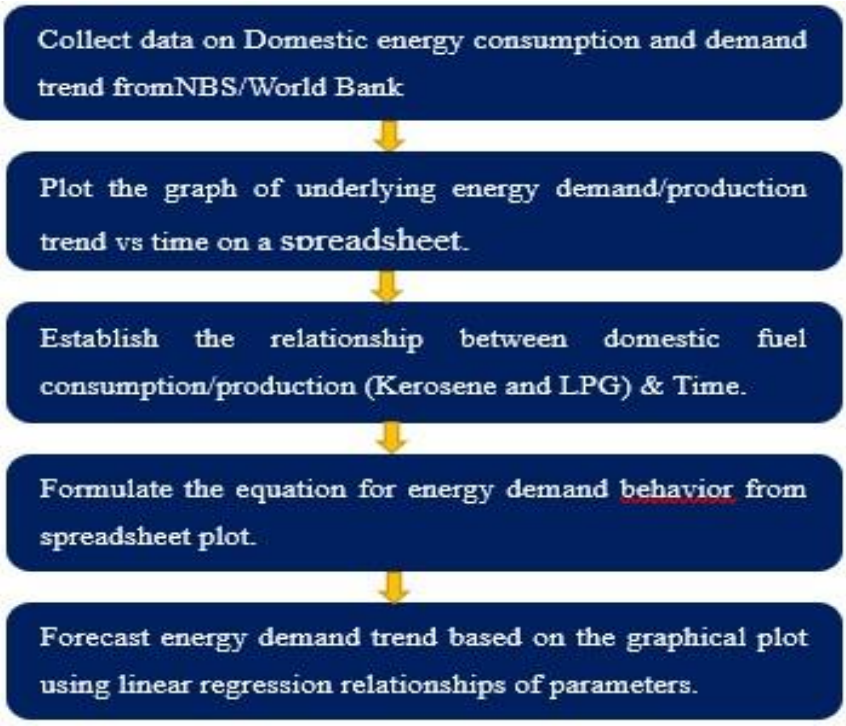

Figure1. *Methodological Procedure*

Time series/trend analysis may lead to a sophisticated mathematical procedure comprising functions; this type of difficult evaluation can be carried out with the help of a variety of software programs, including SPSS, E-VIEW, STRAMP, and others. Stochastic time series models are typical. To demonstrate the pace at which LPG demand and consumption rise over the period, a straight

regression connection for the period as well as existence of LPG demand and consumption will be established in this study utilizing a Microsoft Excel spreadsheet. From past patterns, time series/trend analysis can be used to anticipate short-term trends as well as future trends. Etc.

6. RESULTS AND DISCUSSION

6.1. LPG Consumption and Production

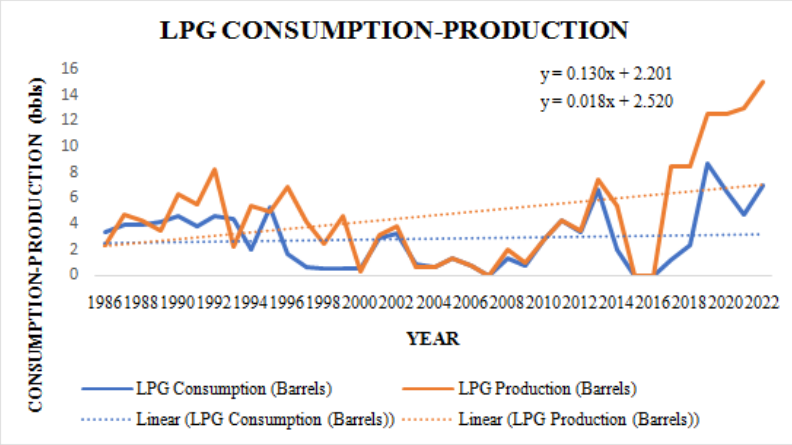

Fig2. *LPG Production & Consumption Linear Regression Pattern*

The plotted graph for LPG as depicted in Fig. 2 reveals that the produced LPG linear regression line can be established in the connection below:

$$y = -0.1306x + 2.2016 \quad [1]$$

Parameters definition

y = Trend of the produced energy

x = Linear regression line intercept, possessing a co-efficient -0.1306, showing the extent through which, the intercept influences the produced energy trend relating toLPG in the future. 2.2016refers to the expression. Eq. 1 reveals the computed LPG production trend.

The plotted graph for LPG as depicted in Fig. 2 reveals that the consumed LPG linear regression line can be established in the connection below:

$$y = -0.0184x + 2.5203 \quad [2]$$

Parameters definition

y = Trend of the produced energy

x = Linear regression line intercept, possessing a co-efficient -0.0184,showing the extent through which, the intercept influences the produced energy trend relating toLPG in the future. 2.5203refers to the expression. Eq. 2 reveals the computed kerosene production trend.

6.2. Kerosene Consumption and Production

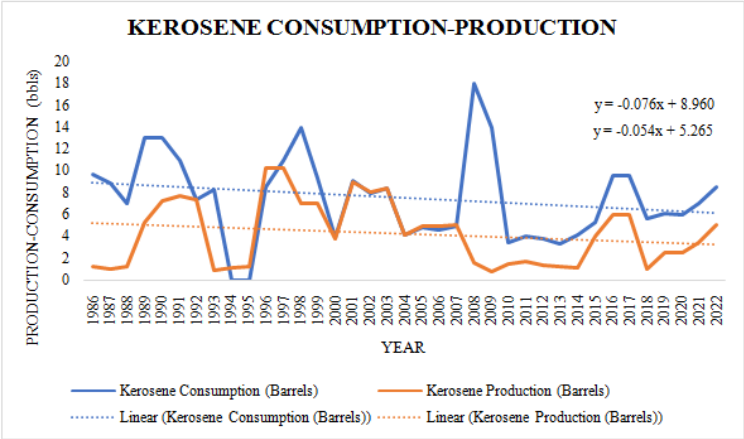

Fig3. *Kerosene Production-Consumption Linear Regression Pattern*

The plotted graph for kerosene as depicted in Fig. 3 reveals that the produced kerosene linear regression line can be established in the connection below:

$$y = -0.0548x + 5.2655 \quad [3]$$

Parameters definition

y = Trend of the produced energy

x = Linear regression line intercept, possessing a co-efficient -0.0548, showing the extent through which, the intercept influences the produced energy trend relating to kerosene in the future. 5.2655refers to the expression. Eq. 3 reveals the computed kerosene production trend.

The plotted graph for kerosene as depicted in Fig. 3 reveals that the consumed kerosene linear regression line can be established in the connection below:

$$y = -0.00766x + 8.960 \quad [4]$$

Parameters definition

y = Trend of the produced energy

x = Linear regression line intercept, possessing a co-efficient -0.00766, showing the extent through which, the intercept influences the produced energy trend relating to kerosene in the future. 8.9604refers to the expression. Eq. 4 reveals the computed kerosene production trend.

The above established connection can be effortlessly handled and broken down, reason is that the x and y variables as considered in this study stands for just two (2) variables representing the consumed and produced energy trend versus time. In the case where different parameters are regarded,

An alternative software packages such as the structural time series evaluation software package (STRAMP) as produced by Harvey(1989) may have been utilized to compute the fundamental energy trend taking cognizance the time, commodity price, income per capita, as well as GDP etc. On the course of the evaluation.

7. DISCUSSION OF RESULTS

7.1. Comparision of LPG And Kerosene Production-Consumption Trends LPG Consumption and Production

Equations (1) and (2) above show the link between LPG output and demand. It is noted that in the period of 36 years, or between 1986 and 2022, X= 36. output of liquefied petroleum gas was high (6.903 mbbls), but consumption was lower (3.1830 mbbls) than output. This supports the finding in the literature (Abdul-kadir, 2015) that there is a low level of LPG consumption in Nigeria. This is attributed to absence of consciousness, problem of openness, and expensive costs, hence there should be an upsurge relating to LPG consciousness as regards cooking stressing on its safety as well as effectiveness to encourage its consumption by the citizens. Establishing LPG production facilities at various sites around the state to support expanded LPG production in Nigeria and provide jobs for young people. According to Abdul-kadir (2015), there are some obstacles to the use of LPG as a residential fuel, including supply chain problems, the growth of the local market, and the acceptance of LPG as a domestic fuel. It is important to remember that there is not a significant gap between output and consumption. Government policies are used to spread knowledge and make LPG available. As seen in Figure 2, demand levels could rise, quickly approaching or even surpassing production levels. From the foregoing,the government and shareholders can partner to assist upsurge the quantity of LPG produced in Nigeria as well as establishing plants that can be used to produce LPG at different sites within the country; no doubt, this initiative will help carve out alternative means of youth employment.

7.2. Kerosene Consumption and Production

On the other side, the kerosene consumption in Nigeria (6.2030 mbbls) will surpass its production (4.0532 mbbls) at the end of 36 years, or between 1986 and 2022. This further supports the finding in the literature (Abdullahi, 2014, 2014) that Nigerian refineries are unable to produce enough kerosene to meet the country's energy needs. As a result, kerosene is imported, and the price of kerosene is subsidized by the Nigerian federal government. Nigeria has a sizable gas reservoir with a capacity of

186.9 trillion cubic feet, which might be used to make LPG, In other words, assuming there is likelihood tomanufacture LPGvia natural gas uniquely. There are four refineries that are yet to be effectively utilized in Nigeria. These refineries have been plagued by treasonas well asproblems arising from operations. The products emanating from oil and gas are yet to be properly maximized in Nigeria that are utilized in Nigeria and to say the least, the said products are refined abroad. Consequently, incentives were provided for the prices of all these fuels through the Nigerian government (Abdullahi, 2014, 2014). At this point it is necessary to examine the implications of the recent elimination of gasoline subsidies on kerosene production and consumption. If this occurs, home energy users may turn to LPG as a fallback, therefore make sure there is enough LPG available to meet demand. It is worthy of note that in reshaping the domestic energy market of Nigeria, policy plays a vital role. To achieve this, there must be a partnership beween the shareholders as well as the government regarding the local energy market. Further findings from the study showed that problem arising from supply, inability to develop local market, alongside enforcing LPG usage as domestic fuel by letting people know about LPG, Citizens being able to make use of it as well as welcoming its usage holistically are some of the issues that have hindered the utilization of LPG as a domestic fuel in Nigeria.

From the comparison above, a clean, readily available, and reasonably priced fuel used for cooking in Nigerian homes is the current clamor. The clean, adaptable, and safe character of liquefied petroleum gas (LPG) has contributed to its rising popularity among both retail and industrial consumers. LPG has established itself as a revolutionary residential fuel. The result found in this study agrees with a recent study, it was observed that the relative growth in LPG demand between 1986 and the present can be attributed to government initiatives to stimulate LPG consumption. Due to the badly refined kerosene fuel that has increased domestic mishaps in Nigerian households, kerosene demand has been on the decline. In Nigeria, LPG is still the residential fuel that is most affordable, cleanest, and safest. To further validate the result of this study, a study on the energy, environmental, and energy compatibility evaluations of HHK and LPG use as home fuels in Nigeria for more than 40 years was conducted by Badmus et al. in 2021.The outcome demonstrated that using HHK for lighting and coking fuel is significantly less efficient. As a result, LPG needs to make up a larger share of the cooking fuel mix because it is more ecologically friendly, energy efficient, and effective.

8. CONCLUSION

Nigeria is fortunate to have a wealth of natural gas resources, including LPG. This suggests that, literally, Nigeria stands on a wealth of reserves that, if properly utilized, can act as a catalyst for the country's economic progress. The purpose of this study is to evaluate and project how LPG gas would be used in Nigerian homes. Based on the outcome, an effort was made to study the variables influencing supply and demand in the Nigerian energy market. The study specifically identified trend associated with the demand for energy for kerosene cum LPGrelating to the domestic market of Nigeria, it is anticipated to provide supportprediction as well as making of choices by collaborators as well as government policymaking.

The World Bank and Nigeria National Petroleum Corporation (NNPC) Statistical Bulletin (now referred to as Nigeria National Petroleum Corporation Limited (NNPCL) were used to gather yearly data regarding the level of LPG produced and consumed including kerosene for a period of 36 years (1986 to 2022) and utilized for this analysis.This study implored the use of time series analysis alongside linear regression method to achieve the purpose of the study.

Results from the study revealed that Nigerian experienced high LPG production level of 6.903mbbls and 3.1830mbbls for consumption, signifying that the production level was higher. This results aligns with previous result obtained in literature (Abdul-kadir, 2015), stating that Nigeria is characterized with low level of LPG consumption due toproblem arising from supply, inability to develop local market, alongside enforcing LPG usage as domestic fuel by letting people know about LPG, Citizens being able to make use of it as well as welcoming its usage holistically are some of the issues that have hindered the utilization of LPG as a domestic fuel in Nigeria.Further, the consumption level of Kerosene in Nigeria was observed to 6.2030mbbls) as against a production value of 4.0532mbbls for the period under review. This results also aligns with previous result obtained in literature(Abdullahi, 2014, 2014) stating that the refineries in Nigeria lack the capacity of producing the required kerosene needed for the Nigerian energy market.This has resulted to kerosene being imported and incentive provided to cushion the arising effect via Nigerian government.

In concluding,LPG consumption will rise over time. Consequently, tit is expedient that effective and efficient polices relating to the domestic energy market of Nigeria by ensuring that every home in Nigeria utilizes LPG. If consumers switched to LPG, the government wouldn't have to spend as much money subsidizing the price of kerosene for the domestic energy market in Nigeria. This study therefore would furnish clarifications for the Nigerian government, and investors because investors will be provided with the needed information about the request as well as consumption patterns of the local energy market in Nigeria, which will increase the use of LPG as a domestic fuel in that country.

9. RECOMMENDATIONS

This study recommends the following:

1. There should be an awareness upsurge relating to LPG consciousness as regards cooking stressing on its safety as well as effectiveness to encourage its consumption by the citizens.
2. The government and shareholders can partner to assist upsurge the quantity of LPG produced in Nigeria as well as establishing plants that can be used to produce LPG at different sites within the country; no doubt, this initiative will help carve out alternative means of youth employment.
3. Establishing LPG production facilities at various sites around the state to support expanded LPG production in Nigeria and provide jobs for young people.
4. Examine the implications of the recent elimination of gasoline subsidies on kerosene production and consumption. If this occurs, home energy users may turn to LPG as a fallback, therefore make sure there is enough LPG available to meet demand.
5. Although there are various methods for determining the trend in energy demand. This study is limited to spreadsheet program utilized for modelling (stochastic) of trend relating to the demand of energy as well as producing a particular direction of flow with the help of curve fitting which will help in the estimation of Nigerian LPG consumption behavior. Other methods could be adopted to compare results obtained from this study.

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