Forecasting the Domestic Utilization of Natural Gas in Nigeria (2015-2020)*

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Abstract

Domestic utilization of natural gas in Nigeria is being hampered by the poor developments in the natural gas sector over the years, with low level of electricity (generation) consumption per capital, weak legal, commercial and regulatory framework amidst poor infrastructure development in natural gas as compared to that which exists for oil. Nigeria ranks the second in gas flaring and shows low volumes of domestic gas utilization, consuming only about 11% out of the 8.25 billion cubic feet produced per day in 2014, despite its natural gas resource endowment. This article examines the determinants of domestic utilization of natural gas in Nigeria from 1990-2013. It investigates its relationship as a function of price of natural gas, price of alternative fuels, foreign direct investment, volumes of gas flared, electricity generated from natural gas sources and per capital real GDP. Going further, it forecasts its likely growth rate for a short-term period, using an econometric methodology of ordinary least squares and an ARIMA model, it estimates the relationship between the variables and uses the historical trend to forecast into the future.

Results of this study show that the determinants jointly explain the pattern of domestic gas utilization in Nigeria by 98%. Individually, per capital real GDP, electricity generated from natural gas sources and changes in the volume of domestic utilization of natural gas was found to have a positive and significant effect on domestic gas utilization. Further, the forecast values show evidence of a slow but gradual increase in the utilization pattern in the near future from 2015-2020. A best-case scenario of an increase of 0.15% and a worst-case scenario of a decrease of 0.14% was presented. In conclusion, having identified significant influences on domestic gas utilization patterns in Nigeria, it is imperative that the government use economic instruments to enhance the utilization patterns in Nigeria by improving economic activities and developing the power sector which shows significant influence in domestic natural gas utilization patterns.

Selected References

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Forecasting the Domestic Utilization of Natural Gas in Nigeria (2015-2020)

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OUTLINE

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INTRODUCTION

- In Africa, Nigeria is the largest natural gas reserve holder with over 180 Trillion Cubic Feet(TCF) of Proven reserves in 2015 virtually without sulphur, low in $C0_2$ and rich in liquid content split in an approximate 50:50 ratio of Associated Gas (AG) and Non-associated gas (NAG) with no deliberate effort for exploitation until date. Exploration efforts in the Benue trough, Chad basin and Anambra basin show that the inland basins have potential to add natural gas reserve volumes DPR (2014).

- However, Nigeria is among the top gas flaring countries of the world, as about 40% of Nigeria's total proved gas reserves have been identified as stranded gas caps, which are not available in the short term.

INTRODUCTION (Contd)

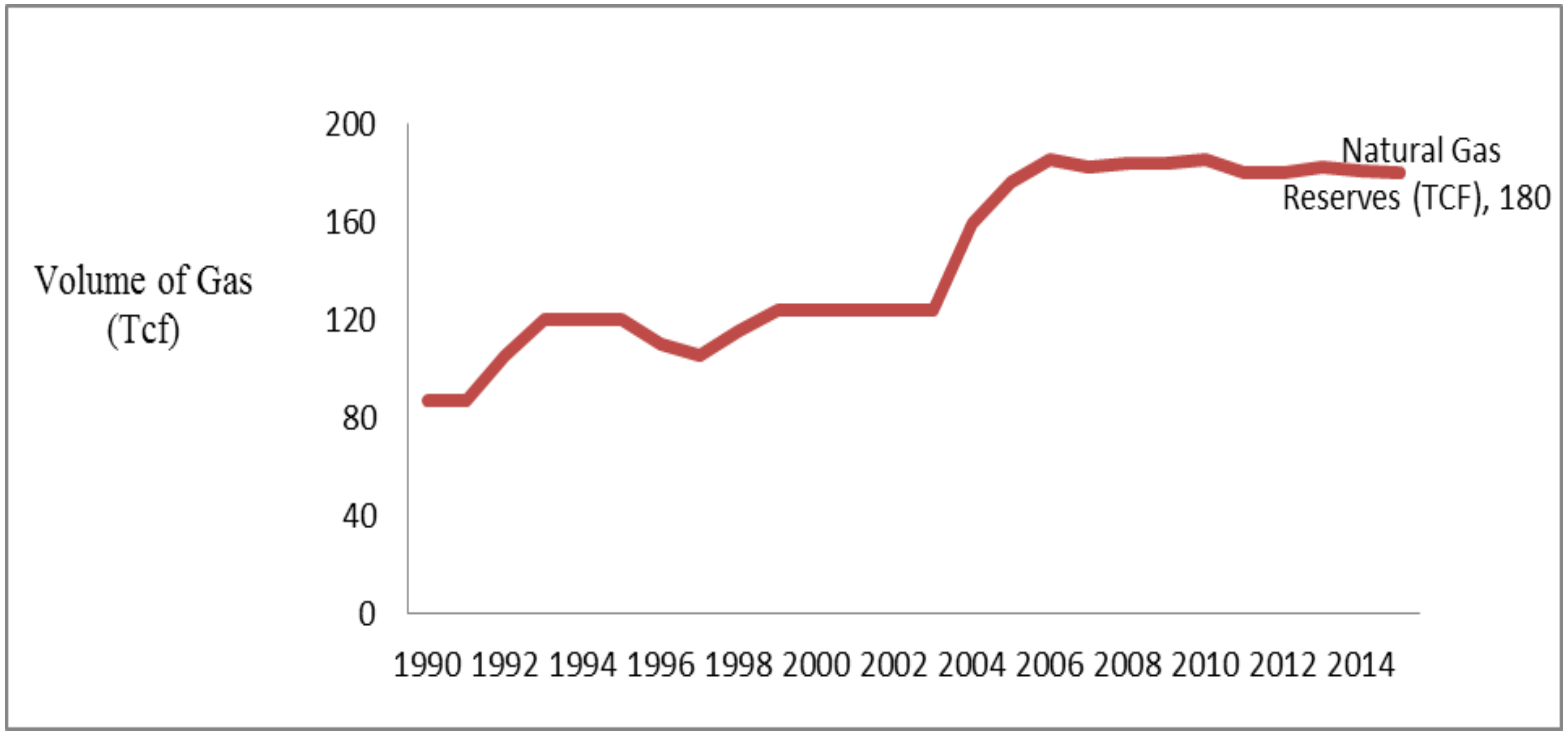

Figure 1: Nigerian Natural Gas Proved reserves (1990-2014)

Source : EIA (Energy information Administration)

BACKGROUND OF STUDY

- Although Gas flaring has more than halved in Nigeria over the years, Nigeria remains the second largest gas flaring country in the world after Russia. To address the threat of increasing global warming, natural gas is becoming the most preferred amongst existing fossil fuels, as it has the lowest emissions of Co_2 as well as other dangerous substances like sulphur and nitrogen compounds.

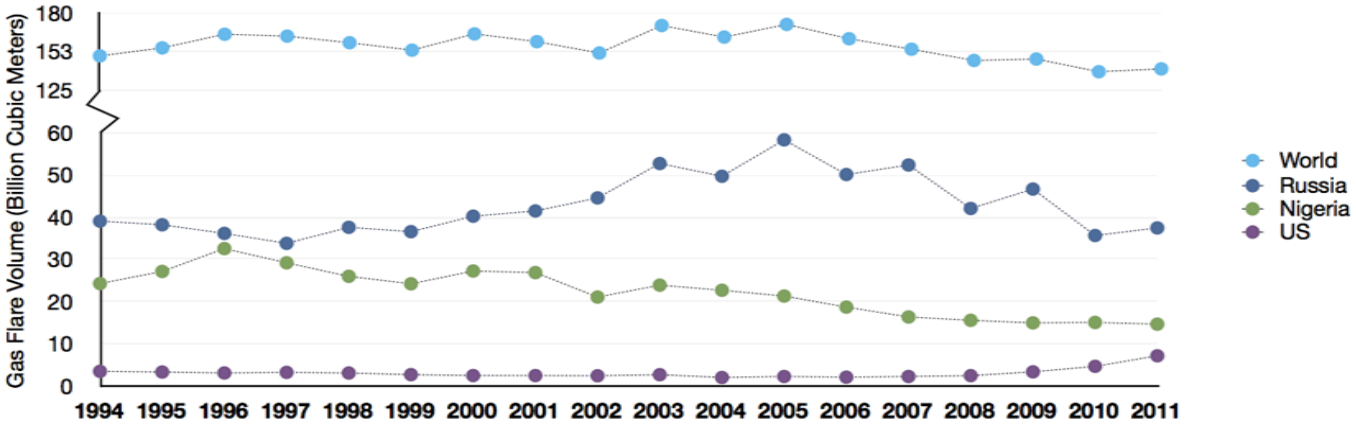

Figure 2: Trends in Global Gas Flaring (1994-2011)
Sources: NOAA (1994-2006); World Bank (2007-2011)

OBJECTIVE OF STUDY

- Thus, this study seeks to estimate the determinants of domestic gas utilization in Nigeria and the underlying relationship between them and to estimate a model that forecast the pattern of domestic utilization of natural gas in Nigeria to enable government understand the benefits of domestic gas utilization and the necessity to develop the gas sector.

LITERATURE REVIEW

- George (2014) raises questions as to how this proportion of energy source utilized domestically is being increased by identifying the most significant drivers and making a case for more economic activities through energy consumption.

- Onuke (2014) critically assessed the available energy resources and their relevance to socioeconomic development and probable energy demand in Nigeria, examining the energy policy and shortfalls on the implementation. With all these as a base, the study critically examined some of the methodology to forecast energy requirement

- Ikechukwu (2013) established the impact of gas production, utilization and flaring on the estimated monetary value of goods and services in Nigeria (GDP).Using a Multiple linear regression analysis and data from a period 2001-2013, the estimates of the results show that while gas utilization has a positive impact on nations GDP, gas production and flaring are negatively associated with GDP.

CONCEPTUAL FRAMEWORK

- In neo-classical micro economics, a consumer attempts to allocate his /her limited monetary income among available goods and services so as to maximize his/her utility (satisfaction) given their preference, income, price of related goods and price of the goods for which the demand function is derived. Further investigations have therefore revealed that consumption expenditure is being determined by many other factors aside income Jhinhjan (2002).

- Birol, (2007) also explains that a derived demand is the demand for a basic good wanted not for its own sake but for the goods derived from it.

METHODOLOGY

A model is therefore developed from the typical demand model and demand is a function of the identified variables below.

$$D = f\,(PC, PR, INC, P, TAS) \qquad (1)$$

Where D = Demand, PC is the Price of the Commodity, PR is the price of related goods, INC is the Income, P is Population, TAS is a change in taste and fashion.

Using the aforementioned assumptions, a functional relationship is being developed below:

$$DGU = f(\,PNG, POF, PCRGDP, ELEC, \mathrm{GF}, \mathrm{FDI}) \qquad (2)$$

Where: DGU = Domestic Gas Utilized; PNG = Price of Natural gas; POF = Price of Alternative fuel; PCGDP = Per Capital Real Gross domestic product; ELEC = Electricity Generated through natural gas; GF = Gas Flared; FDI = Foreign Direct Investment.
Further, equation (1) can be put in econometric form as:

$$DGU_t = \beta_o + \beta_1 PNG_t + \beta_2 POF_t + \beta_3 PCRGDP_t + \beta_4 ELEC_t + \beta_5 GF_t + \beta_6 FDI + \mu_t \qquad (3)$$

Where
β_o= Intercept, $\beta_1 - \beta_6$ are the coefficients of the regressors of the model
μ_t= error term for the random variables, and t is the time dimension of the series.
The a-priori expectation of the signs of the parameters is that β_1 and β_5 *are negative Correlated while* β_2, β_3 and β_4 *are positive correlated*.

RESULTS AND DISCUSSION

1. Stationarity Test Results

Table 1: Augmented Dickey Fuller (ADF) Test

Variable	**AUGMENTED DICKEY FULLER UNIT ROOT TEST**(Trend and Intercept)			
	Test –statistic	Prob value	Order of Integration	Interpretation
DGU	-5.159722*	0.0022	I(1)	Stationary
ELEC	-4.893455*	0.0039	I(1)	Stationary
GF	-5.038560**	0.0038	I(1)	Stationary
PCGDP	-4.068106**	0.0214	I(1)	Stationary
PNG	-3.424546**	0.0144	I(1)	Stationary
POF	-5.192211*	0.0032	I(1)	Stationary
FDI	-5.053266*	0.0037	I(0)	Stationary

*, And ** represent 1% and 5% level of statistical significance.

RESULTS AND DISCUSSION(Contd)

Table 2: OLS RESULTS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-21.14388	9.916985	-2.132088	0.0499**
D(LDGU)	0.487098	0.126415	3.853165	0.0016*
LELEC	0.570924	0.105014	1.564117	0.0386**
LPCGDP(-1)	2.689905	0.837082	3.213431	0.0058*
LGF	0.565236	0.303177	1.864375	0.0820
LPNG	-0.010791	0.037216	-0.289952	0.7758
LPOF	-0.0869	0.044502	1.954413	0.0696
LFDI	-0.330988	0.159520	-2.074904	0.0556
R-squared	0.983422		**Adjusted R^2**	0.975686
F-statistic	127.1194		**D-W statistic**	1.765928
Prob(F)	0.000000			

[1]** and ** represent 1 and 5 % levels of statistical significance

RESULTS AND DISCUSSION(Contd)

Co-integration Analysis

- The estimated regression results from ordinary least square (OLS) from full sample 1990-2013 is been presented and interpreted to show the impact of the stated independent variables on the dependent variable domestic utilization of natural gas in Nigeria.

The estimated equation is been written as;

- **Dependent Variable: LDGU**

$LDGU_t = -21.143 + 0.4870924\ D(LDGU)_t - 0.010791\ LPNGt - 0.0869LPOF_t + 2.689905\ LPCRGDP\ (-1)_t + 0.570924LELEC + 0.56236LGF_t - 0.330988LFDI$

Forecasting Model

- Forecasting and Control by Box and Jenkins in 1976, which is otherwise known as BJ Autoregressive Integrated Moving Average (ARIMA) methodology has been insightful in time series analysis.

The general presentation of ARIMA (1,1,1) is given in the equation below:

$$Y_t = u + \alpha_0 Y_{t-1} + \lambda_1 e_{t-1} \qquad (4)$$

Where

Y_t =Domestic gas utilization

Y_{t-1}= Previous value of domestic gas utilization, while e_{t-1} is the lagged value of the stochastic error term while α_0 and λ_1, λ_2 represent the coefficients of the lagged value of domestic gas utilization, the current value of the error term and its lagged value.

In this case, the normalization formula is stated below.

$$NV = \frac{Y_t - Y_{\min}}{Y_{\max} - Y_{\min}} \tag{5}$$

Where;

NV is the normalized value Y_t refers to the actual utilization value in time period t, while $Y_{\min}, Y_{\max}$ represents the minimum and maximum utilization values of the dataset.

Again, the accuracy of the forecasting ability of the order of the ARIMA model will be judged using 3 different performance measures. These measures in equation 6, 7 and 8 are indices.

They include Root Mean Squared Error (RMSE), Mean Absolute Deviation (MAD), and Mean Absolute Percentage Error (MAPE). The method of calculating each of these indices is stated below:

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n}\left(Y_t - \hat{Y}_t\right)^2}{n}} \tag{6}$$

$$MAD = \frac{\sum_{t=1}^{n}\left|Y_t - \hat{Y}_t\right|}{n} \tag{7}$$

$$MAPE = \frac{\frac{\sum_{t=1}^{n}\left(Y_t - \hat{Y}_t\right)}{Y_t}}{n} \tag{8}$$

Here, Y_t refers to the actual value and $\hat{Y}_t$ refers to the predicted value at time t, and n is the number of observations in the test data set. This process will enable a good forecast for domestic gas utilization in Nigeria

Table 3: ARIMA RESULTS

Variable	Coefficient	Std. Error	t-Statistic	Prob
C	0.1600618	2.405824	0.665310	0.5153
AR(1)	0.918011	0.128020	7.170841	0.0000
MA(1)	-0.084436	0.933832	-0.090419	0.9291
R-Squared	0.793383	**Adjusted R-squared**	0.767555	0.811653
F-Statistics	30.71890	**Durbin-Watson stat**	2.394732	34.47490
Prob (F-statistics)	0.000002			

Table 4: Forecast Result Diagnostics

Forecast	LDGUF
Actual	LDGU
Forecast Sample	2007-2020
Adjusted sample	2008-2020
Included observations	3
Root Mean square error	0.044545
Mean absolute error	0.041689
Mean absolute percent error	0.215890
Theil inequality co-efficient	0.001152
Bias proportion	0.00000
Variable proportion	0.064
Co-variance proportion	0.9353

The forecast Results

- Using exponential smoothening forecast method for the residual term of DGS, after sample adjustment for out-of sample forecast from 2007-2020, both actual and forecast values (worst and best scenarios) are reported.

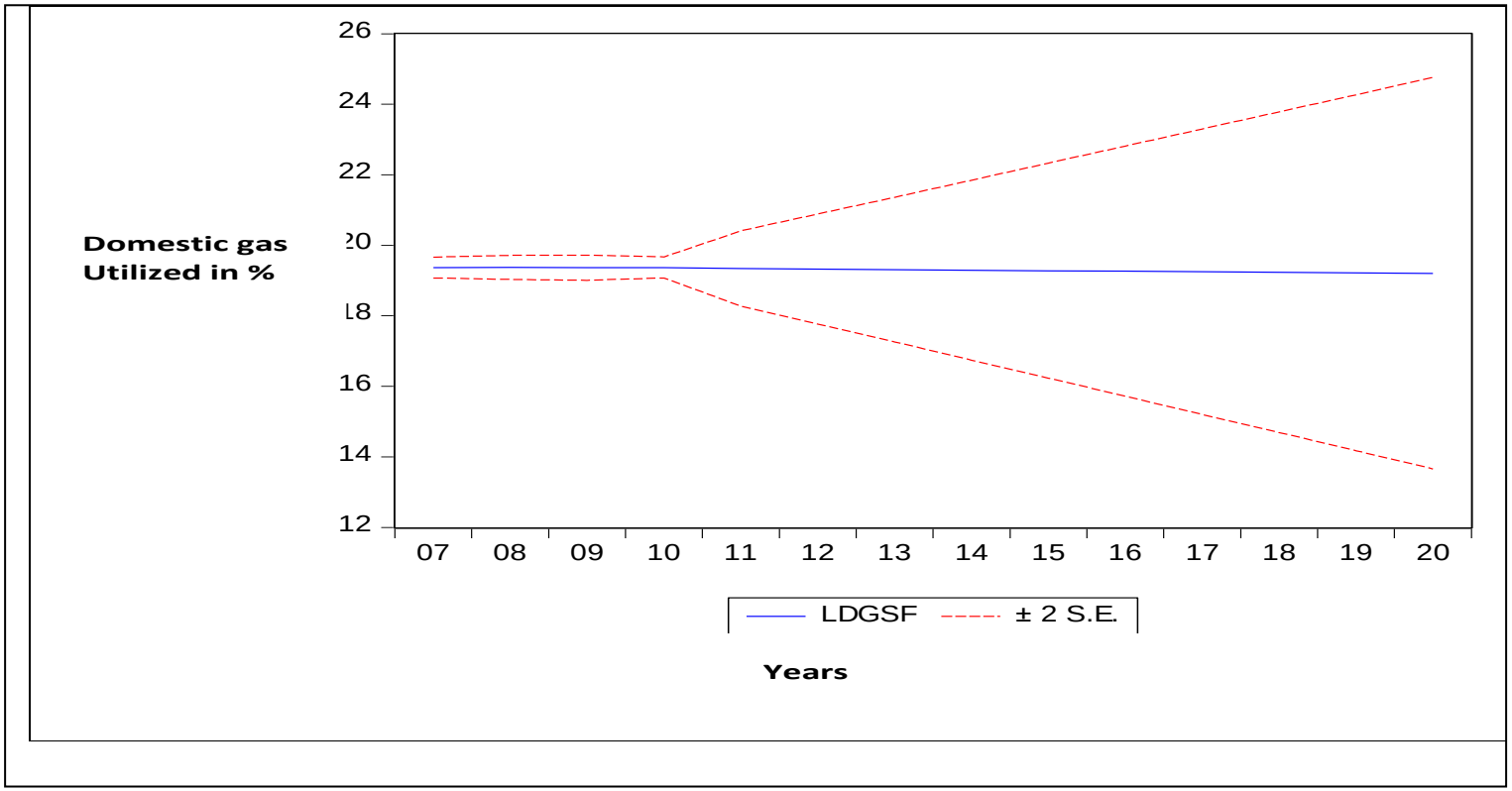

Table 5: Forecast values of Domestic Gas Utilized in Nigeria (%)

Observations	Reference Values	Actual DGSF	Best case Scenario	Worst case scenario
2007	19.4502	19.35	19.7	19.1
2008	19.26296	19.36	19.7	19
2009	19.28478	19.38	19.7	19
2010	19.47081	19.38	19.72	19.1
2011	19.65755	19.4	20.4	18.3
2012	19.73453	19.42	20.9	17.8
2013	19.78533	19.43	21.4	17.3
2014		19.45	21.8	16.7
2015		19.46	22.3	16.2
2016		19.49	22.8	15.7
2017		19.48	23.3	15.2
2018		19.51	23.8	14.7
2019		19.52	24.3	14.2
2020		19.54	24.8	14.0

Source: - E-Views software output

Conclusion

- It is found that the per capital real gross domestic product (PCRGDP) is the most significant driver of domestic gas utilization in Nigeria.
- Also found highly significant is the historical volumes of gas utilized which was being used as an independent variable, which positively affects the gas utilization patterns in a current time.
- Electricity generation also was found to be positively correlated and highly significant in influencing domestic utilization of natural gas.
- Furthermore, the price of natural gas in Nigeria is not a significant driver of domestic gas utilization in Nigeria. Although, they follow a-priori expectations, they do not significantly influence the volumes of domestic gas utilization in Nigeria.

Conclusion(Contd)

- Foreign direct investment which is known to spur economic activities is seen as negatively influencing domestic utilization of natural gas in Nigeria and its effect is statistically insignificant.
- The forecast shows that natural gas will increasingly be the preferred choice fuel in Nigeria, but shows a scenario, which depicts that in the near future under a constraint of gas production, higher volumes of gas flared will directly affect the volumes of domestic utilization.
- There is a universal agreement in natural gas forecast that growth levels will be attained in the coming years, as the future of the gas market seems bright.

Policy Recommendation

This study recommends the following:

1. Economic activities should be spurred by the development of industries which will have a multiplier effect on the standard of living of a people, by providing jobs and promoting local content.
2. The unbundling of the Natural gas market will drive efficiency in prices and also encourage market forces which is known to drive competition and improved services by increasing the inflow of foreign direct investment to Nigeria through gas projects
3. The government should encourage the use of economic sanctions instead of obligations in an attempt to utilize natural gas resources.
4. In the area of electricity generation, the security of supply sources to the power plants should be guaranteed in the best way possible and electricity tariffs should be allowed to reflect the cost of service in order to sustain investment.
5. Lastly, the implementation of a more robust legal, regulatory and institutional framework for Natural gas as there is for crude oil in Nigeria.