Marketing Cost Efficiency of Natural Gas in Nigeria

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Abstract

The research investigated the marketing cost-efficiency of natural gas over other alternative fuels in Nigeria. To establish this, an ipso facto research design was explored using a number of data collected for five years from the Nigerian Gas Company limited (NGC) and some selected gas consuming companies namely PHCN- Egbbin, P.Z Industries – Ikorodu and WAPCO – Shagamu were analyzed. The findings showed that natural gas is more cost efficient than other competing fuels, with various attendant implications for the economy.

Key words: marketing cost efficiency, natural gas, Nigeria

JEL Classification: M31

Introduction

Energy is a very important input in the process of economic development of all nations. In Nigeria, energy resources have been playing a dual role of being a fuel for economic growth and also as revenue. The revenue from crude oil alone has been the single most important component of funds derivable during the past three decades for economic development of Nigeria (Kupolukun, 2002). Other revenue earning sources like gas was not accorded the deserved attention.

However, due to the dwindling fortunes and uncertainties of the crude oil market, Nigerian government has made deliberate efforts to de-emphasize the role of crude oil in the economy while making serious efforts at developing other energy sources which equally have the potentialities of improving the revenue generation base. In this wise, the Obasanjo administration mandated the Nigerian National Petroleum Corporation (NNPC) to create as much revenue from gas as of oil within the decade, end gas flaring, address environmental issues and develop the domestic natural gas market. Also the expected growth rate of natural gas in the energy mix of industrialized countries which in itself guarantees a demand for gas from developing economies with abundant reserves, further emphasizes the need to pay more attention to the establishment of the necessary infrastructure for gas development especially in Nigeria.
A common feature of Nigeria oil field is that they also have considerable accumulation of Natural gas. This is so, much so that Nigeria’s oil fields are also the country’s gas field. Any deviations from that therefore, would be the exception rather than the rule. Gas discovery to date in Nigeria has been incidental to oil exploration efforts (Aluko, 1994). Hitherto, Nigeria has been flaring almost all its associated gas, thereby wasting a veritable resource that can aid the speedy development of the economy. The utilization of natural gas can be extended to assist in providing feedstock for some chemical industries like fertilizer, plants etc. The natural gas has numerous uses with its accompanying advantages. Natural gas if harnessed will meet the entire energy and industrial feedstock requirement of the nation over many decades to come. Lack of knowledge of the marketing cost advantage of natural gas over other alternative fuels by potential users is a major gas demand constraint in the country (Aluko, 1994), it is in this light that this study hopes to establish the marketing cost efficiency of natural gas and thus identifies its relevance as a veritable tool for national development.

The study would thus attempt to prove the claims concerning the marketing cost efficiency of natural gas over competing fuels e.g. diesel (AGO) high and low power fuel oil, premium motor spirit, supply data and information on natural gas utilization pattern and trend since the advent of crude oil and natural gas production in the country. The study will also look at the potential of natural gas in generating revenue to the nation just as crude oil, and finally proffer suggestions toward the effective utilization of natural gas and the socio-economic benefits.

Literature Review

Kotler (2004) sees marketing cost efficiency as the fulfillment of an exchange in the most economical way. This approach assesses efficiency by checking whether resources are being used to produce any given exchange at the lowest possible cost. So, marketing cost efficiency as used in this work is the measure in absolute term of the amount of cost saving that is derivable from using a given energy resource relative to competing alternatives, simply put as the cost competitive advantage.

Egbuna, (1998) reported that the demand for gas in Nigeria has been extremely small, and the low demand for natural gas has been due to a number of reasons; first the tropical climate, which the country enjoy throughout the years, makes it unnecessary to heat houses, as is the practice in temperate countries during certain periods of the year. The domestic requirement for gas in Nigeria homes will thus be for cooking and hot water needs. Secondly, the high prices subsidy, which the petroleum products, viz, gasoline (petrol), aviation tobor kerosene, domestic kerosene, automotive gas oil (AGO), high and low pour fuel oil and liquefied petroleum gas, enjoyed in the country has made industry and commercial establishment to have no desire to switch from their traditional heating oil to natural gas. There has therefore been no commercial incentive for the exploration companies to go into the field for the deliberate search for natural gas. Explorations efforts in Nigeria have therefore been concentrated entirely on the search for crude oil for which there is growing demand worldwide (Ojinnaka, 1999). It is therefore, understandable that natural gas discoveries in Nigerian have been quite unimpressive.

According to the strategic gas plan for Nigeria, a joint UNDP/World Bank Energy Sector Management Assistance Programme of 2004 reported that gas reserves found while looking for oil are conservatively estimated at more than 150trillion cubic feet (TCF)(IEO,2006) They represent over 5% of the world’s total and the undiscovered potentials are considered to be quite high. The report says that up till now, Nigeria has only barely begun to benefit from its gas.

Currently, production of 4.6bcfd is largely wasted with nearly 55% or close to 2.5bcfd being flared (Lakov, Franko, Meyers, McMahon, McNeil & Lutz, 2006). The gross monetary value of this gas was estimated to be in the order of US$50 billion (US$1=₦153) over 20 years. The adverse global environmental impact of Nigeria’s gas flaring is roughly 70 million metric tons
of carbon dioxide (CO2) emissions per year. The yet to be found gas reserves is estimated to be 142 trillion cubic feet. The strategic Gas Plan for Nigeria in 2004 corroborates this fact. Other issues include:

- The poor performance of the nation’s economy;
- Capital intensive nature of gas projects;
- Long period of recovering investment capital on gas project;
- A lack of a clearly stated, long term “vision” for the sector and realistic policy goals to promote and facilitate gas use;
- A lack of a clear gas sector development strategy and implementation plan covering both policies’ directions and integrated investment priorities;
- A lack of adequate legal, fiscal, regulatory and contractual frameworks and institutions that are required to accommodate new investment proposals from international investors while protecting Nigeria’s interests;
- A lack of capacity to evaluate correlates and prioritize proposals received from the private sector, together with growing reservations about the structure of current fiscal incentives;
- An inadequate or non-existent infrastructure for the commercialization of gas in the Nigeria domestic market.

Okwoche (2002) in expressing his view on the growth of the gas industry in Nigeria blamed the slow pace of its development on the exploration and production (E&P) joint venture partners whose level of investment in the gas business has been relatively low. In his opinion, a major area of concern to the development of the gas sector is the promotion of natural gas in the country which is not located within the petroleum producing area; hence it would require substantial investment to bring natural gas to the areas of demand.

In his work, Osezua (2004) explained the level of gas utilization in the domestic energy market. He noted that the initiative to step up gas utilization in the country is part of the measures taken to remove some pressures on the refinery sectors and free some liquid fuels for export to earn foreign exchange for the country. In this regard, the Nigerian Gas Company (NGC) constructed a pipeline system in the Eastern part of the country to supply gas as industrial fuel to power the gas turbines of the Aluminum Smelting Company of Nigeria (ALSCON). Also, in an attempt to promote gas utilization in most homes in the country, NGC constructed a Terminal Gas Station (TGS) adjacent to the NNPC Housing Complex at Ekpan-Warn’ and Shell’s (SPDC) residential Estates at Ogunu and Edjeba all in Warri. As a pilot scheme, the project is expected to alleviate the problem of cooking gas faced by the residents of these estates. Also, consumers are expected to have value for their money since natural gas for cooking is believed to be cheaper than LPG (NGCL, 2004).

Ojinnaka (1999) noted that the world reserve estimate is about 149 trillion cubic metres (TCM), of which Nigeria accounts for 3.8 TCM or 2.6% and that since natural gas share in the total energy consumption has been on the increase in recent years, the future of Nigeria’s vast gas resources is quite promising. The Energy Information Administration (Official Energy statistic from the US Government) on International Energy Outlook reports that world natural gas reserves were estimated at 6,112 trillion cubic feet - 7,000tcf trillion cubic feet (about 1 percent) higher than the estimate for 2005, between 2005 and 2006, the volume increased from 940 trillion cubic feet to 971 trillion cubic feet. Also in the Middle East, higher reserve estimates were reported by Saudi Arabia with an increase of 7 trillion cubic feet (3 percent). Other countries with substantial increase in reserve include Norway with a gain of 11 trillion cubic feet (14 percent),(Neff Toad, , 2005; Marcano and Cheung, 2006) and Nigeria with an increase
of 7 trillion cubic feet (8 percent), this further lay credence to the degree of availability of natural gas in Nigeria.

Elliot (2004) expresses his opinion on the environmental friendliness of natural gas, he noted that gas is preferred over oil and coal, as Environmental Protection Agency reported that sulphur and nitrogen discharged is associated with the use of oil and coal. He describes natural gas as one of the cleanest fossil fuels available; and thus recommending its increasing usage for residential and commercial use as a way of reducing air pollution.

Olorunfemi (1997) identified three major objectives for which Nigeria has opted for the Joint Venture arrangement in the exploration of natural gas. These include:

- the exploitation of Nigeria’s hydrocarbon resources with which the country is richly endowed;
- the existence of an upstream sector which permits maximum value added, through active participation of Nigerians and the utilization of indigenous resources and
- the process of exploitation that engenders a self-sustained development of the environment.

This will include increasing utilization of gas to reduce gas flaring to the minimum.

However, Osezua (2004) observed that the country’s state of infrastructural support is far from what is required for the growth of the gas industry in the domestic energy market. According to him, the inability of consumers to sometimes convert their equipment from conventional energy source to gas without recourse to foreign experts leads to delays in meeting scheduled dates with attendant cost implication.

Onuoha (2000) is of the view that based on the volume of gas production and consumption in the country, the gas sector is heavily characterized by poor gas utilization and massive flaring. According to him, he explained that for a period of 32 years (1966 – 1997) an average of 87.74% of total gas produced during the period was flared while the balance of 12.28% was either utilized or re – injected into the reservoir. Also, Nigeria did not export natural gas during the period. However, things have changed considerably since then, the growth in gas utilization has translated into steady decrease in gas flares from 68% in 1999 to about 38% in 2005, total natural gas demand is forecast to grow significantly from the current 3,400mmscf/d to about 15,000mmscf/d by 2010 and 25,000mmscf/d by 2025. Of this, domestic consumption is expected to increase from 600mmscf/d to over 5,000mmscf/d as a result of rapid demand growth in the power sector. This projected growth is unprecedented by world standard. Also, noting that the Okpai power plant in Delta State utilizing 140mmscf/d of gas and generating 480MW of electricity into the national grids has been commissioned. These represent a major step towards industrialization, contributing to the government agenda to grow electricity – generating capacity significantly.

Similarly, gas export is expected to grow significantly from its current level of 2,800mmscf/d to about 12,400mmscf/d (Grant, 1998; Ole Gunar Astvik, 2002; Prindle, 2003). This is underpinned by the phenomenal growth in the Liquefied Natural Gas (LNG) sector. Train 4 of the Nigerian Liquefied Natural Gas (NLNG) was commissioned in November 2005 and is currently producing additional 10,000 tons per day, while Train 5 is awaiting commissioning and Train 6 is under construction. Scouting studies have commenced for the establishment of trains 7 and 8, the other ongoing LNG projects include the 20 metric Tons Per Annum (MTPA), Olokola LNG which MOU was signed between NNPC, Chevron, Shell and BG in April 2005. The Final Investment Decision (FID) was expected to be taken in the third quarter of 2006 with the first LNG delivery scheduled for 2006. The two train IOMTPA Brass LNG is scheduled to take FID (Final Investment Decision) in 4th quarter of 2006 and deliver first shipment by 2009. Furthermore, the Front End Engineering Design (FEED) of the %MTPA NNPC/Mobile LNG commenced in March 2006. The foregoing LNG capacity growth makes Nigeria the 2nd world fastest after Qatar (NGCL, 2007, Schlegel, 2007).
The West African Gas Pipeline (WAPG) which is of strategic importance to countries in the sub-region in fostering cooperation and economic development as well as providing a platform for regional economic integration is on course. The project is now in the construction phase and progressing steadily to deliver gas to Benin, Ghana and Togo by 1st to 2d quarter of 2007. The feasibility study for the Trans-Saharan Gas Pipeline is ongoing. This project is expected to transport over 2 billion cubic feet per day of gas from Nigeria to European market through Algeria. Also the Final Investment Decision (FID) of the 35,000 bpd Escravos Gas to Liquid plant was taken in 2005 (NGCL, 2007, Schlegel, 2007).

It is expected that the government earning from oil and gas sector will be greatly enhanced and also help to reduce substantially the adverse impact oil and gas exploitation on the environment.

Onuoha (2000) exclaimed on gas demand among European countries, when evaluating the forecasts that European gas demand is expected to rise by 50% in about 15 years time, so export to such nations is inevitable. And in power generation sector in Nigeria, the high efficiencies and low capital costs of new gas fired power plants will continue to make gas a preferred fuel choice (Schlegel, 2003), he further observed that natural gas is among the largest of the world’s primary energy resources. He explained that natural gas resources at the end of 1994, was about 148 trillion cubic metres. Considering the foregoing, it is hypothesized that:

\[ H_0 : \text{There is no significant difference between the mean marketing cost efficiency of AGO and natural Gas consumed per annum.} \]

\[ H_1 : \text{There is significant difference between the mean marketing cost efficiency of AGO and Natural Gas consumed per annum.} \]

**Research Methods**

Ipso facto research design was used with a combination of descriptive and analytical research methods. The choice of these methods was based on the nature of the data required for the study.

The study relied solely on secondary sources of data. The data was collected from PHCN-Egbin, PZ Industry Ikorodu and WAPCO-Shagamu. These three companies were selected based on judgmental sampling method taking into consideration high volume consumption which is expected to have direct relationship with marketing cost efficiency of natural gas.

The data was specifically collected from the production units/archives of the chosen companies. In addition, the overall gas utilization records as kept by the Nigerian Gas Company (NGC) were properly examined. In this regard, the Commercial, Accounts and Planning/Budget departments of NGC was visited. In doing this however, care was taken to ensure that biases and prejudices of other studies and writer opinions were not allowed to unduly influence judgment and perception of this research work.

**Result and Discussion**

The tables show the cost advantage of natural gas over diesel from 1999-2003 and from the global outlook, the cost advantage of natural gas over other fuels. In each of the tables, for the 3 companies chosen, column A shows the period i.e. year, column B indicates the annual gas consumption in million standard cubic feet (MMscf), while column C shows price in Naira per Mscf. To obtain the cost of gas consumed per annum, which is represented by column D, the annual gas consumption i.e. column B was multiplied by gas price i.e. column C; that is (BxC) = D. To derive the annual consumption of diesel equivalent (in million litres) in energy terms column B is multiplied by 27 and the sum divided by 1000. This gives column E. (Note that, in
energy terms, 1000Scf of natural gas is equal to 271 litres of diesel). Also, to obtain the annual cost of diesel, which is represented by column G, column E was multiplied by the diesel price per litre that is column F i.e. (E x F). thus, column G is the amount, the company would have spent on diesel per annum if it had used diesel instead of natural gas, the marketing cost efficiency of diesel was obtained by subtracting cost of gas per annum (column D), from the supposed cost of diesel per annum (column G), and this represented by column H, that is (G-D).


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<tbody>
<tr>
<td>A</td>
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<td></td>
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</tr>
<tr>
<td>1999</td>
<td>59,855.93</td>
<td>10.4</td>
<td>627.29</td>
<td>1,616.11</td>
<td>19.00</td>
</tr>
<tr>
<td>2000</td>
<td>57,312.51</td>
<td>11.32</td>
<td>648.77</td>
<td>1,547.44</td>
<td>21.00</td>
</tr>
<tr>
<td>2001</td>
<td>76,342.20</td>
<td>12.23</td>
<td>933.66</td>
<td>2,061.24</td>
<td>21.00</td>
</tr>
<tr>
<td>2002</td>
<td>90,453.68</td>
<td>13.21</td>
<td>1,194.89</td>
<td>2,442.25</td>
<td>26.00</td>
</tr>
<tr>
<td>2003</td>
<td>89,677.13</td>
<td>14.27</td>
<td>1,279.69</td>
<td>2,421.28</td>
<td>38.00</td>
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<tr>
<td>TOTAL</td>
<td>4,684.30</td>
<td></td>
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Note: 10^3 SCF (MSCF) of gas = 27 litre of Diesel (AGO), 10^6 MSCF of gas = 27,000 litres of Diesel (AGO), US$1 = ₦153 (₦ = Naira)


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<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>168.06</td>
<td>194.10</td>
<td>32.62</td>
<td>4.54</td>
<td>19.00</td>
</tr>
<tr>
<td>2000</td>
<td>170.36</td>
<td>210.28</td>
<td>35.82</td>
<td>4.60</td>
<td>21.00</td>
</tr>
<tr>
<td>2001</td>
<td>178.65</td>
<td>226.45</td>
<td>40.45</td>
<td>4.82</td>
<td>21.00</td>
</tr>
<tr>
<td>2002</td>
<td>192.76</td>
<td>242.63</td>
<td>46.76</td>
<td>5.20</td>
<td>26.00</td>
</tr>
<tr>
<td>2003</td>
<td>325.91</td>
<td>258.80</td>
<td>84.34</td>
<td>8.80</td>
<td>38.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>239.99</td>
<td></td>
<td></td>
<td></td>
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</table>

Note: 10^3 SCF (MSCF) of gas = 27 litre of Diesel (AGO), 10^6 MSCF of gas = 27,000 litres of Diesel (AGO), US$1 = ₦153 (₦ = Naira)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>ANNUAL GAS CONSUMPTION (MMSCF)</th>
<th>GAS PRICE PER MSCF (4)</th>
<th>COST OF GAS CONSUMED (B x C)XM</th>
<th>AGO CONSUMPTION EQUIVALENT B X 27/1000 MILLION LITRES</th>
<th>AGO PRICE PER LITRE (₦)</th>
<th>COST OF SAVINGS FROM USE OF GAS (E x F) XM</th>
<th>COST SAVINGS FROM USE OF GAS (G -D)XM</th>
</tr>
</thead>
<tbody>
<tr>
<td>199</td>
<td>5,676.72</td>
<td>242.63</td>
<td>1,377.34</td>
<td>153.27</td>
<td>19.00</td>
<td>2,912.13</td>
<td>1,534.79</td>
</tr>
<tr>
<td>200</td>
<td>6,044.80</td>
<td>194.10</td>
<td>1,173.29</td>
<td>163.21</td>
<td>21.00</td>
<td>3,427.41</td>
<td>2,254.12</td>
</tr>
<tr>
<td>200</td>
<td>5,497.15</td>
<td>210.28</td>
<td>1,155.94</td>
<td>148.42</td>
<td>21.00</td>
<td>3,116.82</td>
<td>1,960.88</td>
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<tr>
<td>200</td>
<td>5,489.26</td>
<td>226.45</td>
<td>1,243.04</td>
<td>148.21</td>
<td>26.00</td>
<td>3,853.46</td>
<td>2,610.42</td>
</tr>
<tr>
<td>200</td>
<td>5,286.32</td>
<td>242.63</td>
<td>1,282.62</td>
<td>142.73</td>
<td>38.00</td>
<td>5,423.74</td>
<td>4,141.12</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>6,232.23</td>
<td></td>
<td></td>
<td>18,733.56</td>
<td>12,501.33</td>
</tr>
</tbody>
</table>


Note: 10^3 SCF (MSCF) of gas = 27 litre of Diesel (AGO), 10^6 MSCF of gas = 27,000 litres of Diesel (AGO), US$1 = ₦153 (₦ = Naira)

Tab. 4. Summary analysis of two tailed t – test of difference between means of marketing cost efficiency of AGO and GAS in PHCN Egbin

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D</th>
<th>N</th>
<th>Df</th>
<th>Standard Error</th>
<th>t-calculated Error</th>
<th>t- table</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGO</td>
<td>52,399</td>
<td>22,986.53</td>
<td>5</td>
<td></td>
<td></td>
<td>10,280.36</td>
<td>5.01</td>
</tr>
<tr>
<td>GAS</td>
<td>937</td>
<td>270</td>
<td>5</td>
<td>8</td>
<td></td>
<td>42.48</td>
<td>2.42</td>
</tr>
</tbody>
</table>

Source: Researchers’ Data Computational Result

Tab. 5. Summary analysis of two tailed t – test of difference between means of marketing cost efficiency of AGO and GAS in WAPCO Nigeria Limited

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D</th>
<th>N</th>
<th>Df</th>
<th>Standard Error</th>
<th>t-calculated Error</th>
<th>t- table</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGO</td>
<td>151</td>
<td>93.15</td>
<td>5</td>
<td></td>
<td></td>
<td>42.48</td>
<td>2.42</td>
</tr>
<tr>
<td>GAS</td>
<td>937</td>
<td>270</td>
<td>5</td>
<td>8</td>
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</tbody>
</table>

Source: Researchers’ Data Computational Result

Tab. 6. Summary analysis of two tailed t – test of difference between means of cost efficiency of AGO and GAS in FZ Industries

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D</th>
<th>N</th>
<th>Df</th>
<th>Standard Error</th>
<th>t-calculated Error</th>
<th>t- table</th>
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</thead>
<tbody>
<tr>
<td>AGO</td>
<td>37347</td>
<td>896.67</td>
<td>5</td>
<td></td>
<td></td>
<td>402.68</td>
<td>6.21</td>
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<tr>
<td>GAS</td>
<td>937</td>
<td>270</td>
<td>5</td>
<td>8</td>
<td></td>
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</tbody>
</table>

Source: Researchers’ Data Computational Result
The relationship between the cost of gas \( y_1 \) consumed and annual consumption of gas \( x_1 \) for PHCN Egbin could be represented thus:

\[
y_1 = a + bx_1 = a_0 + b_0x_1
\]

Multiply both sides by (-):

\[
-b_0x_1 = -a_0 - y
\]

\[
-b_0x_1 = -y + a_0
\]

\[
b_0x_1 = y - a_0
\]

where \( b_0 \) = Marginal cost of consumption of natural gas.

Similarly for AGO we have:

\[
\frac{y_2}{x_2} = b_1 + b_2
\]

The savings in marginal cost will be:

\[
b_1 - b_2 = \frac{y_1 - a_0}{x_1} - \frac{y_2 - a_0}{x_2}
\]

**Marginal Savings** = \( b_1 - b_2 \)

To obtain \( b_0 \) and \( b_1 \) for GAS and AGO for the different industries will have:

**For PHCN:**

**Natural Gas**

First year:

\[
627.29 = a_0 + b_0 59,855.93
\]

\[
1,279.69 = a_0 + b_0 89,677.13
\]

\[
- a_0 = 59,855.93b_0 - 627.29
\]

\[
a_0 = 627.29 - 59,855.93b_0
\]

For the last year:

\[
a_0 = 61,279.69 - 89,677.13b_0
\]

\[
\therefore 627.29 - 59,855.93 = 1,279.69 - 89,677.13b_0
\]

Bring like terms together:

\[
59,855.93b_0 + 89,677.13b_0 = 652.4
\]

\[
29,621.2b_0 = 652.4
\]

\[
b_0 = \frac{652.4}{29,621.2}
\]

\[
b_0 = 0.022
\]

**AGO(PHCN)**

First year:

\[
30,706.09 = a_0 + b_0 (1,616.11)
\]

For the last year:

\[
92,008.64 = a_0 + b_0 (2,421.28)
\]

\[
a_0 = 1,616.11b_0 - 30,706.09
\]

\[
a_0 = 2,421.28b_0 - 92,008.64
\]
Equation (3) - (4)

\[
\begin{align*}
1.616.11b_2 - 30.706.09 &= 2.421.28b_0 - 92.008.64 \\
2.421.28b_2 - 1.616.11b_0 &= 92.008.64 - 30.706.09 \\
b_0 &= 61.302.5 \\
b_0 &= 76.14
\end{align*}
\]

Marginal cost = \₦76.14M

Marginal savings = \₦76.14M - 0.022

Marginal savings = \₦76.118M or US$0.5M or US$500,000

For PZ industries

\[
\begin{align*}
32.62 &= a_0 + b_0(168.06) \\
84.34 &= a_0 + b_0(325.91) \\
a_0 &= 168.06b_0 - 32.62 \\
a_0 &= 325.91b_0 - 84.34
\end{align*}
\]

Equation 3 - 4:

\[
\begin{align*}
168.06b_2 - 32.62 &= 325.91b_0 - 84.34 \\
325.91b_0 - 168.06b_2 &= 84.34 - 32.62 \\
b_0 &= 157.85 \\
b_0 &= 31.72 \\
b_2 &= 0.33
\end{align*}
\]

Marginal cost = \₦0.33M or \₦330,000 or US$2,156.9

AGO (PZ industries)

\[
\begin{align*}
86.26 &= a_0 + b_0(4.54) \\
334.40 &= a_0 + b_0(8.80) \\
a_0 &= 4.54b_0 \\
a_0 &= 8.80b_0 - 334.40
\end{align*}
\]

Equation (3) - (4)

\[
\begin{align*}
4.54b_2 - 86.26 &= 8.80b_0 - 334.40 \\
0.00b_0 - 4.54b_2 &= 334.40 - 86.26 \\
4.26b_0 &= 248.14 \\
b_0 &= 58.25
\end{align*}
\]

Marginal cost = \₦58.25M or 0.38M - 1 or US$380,000

Marginal savings = \₦58.25M - 0.33M = \₦57.92M or US$ 0.379M

Marginal savings = US$379,000

For WAPCO (Natural Gas)

\[
\begin{align*}
1,377.34 &= a_0 + b_0(5,676.72) \\
1,282.62 &= a_0 + b_0(5,286.32) \\
a_0 &= 5,676.72b_0 - 1,377.34 \\
a_0 &= 5,286.32b_0 - 1,282.62
\end{align*}
\]
Equation (3) - (4):

\[
\begin{align*}
5.676.72b_0 - 1.377.34 & = 5.286.32b_0 - 1.282.62 \\
5.286.32b_0 - 5.676.72b_0 & = 1.282.62 - 1.377.34 \\
-390.4b_0 & = -94.72 \\
b_0 & = -390.4 \\
b_2 & = 0.24
\end{align*}
\]

Marginal cost = ₦0.24M or ₦240,000 or US$1.568.6

**AGO (WAPCO)**

\[
\begin{align*}
2,912.13 &= a_0 + b_0(153.27) \\
5,423.74 &= a_0 + b_0(142.73) \\
a_0 &= 153.74b_0 - 2,912.13 \\
a_0 &= 142.73b_0 - 5,423.74
\end{align*}
\]

Marginal cost = ₦238.29M

Marginal savings = ₦238.29M + 0.24M = ₦238.53M or

**Marginal savings = US$1.56M**

<table>
<thead>
<tr>
<th>PHCN</th>
<th>PZ</th>
<th>WAPCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>₦76,118M</td>
<td>₦57,92M</td>
<td>₦238,53M</td>
</tr>
<tr>
<td>or US$500,000</td>
<td>or US$379,000</td>
<td>or US$1.56M</td>
</tr>
</tbody>
</table>

Source: researchers’ data computational result

Table 7 reveals the marginal savings that arose from the marginal cost differences of the cost and consumption of actual gas and AGO by the industries under study. WAPCO has the highest savings of US$1.56M, then PHCN with US$500,000 and finally PZ with US$379,000. This further shows the cost efficiency of natural gas over AGO.

The data on natural gas consumption by the three selected companies for the period 1999 – 2003, in tables 1-3 showed that each of the companies saved huge sums of money by using natural gas instead of diesel to run their plants. For instance, for the five years, PHCN Egbin saved the sum of ₦257,311.21 million or US$1,681.8million, WAPCO – Shagamu plant saved ₦12,501.33 million or US$81.7million and PZ Industries, Ikorodu saved ₦513.69million or US$3.4million, altogether the three companies saved total sum of ₦270,326.23 million or US$1,766.8million. The savings would have been more if petrol (PMS) had been used as alternative fuel for the consumption since its price is costlier i.e. ₦43.00 per litre(US$0.28) or if Low Pour Fuel Oil (LPFO) of ₦323.50(US$2.11) per MMBTU had been used. From the evidence as adduced in the analysis of gas consumption by the three companies, it shows that natural gas is marketing cost-efficient than diesel and other alternative fuels. Similarly, in tables 4-6, all the three gas consuming organizations had the t-calculated value greater than the t-tabulated value. Therefore, the null hypotheses are rejected, indicating that there is significant
difference between marketing cost efficiency in the use of natural GAS over that of fuel oil – AGO.

The cost efficiency of natural gas has great implications for the Nigerian economy. Firstly, cheaper energy has the tendency of reducing the cost of production with attendant reduction in the prices of goods. Secondly, the money saved by utilizing natural gas could be used for further plant expansion which could create more employment opportunities. Also, cheap input (fuel) has the tendency of increasing capacity utilization and hence productivity.

It is obvious from the result of this work that though the level of utilization of natural gas in the domestic energy market is still low, the future of gas in the energy mix is quite promising. Oyebadejo (1998) said that Africa’s natural gas has been put at 420 trillion cubic feet (tcf), out of which Nigeria, widely known as gas province with a little of Crude Oil, holds a whopping 25 trillion standard cubic feet. He explained further that about 80% of currently produced associated gas in Nigeria (put at about 1 trillion standard cubic feet) is being flared, thereby constituting environmental hazards and begging for private initiatives to tap and develop. He also emphasized that consumption growth rate has been in the range of 3-5% per annum in the last ten years.

The authors are of the opinion that although the present level of gas utilization in the domestic energy mix is low, there is still great potential for gas market in the country. Olukoga (2004) observed that the loss in revenue to the Nigerian Gas Company (NGC) from its gas business is not only traceable to the low capacity utilization of its gas pipeline system but also from the prices charged. The issue of pricing of natural gas to customers could make or mar the growth of the gas market if not properly managed. It was noticed that the price of natural gas by NGC to the customers which is currently indexed on the price of fuel oil was not competitive enough (Kupolukun, 2002). Accordingly, this pricing mechanism which has created extra financial burden on the companies is perceived to be responsible for the low growth rate of the gas industry. Also the absence of a formal trade agreement between NGC and the government parastatals remains largely the greatest threat to the growth of the gas industry in particular and the entire energy sector of the nation’s economy in general.

Nagelvoorf (2004) is also in agreement that in spite of the country’s huge gas reserves, domestic gas utilization is still very low. He attributed this state of development to the country’s level of industrialization which is also low, lack of funds, technology etc. In addition, he explained that some critiques are of the opinion that since Nigeria got its gas reserves without directly looking for it, this has made the country not know its usefulness.

As obvious from previous studies carried out, the issue of low utilization of natural gas in the domestic energy market is not in doubt. Many recommendations have equally been proffered on how to further enhance gas utilization in the county for the benefit of the people and government of Nigeria, noting from the result of this study that natural gas is more cost efficient than other related sources of energy.

**Conclusions and Recommendations**

Based on the research findings, it is important to note that natural gas is more cost-efficient than other competing fuels, there is therefore the need to promote commercialization of natural gas and provide necessary infrastructure with a view to ensuring judicious utilization of our abundant natural gas.

On the basis of the findings of this study, which has proved the marketing cost efficiency of natural gas as an added advantage over other alternative fuels, the following recommendations aimed at promoting gas utilization culture are being made:

1. Government (federal and state) and foreign investors should establish independent power
plants (IPPS) to reduce the high gas pipeline transmission cost. Such plants should be built at or adjacent to PHCN plants already served by NGC, to minimize overall cost of power supply.

2. NGC commercial price for gas should encourage more franchise arrangement in the other parts of the country similar to gas link in Lagos, Falcon in Ikorodu and Shell Nigeria Gas (SNG) at Agbara Otta.

3. NGC should extend its Compressed Natural Gas (CNG) Stations to the East, in particular. Port-Harcourt Area where a lot of market exists for this products.

4. NGC should embark on aggressive market development strategy through increase in its enlightenment/awareness programmed gas utilization. On the local scene, it should place paid advertisement on national television network and state television stations and radios revealing the cost efficiency of natural gas over other energy alternatives.

5. At international level, NNPC, through NGC should consider placing advert on the Internet, and also NGC should overhaul its marketing department and bring on board pure marketers with the right skills to facilitate awareness and sales.

6. An encouragement of the use of natural gas would likely reduce the use of kerosene and firewood and thus reducing attendant environmental pollution often caused by the use of firewood. Organized housing estates within the corridors of gas transmission lines could for now be the target market.

7. Government should support and show commitment to the various gas projects that are currently on-going or at the conception stage. Such projects include:
   - West Africans gas pipeline project (WAGP);
   - Trains 7 and 8 of Nigeria LNG project;
   - Brass LNG project;
   - Trans-Sahara gas pipeline project;
   - Statoil LNG project etc.

References


Eficiența costului de marketing în domeniul gazelor naturale în Nigeria

Rezumat

Cercetarea a supus investigării eficiența costului de marketing în cazul gazelor naturale comparativ cu alți combustibili alternativi în Nigeria. În acest scop, cercetarea celor două opțiuni s-a realizat în baza datelor colectate în cadrul Companiei Nigeriene de gaze (NGC) și a altor companii consumatoare de gaze, precum PHCN- Egbin, P.Z Industries – Ikorodu and WAPCO – Shagamu. Rezultatele indică faptul că gazele naturale sunt mai eficiente decât combustibilii concurenți, ceea ce conduce la efecte diverse asupra economiei.