Use of CNG as Autofuel in Nigeria

Ubani E. Chikwendu and Ikpaisong S. Ubong

Abstract—Natural gas is a clean-burning, safe fuel that can save you money at the pump while benefitting the environment and reducing Nigeria’s dependence on petroleum. It is a naturally occurring mixture of gaseous hydrocarbon, non-gaseous non-hydrocarbons and gaseous non-hydrocarbons found in underground reservoir rocks either on its own (non-associated gas) or in association with crude oil (associated gas). Natural gas is today accepted as one of the best sources of energy for the world and for the future because of its environmentally-friendly nature compared to other kinds of fossil fuels. Nigeria is ranked as the seventh most natural gas endowed nation in the world and relaxes on number one spot in Africa as she seats on about one hundred and eighty-eight trillion cubic feet of natural gas deposits.

Current opportunities to utilize gas in Nigeria include: Gas to reinjection schemes, Gas to power schemes, Gas to petrochemicals (as feedstock), LNG-Liquified Natural Gas, LPG-Liquified Petroleum Gas, and CNG- Compressed Natural Gas. The use of CNG as auto fuel in Nigeria presents so much benefits as have been highlighted in this paper with emphasis on the economic advantage. Compressed Natural Gas (CNG) is a product of compressing natural gas to one hundredth the volume it occupies at standard atmospheric pressure.

A comprehensive economic analysis to determine the cost savings from driving a car on CNG against PMS considered the case of a motorist who covers an average of 100 km every day in the approximately thirty days that make a month was employed. Results established that running a car on CNG amounts to saving N1 143 daily and N34 284 monthly, the cost of converting the car from PMS - driven to CNG - driven is recovered before the end of the sixth month. From the sixth month to the end of the first year, savings of N211 402 is made. Savings of N411 408 is enjoyed each year after the first year.

Running vehicles on CNG will greatly reduce the friction and troubles encountered in importing fuel into the country. This will also cut down largely the hardly available foreign exchange expended in bringing in PMS for fuelling vehicles. To this end, the Nigerian Government should as a matter of national development ensure legal and regulatory framework encompassing both technical and commercial aspects for natural gas utilization in Nigeria. Worthy of note is the aspect of gas gathering, gas transmission and distribution which will further encourage the planting of CNG refuelling stations that will serve the expected large fleet of natural gas vehicles. Currently, Green Gas Limited, a joint venture between Nigeria Gas Company (NGC) a Nigerian National Petroleum Corporation (NNPC) and NIPCO Plc. that has nine operational CNG refuelling stations and others under construction is the only company driving the CNG revolution in the country.

Index Terms—Autofuel; Compressed Natural Gas (CNG); Naira.

I. INTRODUCTION

Natural gas is a naturally occurring mixture of gaseous hydrocarbon, non-gaseous non-hydrocarbons and gaseous non-hydrocarbons found in underground reservoir rocks either on its own (non-associated gas) or in association with crude oil (associated gas). Natural gas is today accepted as one of the best sources of energy for the world and for the future because of its environmentally-friendly nature compared to other kinds of fossil fuels. Nigeria is ranked as the seventh most natural gas endowed nation in the world and relaxes on number one spot in Africa as she seats on about one hundred and eighty-eight trillion cubic feet of natural gas deposits [1].

Oil and gas experts believe that Nigeria would earn more from full utilization of gas resources than what it is currently been realized from crude oil exports [2]. Current opportunities to utilize gas in Nigeria include:
1. Gas to reinjection schemes
2. Gas to power schemes
3. Gas to petrochemicals (as feedstock) [3]

In the same vein, natural gas is also being utilized in these three different physical forms:
- LNG-Liquified Natural Gas
- LPG-Liquified Petroleum Gas
- CNG- Compressed Natural Gas

Owing to the drawback in the collection and transportation/storage often associated with natural gas, it is usually shipped in liquid form from an available region to where it is needed. Natural gas in this form is referred to Liquefied Natural Gas (LNG). LNG occupies 1:600 of its original volume, helping to reduce transportation costs considerably. Nevertheless, the special treatments required during liquefaction and transport means LNG attracts huge CAPEX. Natural gas is also compressed to 200 bar to achieve a 99% volume reduction, and hence make it more portable. Natural gas stored in this form is known as CNG. Although CAPEX for CNG production is considerably lower than that of LNG, there is an element of risk because it is stored in a pressurized cylinder. The last form is Liquefied Petroleum Gas. LPG is usually produced during crude oil refining. LPG composition is mainly propane and butane. Its high calorific and heating values have made it the most popular household cooking gas in most of the third world countries.

Of all these fractions, Nigeria currently exports 18.6 million tonnes per annum of LNG [4] while LPG usage among the populace for domestic cooking is on the rise. Several merits exist for boosting these figures and also increasing the use of other natural gas fractions. For example, the nation could have been immune from the plummeting GDP from the current low price regime in crude oil sales if avenues for the utilization of LPG are explored as
Compressed Natural Gas (CNG) is a product of compressing natural gas to one hundredth the volume it occupies at standard atmospheric pressure. It is contained and distributed in hard cylindrical or spherical containers at pressures between 3000 to 3600 psi. It is mostly used for generating power and as fuel for vehicles. Natural Gas Vehicles (NGVs) drive on CNG stored in cylinders installed in the rear, roof or undercarriage of the vehicles. When needed to power the vehicle the natural gas leaves the cylinder to the engine combustion chamber through a specially designed system. [5].

Compressed Natural Gas (CNG) has been used as fuel been in domestic households for many years but it has not achieved mainstream use as fuel for automobiles. Today CNG is gradually being recognized as one of the most viable alternative fuel options available. Being a much cleaner fuel source, its increased portability and reduced cost has made it very popular as a transportation fuel. Presently, there is an increasing use of CNG in public transportation. For example, cities like New Delhi have made CNG usage in public transportation very mandatory, resulting in considerable pollution reduction. In the past, owing to its heavy and voluminous tank requirement, CNG deployment in small vehicles was not widespread. However, this has considerably advanced over the last decade by the development of lightweight high-pressure storage cylinders. [5].

In this section, we will review the economic advantages of running a vehicle using natural gas compared to running same vehicle on the conventional premium motor spirit. A comparative economic analysis was carried out on the capital expenditure and operating expenditure of running a vehicle on CNG against running same vehicle on the conventional gasoline (premium motor spirit - PMS) for a given distance. Factors considered in making the comparison include initial cost of converting the vehicle from a PMS – driven vehicle to a CNG - driven vehicle. The capital cost of the vehicle is not considered as it is same vehicle. Other economic factors considered is a conversion cost of about N 200 000 required to convert a conventional automobile to CNG [8]. Tables 1 and 2 are used to estimate the fuel consumption of a car driven on PMS and one driven on CNG.
TABLE I: RUNNING COST OF CAR PER KILOMETER TRAVELLED IN 2011

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Running Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>N14/Km</td>
</tr>
<tr>
<td></td>
<td>N5.5/Km</td>
</tr>
</tbody>
</table>

TABLE II: PRICE OF VEHICLE FUELS IN 2011

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Cost (Naira)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol</td>
<td>97/litres</td>
</tr>
<tr>
<td>CNG</td>
<td>55/SCM</td>
</tr>
</tbody>
</table>

For a distance of 100 km

To carry out a comprehensive economic analysis to determine the cost savings driving a car on CNG over PMS, the case of a motorist who covers an average of 100 km every day in the approximately thirty days that make a month is employed. [9]. The analysis involved the use of fuel consumption for the car (Table III above) and the current prices of vehicle fuels in Nigeria. (See Table IV)

TABLE III: FUEL CONSUMPTION PER KILOMETRE

<table>
<thead>
<tr>
<th>Fuel consumption</th>
<th>Petrol (litre/km)</th>
<th>CNG (SCM/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.14432</td>
<td>0.1000</td>
</tr>
</tbody>
</table>

Cash flow is generated for a car that runs on CNG on a monthly basis, refer Table VI.

Monthly savings = Daily savings × 30 = N1 142.783505 × 30 = N34 283.50515

TABLE V: SAVINGS USING CNG

<table>
<thead>
<tr>
<th>Fuel consumption</th>
<th>Distance in a day (km)</th>
<th>Total fuel consumption/day</th>
<th>Fuel cost (Naira)</th>
<th>Total Fuel cost/day (Naira)</th>
<th>Daily Savings on CNG over petrol (Naira)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.14432 litre/km</td>
<td>100</td>
<td>14.432</td>
<td>145/litre</td>
<td>2092.78</td>
</tr>
<tr>
<td></td>
<td>0.1 SCM/km</td>
<td>100</td>
<td>10 SCM</td>
<td>95/litre</td>
<td>950</td>
</tr>
</tbody>
</table>

\[
\text{Payback period} = \frac{\text{Initial outlay}}{\text{Annual cash flow}} = \frac{200 000}{34 283.50515} = 5.8337 \text{ months}
\]

VI. SUMMARY OF RESULTS

Daily saving on CNG over PMS = N1 143
Monthly saving = 34 284
Payback period = approximately 6 months

VI. CONCLUSION AND RECOMMENDATION

From the economic analysis and results above, running a car on CNG over PMS amounts to a daily savings of N1 143 and N34 284 monthly, and the cost of converting the car to CNG driven car is recovered before the end of the sixth month. From the sixth month to the end of the first year, savings of N21 402 is made. For subsequent years, savings of N41 108 is enjoyed each year. Apart from the economic advantage, other benefits highlighted above such as environmentally friendly, vehicle performance and efficiency, safety and low operation and maintenance cost make it a choice fuel for vehicles in Nigeria. The abundance of Nigeria’s natural gas reserves in excess of 187 trillion cubic feet further establishes its necessity to be the fuel to drive vehicles in the country.

Running vehicles on CNG will greatly reduce the friction and troubles encountered in importing fuel into the country including subsidy payment and the accompanying disagreements. This will also cut down largely the hardly available foreign exchange expended in bringing in PMS for fuelling.

The Nigerian Government should as a matter of national development ensure legal and regulatory framework encompassing both technical and commercial aspects for natural gas utilization in Nigeria. Worthy of note is the aspect of gas gathering and gas transmission/distribution which will further encourage the planting of CNG refuelling stations that will serve the expected large fleet of natural gas vehicles. Currently, Green Gas Limited, a joint venture between Nigeria Gas Company (NGC) a Nigerian National Petroleum Corporation (NNPC) and NIPCO Plc. that has nine operational CNG refuelling stations and others under construction is the only company driving the CNG revolution in the country [10].

References


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REFERENCES