

Assessment of Natural Gas Market in Transportation Sector from Consumers' Perspective

A. BARATIMALAYERI, Iranian Fuel Conservation Organization

Abm826@yahoo.com, Barati@ifco.ir, barati@iies.net

MAYSAM BIDABADI, MSc. Energy Economy

maysam_b5@yahoo.com

Abstract

In this article, it is attempted to study and recognize natural gas fuel market as one of the most important alternative options for gasoline and diesel oil for transportation sector. We have tried to recognize the arguments of governments and other policymakers as well as active Iranian firms in the market by introducing the advantages of natural gas in various fields like less pollution, abundant reservoirs, more suitable price and more safety compared to gasoline and diesel oil as well as its disadvantages such as lower efficiency on vehicles and the lack of enough natural gas stations compared to oil products' refueling stations.

Then, the cost effectiveness of purchasing NGV's to gasoline cars for Iranian consumers are studied by applying cost-benefit method and then the effects of increasing gasoline price as well as development and expansion of infrastructures especially natural gas stations on cost-effectiveness of NGV buyers are determined.

Keywords: Natural Gas Vehicle (NGV), pollution, alternative fuel.

Introduction

Today, one of the most important problems of the countries in consuming common fuels (gasoline and diesel) in transportation sector is that they are facing with two constraints; They are exhaustible and pollutant. So, nowadays all governments, environmental organizations and other relevant agencies throughout the world are looking for suitable alternatives for these fuels in order to use in transportation sector.

It is also an important problem in Iran where there are also other significant difficulties like paying huge subsidies by the government for gasoline and diesel.

Globally, experts have introduced two fuel groups as alternatives for these two fuels:

The first group: alternative fuels with less pollution but still exhaustible (like natural gas).

The second group: alternative fuels with less pollution but renewable (like hydrogen, solar)

What has been obvious so far is the more successful performance of the first group in the market in competition with oil fuels. Natural gas is among the most important fuels in the first group which has the highest share among gasoline and diesel alternative fuels. Some of the most important reasons to choose natural gas as an alternative for oil fuels are as follow:

1. Natural gas has more reservoirs than oil and it has the more capability to supply needed fuel for transportation sector than oil in longer period.
2. It produces less pollution in comparison with oil fuels.
3. It has more proper price than other alternative fuels for substituting oil fuels.

Present and future of transportation fuels

Energy consumption in transportation sector includes consumed energy to transport people and goods via roads, railways, air routes and pipelines. Road transportation vehicles includes light vehicles such as cars, sport utility cars (SUV's), minivans, light trucks, motorcycles and heavy vehicles such as buses and large trucks. Economical activities growth and population increase are among key factors that determine energy demand in transportation sector.

In next 25-year outlook, it is expected that the demand for oil and other liquid fuels in transportation sector increases rapider that other end-user sectors.

Increasing urbanization and personal incomes are effective factors of air travels' growth and using more motor vehicles in a developing economy. Increase in goods transportation creates a high growth expectation in the GDP of OECD or non-OECD countries. Furthermore, because of goods transportation growth, it is

expected that fuel demand of road transportation sector for trucks and lorries grow rapidly. Also, as the result of increase in trading among different countries, the volume of international transportation via air or sea routes creates more increase in fuel demand.

Regarding the oil fuel prices in recent years, alternative fuels have highly paid attention. For example, USA has introduced the law of increasing ethanol share in liquid fuels and increased the research budget for bio-fuels. In European OECD countries, there is a heavy pressure on increasing the consumption of alternative fuels in transportation sector including natural gas. Owing to the fact that alternative fuels are still expensive and their competitiveness is lower than traditional fuels, it is expected that the global rate of alternative fuels consumption in transportation sector remains in a low level by 2030 among OECD and non-OECD countries.

Future outlook of natural gas production and consumption

Based on the reference scenario of International Energy Outlook (EIA, June 2006), it is expected that the world natural gas consumption with 2.4% annual average growth would increase from 95 trillion cubic feet in 2003 to 182 trillion cubic feet by 2030. The share of natural gas from total world energy consumption would increase from 24% at the beginning of this period to 26% at the end of the period.

Based on U.S. Geological Survey (U.SGS), it is expected that 2347 trillion cubic feet will be added to world natural gas discovered reserves by 2025. The forecasts indicate that more than half of untapped reserves are located in former Soviet region, the Middle East and north Africa and about one fourth is in north, central and south America.

The reasons for selecting natural gas as a fuel for vehicles in transportation sector

1- Inexpensive

In a survey made in Blue Corridor member states, it was recognized that the cost of one cubic meter of natural gas to one liter diesel fuel is 27% in Norway;

41% in Poland; 46% in Russia; 49% in Belarus; 63% in Austria and 65% in Germany.

2- Renewable

As the most important component of natural gas, methane is extracted from under-soil garbage excretion, sewage repulse and agricultural activities.

3- Domestic resources

Iran possesses 15.9% of total discovered natural gas reserves of the world and has the second rank after Russia. The existence of abundant domestic resources is not only important economically but also provides the country with proper situation politically and strategically.

4- Less pollution

Natural gas vehicles (NGV's) decrease the rate of CO₂ emission (the most important greenhouse gas) between 20%-25% in comparison with gasoline vehicles.

Technical assessments show that only NGV's have been so far able to obtain U.S. Environment Protection Agency's 2010 Emission Standard for heavy trucks.

5- Safety

a) Natural gas safety compared to gasoline

Natural gas is lighter than air; so it moves up rapidly if it leaks out of storage tanks, while gasoline pours on the ground and creates basin. The combustion temperature of natural gas (540°C) is almost two times more than gasoline (232°C); It causes remarkable decrease in the danger of explosion or burning NGVs.

b) CNG cylinder safety

Compressed natural gas cylinders are made by in-seam pipes and by complicated industrial techniques without any need to welding. The cylinders have complicated standards and pass various test such fire, bullet, throw down from height, etc. They have complete safety during their life cycle which is usually 20 years.

6- A bridge to hydrogen

In contrast with other alternative fuels, H₂ and CH₄ are able to be combined to decrease vehicle's emission. The combination is called HCNG.

HCNG is a mixture of hydrogen and compressed natural gas. Adding hydrogen to natural gas will improve combustion because of better performance of the engine. It enhances the efficiency and decreases emissions remarkably.

HCNG provides the opportunity for hydrogen use as a cost-effective transportation fuel. It acts as a catalyst in order to improve the hydrogen infrastructure needed for future vehicles which their power would be supplied by net hydrogen and fuel cells.

NGV purchase cost-benefit analysis

To determine the cost-effectiveness of a NGV compared to a gasoline vehicle cost-benefit technique is applied. In this study, the vehicles are divided into three groups (see table 1).

Table 1: categorization of passenger cars in order to use cost-benefit technique

	Engine volume (cc)	Gasoline consumption (liters per 100 km)	Natural gas consumption (cubic meters per 100 km)
Group 1	1400 & 1300	6.5	5.8
Group 2	1600	7.5	6.8
Group 3	1800 & 2000	9	7.7

First scenario

In this scenario, the cost-effectiveness of purchasing NGV is studied with regard to gasoline rationing.

The hypotheses in this scenario are:

1. The quota of each vehicle is 120 liters of gasoline per month.
2. The price of of rationed gasoline is 1000 Rials per liter and purchasing more than quota costs 4000 Rials per liter.
3. The price of one cubic meter of natural gas is 200 Rials.
4. The difference between new NGVs prices and gasoline ones is 8,000,000 Rials for group 1, 10,000,000 Rials for group 2 and 11,000,000 Rials for group 3.
5. The cost of maintenance and CNG kit spare parts¹ is 500,000 Rials per two years.
6. Cylinders are tested every 3 years and it costs 1,000,000 Rials.
7. The considered period is 10 years.
8. Discounted rate is 14%.
9. Owing to the fact that it was not possible to use natural gas in overall mileage of NGVs because of various reasons including the lack of CNG stations, it is assumed that 30% of the mileage is with gasoline and 70% with CNG.

Part one

In first part of the scenario, it is not possible to buy gasoline more than quota. In this case, the mileage is calculated based on 120 liters quota for vehicles in all groups. The vehicles in group 1, 2 and 3 travel 1846km, 1600km and 1333km per month respectively. Based on the mileage of gasoline vehicles, NGV's in groups 1, 2 and 3 consume 107m³, 104m³ and 103m³ per month respectively.

Based on results of natural gas consumption and scenario's hypotheses, the cost-effectiveness for all groups is calculated and shown in table 2.

¹ It should be noted that although currently there are several kinds of CNG kits in the Iranian market, in most exchanges, CNG Kit Type 1 is utilized which is the basis for the assumptions of the calculations.

Table 2

	Group 1	Group 2	Group 3
100% natural gas	-348,617	-544,335	-642,908
70% natural gas	-559,832	-756,977	-855,550

- The first finding is that buying NGV is not cost-effective if there would be no possibility to buy gasoline more than determined quota.
- Another finding is that increase in natural gas consumption improves the cost-effectiveness of NGV's. So, infrastructures like natural gas stations should be developed in order that the owners of NGV's allocate more share of their fuel consumption to natural gas.
- With current price and quota of gasoline, the NGV owners will lose even if the natural gas price would be zero (groups 1, 2 and 3 will lose 1,959,140 Rials, 3,959,140 Rials and 4,954,140 Rials respectively). It shows the importance of increasing gasoline price as a driving force to purchase NGVs.

Part 2

In part 2 of the scenario, all hypotheses are similar to previous ones; only it is possible to buy gasoline more than quotas.

In this case, it is assumed that determined quota (120 liters per month) is appropriate for the buyers of group 1 vehicles. Based on traveled distance of gasoline vehicles of group 1 by 120 liters consumption per month, the monthly consumption of gasoline and natural gas by the vehicles of the other groups were calculated.

On this basis, group 1 vehicles with 120 liters of gasoline travel 1846km per month. For the same mileage, vehicles in groups 2 and 3 need 138.5 liters and 166 liters of gasoline per month respectively. Natural gas consumption in the vehicles of all three groups is 107m³, 120m³ and 142m³ per month respectively. The cost-effectiveness analysis is shown in table 3.

Table 3

	Group 1	Group 2	Group 3
100% natural gas	-348,617	-39,131	-614,393
70% natural gas	-559,832	-284,241	-318,977

- As seen, if mileage is considered as a fixed variable to compare the fuels, the condition of high consumption vehicles to achieve the ideal point will be better economically. So, it is suggested to prioritize the conversion of high consumption vehicles to NGV's.
- Again, the necessity of increasing gasoline price is obvious as the most important driving force for buying NGVs. NGV buyers won't achieve positive cost-effectiveness if more gasoline than quota to be supplied with the same 1000 Rials price.

Second scenario

In this scenario, rationing and gasoline/natural gas price assumptions are changed compared to the hypotheses of the first scenario. The monthly consumption of first group is assumed 120 liters. By obtaining the traveled distance by 120 liters of gasoline in gasoline vehicles of the first group, gasoline and natural gas consumptions of the other groups are also calculated.

It is assumed, in this scenario, that prices are liberized. So by considering the prices in countries that are close to Iran geographically and the existence of NGVs in their transportation fleet, gasoline and natural gas prices in Uzbekistan were selected because its gasoline price is less than the other countries and this price is near to current free sale of gasoline in Iran. Based on the information published in The GVR Magazine (January 2008), the price of gasoline is 0.34 Euro/Liter and the price of natural gas is 0/11 Euro/m³ in Uzbekistan. According to Iran's Central Bank Statistics, 1 Euro equals to 13,500 Rials (year 2007); so, the prices of gasoline and natural gas are 4,600 and 1,500 Rials respectively.

Based on the assumptions of this scenario, the cost-effectiveness of each group of vehicles is analyzed in table 4.

Table 4

	Group 1	Group 2	Group 3
100% natural gas	1,503,5591	2,009,513	2,576,696
70% natural gas	696,518	1,032,643	1,395,746

- Increasing Gasoline price makes natural gas price increase possible too. In other words, the government does not need to pay any subsidy for natural gas in order to stimulate the usage of NGVs.
- Increasing gasoline price makes technological changes possible in shorter time. So, it would be possible to promote the efficiency of NGVs and decrease their emissions in shorter time period.

Third scenario

In this scenario, we address a situation in which gasoline price is liberized but natural gas price is still determined by the government. It is attempted to find a price limit for natural gas which NGV is an ideal choice for user and poses the lowest financial pressure on the government.

Liberized gasoline price is considered equal with Persian Gulf FOB (8000 Rials per liter). The final price selected by the government could be a price that considers no economic difference between buyers of NGVs and gasoline vehicles in a 10-year period with 14% discounted rate. In other words, the cost-effectiveness of NGVs is zero. According to this assumption, natural gas prices are shown in table 5.

Table 5

Natural gas price Rials	Group 1	Group 2	Group 3

100% natural gas	7,590	7,770	8,020
70% natural gas	6,990	7,140	7,470

- The finding is that natural gas price is getting close to gasoline price. In other words, increase in gasoline price would increase ideal relative price (natural gas to gasoline).

Conclusion

Generally, some issues like less emission, cheapness, abundant domestic reserves, the possibility of domestic infrastructural expansion and safety are considered as the reasons of selecting natural gas as an alternative fuel for gasoline and diesel. In part, it can justify the supports of the government and other policymaking agencies.

Overall, one can say that this plan needs a careful planning and regular execution. According to the results of cost-benefit analysis for natural gas and gasoline vehicles, the impact of higher gasoline price on the selection of NGV buyers is undeniable. Also, the influence of expanding natural gas stations is very important. What seen so far, indicates the weakness in proportional expansion of natural gas market. Regarding current limitations and future difficulties such as the number of NGVs which is not proportionate with the number of natural gas stations, this market is only growing marginally. It has caused some problems for NGV owners that finally encourage them to consume gasoline. Furthermore, without considering the expansion potential and increasing of the supply of natural gas, increasing the number of NGVs has caused increase in natural gas demand. As a result, in wintert, failure in supplying natural gas leads to shut down of natural gas stations and even manufacturing units in order to meet residential demand.

Finally, in the process of expansion and development natural gas fuel market, the government and other policymakers should pay attention to both supply side (including the ability of proportionate expansion of NGVs with the number of natural gas station and the ability of meeting natural gas demand increase with its supply) and demand side (the most important natural gas consumption motivation for NGV owners is gasoline/diesel prices).

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