The Asian Journal of Technology Management Vol. 7 No. 1 (2014): 1-8

Potentiality of the Usage of Compressed Natural Gas for Competitiveness in Service Delivery Industries

Gazi Mohammad Hasan Jamil[1] **and Fuad Hasan**[2*]
[1]Department of Finance, University of Dhaka, Bangladesh
[2]Department of Marketing Studies and International Marketing,
University of Chittagong, Bangladesh

Abstract. With the rising costs of gasoline, many vehicle owners are looking for alternatives of it. Compressed natural gas (CNG) has been tested for this very purpose in some countries and found as a better alternative so far. CNG comes from country's natural resources and it is clean and less costly to use. This paper is mainly an analysis of the potential benefits of using natural gas as a transportation fuel by the service delivery industries. It will examine CNG's potential contribution in reducing delivery and vehicle maintenance cost, saving money in the long run projects, improving fuel efficiency, enhancing physical safety and assuring environment friendly emissions of carbon monoxide or reactive gases for the service delivery industries.

Keywords: Compressed natural gas (CNG), Service Delivery, Fossil fuel, Global warming, Competitiveness.

1. Introduction

Fossil fuel reserves are now one of the most serious issues of concern of the world. It is argued that crude oil and derivative products like gasoline and diesel will become scarce and most costly (Catania et.al. 2004). Optional fuel know-how, accessibility and its utilization must and will become more widespread in the next decades. Natural gas is found in a range of spheres in oil and gas bearing sand strata placed at various depths below the earth surface (Catania et.al. 2004). Apart from the concern regarding scarcity and cost, the issues regarding environmental pollution due to gasoline has become another great public concern and, as such, a tighter regulation for both of local and global emissions from engines is easily anticipated. Among others, Asians, being the worst affected region by environmental pollution (World Bank, 1999), need to take the issue more seriously than any other part of the world.

*Corresponding author. Email: fuad@cu.ac.bd

DOI: http://dx.doi.org/10.12695/ajtm.2014.7.1.1
Print ISSN: 1978-6956; Online ISSN: 2089-791X.

On this backdrop, natural gas is thought as the most favorite for fossil fuel substitution. Compressed Natural Gas (CNG) is a gaseous form of natural gas. It has been experienced as one of the most promising alternative energy due to its substantial benefits compared to gasoline and diesel.

At present, almost all delivery vehicles use gasoline and the gasoline price has been growing gradually. As a result, the operating and delivery costs of packages and documents are also increasing at the same time. So, it has become a problem to control the fuel expenditures and, as such, service delivery has also become costlier. Besides, the burning issue of global warming due to burning of gasoline is also worth considering. But, the service should be efficient and low at cost to be competitive. Moreover, the issue of technology management with the adoption of required changes for introducing CNG instead of gasoline is also an important issue.

Natural gas vehicle started to appear in 1969 in the U.S. on a very small scale, primarily through conversion kits sold by small natural gas utilities and, by 1992, the market share of natural gas vehicle has grown significantly as they are primarily adopted by government light-duty vehicle fleets (Davis & Diegel, 2006). The supporters of compressed natural gas vehicles state that at least all fleet vehicles need to be converted to CNG compatible engines to attain the economies of scale.

2. Literature Review

Search for alternative fuel is a common area of study for the researchers. Topolansky (1993) and Kazimi (1997) studied the commercial feasibility of natural gas as an alternative to gasoline. O'Connor (1993), Shashikantha (1999), Goyal and Sidhartha (2003) and Cohen (2005) studied the technological aspects of natural gas for the same purpose at the same time. The political impact in procuring natural gases were also studied by Painuly and Parikh (1993) and Flynn (2002). Yeh (2007) studied the evolution in the usage pattern of natural gas over the decades. Turrio-Baldassarri et al. (2006) and Reynolds and Kandlikar (2008) studied the opportunity benefits of the use of natural gas instead of gasoline.

Tzeng et al. (2005) and Frick et al. (2007) studied the modes of transportation and the transportation systems with a view to judge the potential of natural gas in the transportation related businesses. Schlesinger (1995) studied the marketability of natural gas as an alternative to gasoline. Birol (2005) studied the economics of CNG that provided support to the relevant studies on its business feasibility and marketability. Scholars, in their works mentioned above, argued several times that CNG may not be the best alternative for any type of industry. However, industry based analyses are yet to get the attention of the academicians and practitioners.

The prime objective of this article is to assess the prospective advantage of using natural gas instead of gasoline as a transportation fuel by the service delivery industries of different countries. However, the specific objectives are as follows:

- To examine CNG's potential role in alleviating delivery and vehicle maintenance cost,
- To assess CNG's capacity of enhancing fuel efficiency,
- To verify CNG's support in assuring environment friendly emissions of carbon monoxide or reactive gases for the service delivery industries.

3. Methodology

The article is mainly based on secondary materials. Several books and articles of the renowned academicians are consulted to get a clear concept of the topic in respect to objectives mentioned above. Related policy analyses of different countries were also studied to analyze the study problem. The recommending decision was finalized only after considering the potential incremental benefits and associated opportunity costs.

CNG Vehicles – How It All Started

The use of natural gas vehicles, first introduced in Italy in the mid-1930s as an alternative to gasoline-powered vehicles, began to spread out to other countries as early as 1940 (Yeh, 2007, 5865). CNG vehicles normally use pressurized tanks for storing gas and ignite the gas inside the engines. Natural gas contains 90 percent methane, higher octane rating than gasoline and, therefore, accomplishes superior efficiency (Shashikantha, 1999). It is also lighter than air so it will evaporate quickly into the atmosphere giving little chance for ignition (Murphy et al., 1995).

Natural gas vehicle have been started to get encouragement from governments as a clean alternative to gasoline vehicles to reduce dependence on foreign oil especially after the energy crisis of the 1970s (Yeh, 2007, 5865). Then, CNG system was commenced and implemented by both of the developed and developing countries who have availability to extract facilities for natural gas.

Potentiality of CNG Vehicles in Service Delivery Industries

Delivery cost is basic and crucial cost element for any company. The conversion cost for making engines CNG compatible is high and fixed in nature for the company. But, it can contribute to comparatively greater extent in minimizing the per unit variable cost for delivery of products. In case of compressed natural gas it is normally measured as equivalent gallon and 121.5 cubic feet is equal to one equivalent gallon. The fuel costs for a diesel 'control' bus ($0.14/mile, $0.09/km), an 'advanced diesel' bus (exact technology not specified) ($0.16/mile, $0.10/km), and CNG vehicles ($0.13/mile, $0.08/km)" (Cohen, 2005, 1716-1717). Since the cost per mile for CNG vehicle is lesser than the gasoline vehicle one should introduce and adopt CNG compatible engine to attain the economies of scale.

By using the compressed natural gas compatible engine usually the overhead and the maintenance costs become lower in comparison to gasoline engine. The burden of the increase in fixed cost is spreading into number of units produced and some portion of the fixed cost is also carried by the buyers of the manufacturer's product. The effect of increase in fixed cost eventually comes to an end by increasing consumers and producers' surplus with the effect of lesser variable cost and favorable individual savings through lesser future price of the product. The conversion cost of a CNG-fueled vehicle is about higher by $900 than that of a gasoline-propelled vehicle (Topolansky, 1993, 45).

Some of these costs will possibly be shifted to the consumer in the form of higher retail prices, and some will be absorbed by the auto producers. However, consumers might benefit in the form of lower operation and maintenance costs because the unit cost of liquefied petroleum gas and compressed natural gas are cheaper than that of conventional gasoline.

The rapid growth of gasoline price has led to a great cause of concern for long run feasibility of a project for delivery service

industry which depends on the usage of fuel. Consequently, valuable attention is required for finding the cost efficient and long-lasting means of fuel utilization for future profitability and growth of the company. Compressed Natural gas could be a prospective replacement for gasoline for most vehicles, and will relieve the pressure on gasoline.

Tax incentive is part of long run initiative for those companies who use alternative fuel vehicles other than gasoline. "Additional Congressional initiatives also began to encourage the use of alternative fuels, which included, 1) additional mandated increases in the number of alternative fuel vehicle (AFV) used by the U.S. government, especially in certain urban areas with air quality problems; 2) tax incentives and credits for producers of alternative fuels, including an efficient distribution system; 3) financial incentives to encourage state and local governments to purchase AFVs" (Topolansky, 1993, 39). Tax incentives not only extended to user of natural gas but also the producers and state and local government for encouraging the adaptation of natural gas. Collective initiation and implementation procedure will help to spread the socio-economic benefit to all the sectors of the economy.

Not only for the tax benefits but also for the increased price divergence between compressed natural gas and gasoline (for which one needs to depend on the import as well) attention is due to future mode of operation, sources of energy and cost benefit analysis of the project. Similarly, if the fuel price difference between natural gas fuel and gasoline is increased from the current level of 15% to 50% the payback period for NGVs in the US can be reduced to around 2.6 years (Yeh, 2007, 5873). If payback period is reduced there will be enough opportunity to invest more funds for sustainable future expansion and this is also an issue of future growth and wealth maximization of the company.

Fuel Efficiency of CNG Vehicles

There are several studies and report that carry different conclusion about fuel efficiency and there remain several aspects to consider before going for any concrete conclusion about the efficiency of CNG as a fuel. The efficiency of CNG fuel depends on a number of variables, such as; vehicle size, vehicle use, fuel options, engine design and etc. Realistically, a vehicle designed for and dedicated to CNG use only should be expected to have a greater efficiency than a gasoline or diesel fueled engine. "The average gasoline engine may possess a ratio of 8:1 and run on fuel with an octane number of 90. In contrast, the average natural gas engine may possess a ratio of 12:1 and may run on a fuel of 130 octanes or lower, depending on the quality of the fuel. The higher ratio causes an increase in thermal efficiency, which in turn reduces the fuel consumption" (O'Connor 1993, 54). The same conclusion about efficiency was also found in Kazimi's (1997) research - "Benefits from the introduction of only CNG and methanol vehicles increase from $21.1 million in 1998 to $121.2 million in 2008".

CNG – An Environment Friendly Fuel

Natural gas is an almost pollution free fuel for transportation. Emissions, which are really harmful for human being, are very low in CNG compared to other harmful emissions from usual fuels. Engine noise is also reduced significantly. This leads to a reduction of health hazards and associated diseases such as asthma, bronchitis, colds etc (Painuly & Parikh, 1993, 51). So the total medical expenses for the individual and as well as for the insurance company will reduce drastically. The introduction of CNG and methanol vehicles lead to health

benefits of between $20 and $120 million depending upon the year (Kazimi, 1997, 163). Vehicular traffic of a highly developed country like U.S. accounts for a relatively significant portion - about 3% - of the earth's total carbon dioxide emissions annually (Topolansky,1993, 39). Every country is becoming more concerned for adaptation of compressed natural gas engine because environment is now a national phenomenon and gasoline is harmful for the environment which emits high levels of particulate matter. "Compared with diesel buses or heavy-duty and light duty diesel/gasoline vehicles, NGVs have the potential to emit lower levels of particulate matter… to reduce evaporative emissions and running-loss emissions" (Goyal & Sidhartha, 2003). So, to make the world pollution free, introduction of CNG will be a giant step towards future environment friendly energy source.

Since the government is becoming more defensive concerning environment and issue laws to protect atmosphere the organizations need to adopt compressed natural gas for their fleets which is less damaging for human beings as well as for the environment. Compressed natural gas fueling for vehicles is seen as a means of reducing environmental and human health costs of transportation as internal combustion engines, running on CNG, produce inherently less pollutant emissions than comparable liquid-fuel engines (Reynolds & Kandlikar, 2008, 5860).

In the United States, "Texas, Louisiana, Oklahoma and Colorado also adopted legislation that mandates the use of a certain number of AFVs in state-owned government fleets by the mid-1990s" (Topolansky, 1993, 40). This sort of legislations and mandates ultimately spread out all the states in the USA in future and adaptation of CNG engine will be a very timely and contemporary decision for the organizations. In the high traffic areas, usually in urban regions, CNG plays an important role for health safety and environmental concern. "Large-scale use of CNG as fuel for automotive engines would impact beneficially on human health, especially in high traffic, urban areas plagued by air pollution" (Turrio-Baldassarri et al., 2006, 72). So, especially for urban areas the importance of CNG fuel vehicle is inevitable for the health safety and pollution free atmosphere.

Natural gas prices are still subject to some regulation, whereas domestic oil prices are increasingly tied to a fluctuating world market that is strongly influenced by political events (Flynn, 2002, 614). Import expenditure of oil and products in consequence of import of these items depend on prices of import, quantity of the items imported, distance between countries, local market conditions, government regulation and political stability among importing and exporting nations. So, by decreasing dependency on oil import a country can pave the way of sound political and economic environment.

Natural gas is seen as being an importable from politically unstable or hostile areas. In view of the uncertainty in oil prices and dependency on other countries, it may be advisable to advance a plan to adopt the use of natural gas in transportation sectors. It is shown that when international crude oil prices increase the natural gas allocated to the transport sector increases (Painuly & Parikh, 1993, 43). The more is the intensity to consume compressed natural gas in transportation sector, the more will be the technological advancement in gas related technology, infrastructure and availability of CNG stations.

Marketability of CNG Vehicles

The CNG vehicle is a better alternative to diesel vehicle following a multi-criteria analysis for public transportation (Tzeng et al., 2005). But, the distribution of natural gas is a very important concept that can be brought about when using natural gas in vehicles. Different industries can come together and share each others' processes and resources so that they can maximize their resources. Network of CNG filling stations is important for faster and more comprehensive adoption of CNG vehicles. The distribution of natural gas would ensure the availability of natural gas for all states through proper establishment of CNG station. Today, more than 5.1 million natural gas vehicles are on the road and close to 9,000 natural gas refueling stations are in operation worldwide (Yeh, 2007).

To become a mass-market item for consumption, compressed natural gas (CNG) cars will need an intense arrangement of filling stations. It is reasonable that the current set of locations reflects the demands of the customers in terms of accessibility and convenience, as well as those of local government in terms of public acceptability (Frick et al., 2007).

Marketability and demand for the CNG based vehicle and natural gas is also another important aspect. The marketer need to ensure that they can maintain the CNG price lower than the gasoline price and possible benefits of using CNG will persist for the long-term. Marketers need to ensure that the fuel price difference will always be greater than at least, for example, 30 cents a million British Thermal Unit (BTUs), enough to ensure payback of the customer's NGV program within a specified time (e.g., three years) (Schlesinger, 1995). The customer's total cost of converting the CNG adopted engine can be compared with the price differences and the cost benefit analysis and measurement of project feasibility study like net present value (NPV) and internal rate of return (IRR) can be introduced to motivate customers.

4. Conclusion

Using the natural gas or preferring natural gas more to gasoline has multiple and severe impact on economy and market. This will first bring about a change in the world's energy outlook. It would pave a new way for the need of energy protection methodology in which emphasis will be laid on preserving energy so that the industries do not face shortage of it in near future. It will also encourage the industries to always look for alternatives (Birol, 2005).

The practice of using CNG as alternative fuel in transportation can significantly reduce adverse health effects and, consequently, the high social cost related to air pollution, successfully contributing to the improvement of urban air quality (Turrio-Baldassarri et al., 2006, 75). This study also finds that CNG can improve fuel efficiency, enhance physical safety and assure environment friendly emissions of carbon monoxide or reactive gases for the service delivery industries. As an alternative fuel for transportation, CNG can also be effective for reducing transportation costs. It will also help the companies in lowering maintenance cost for the fleet vehicles and ensuring cost effective service for the delivery vehicles thereby. It has also been experienced in many parts of the world that conversion of engines to make it compatible for using CNG as an alternative to gasoline is not impossible or difficult.

Rather, technologies are already available to support this business strategy in the service delivery sector. Proper guidelines of technology management can also help make it an added source of competitive advantage.

However, actions in technology development and/or acquisition and/or transfer should be undertaken keeping the organizational objectives in mind. Long run profitability purposes can also be served by the use of natural gas rather than gasoline in vehicles of the service delivery sector. In short, it can be said that countries especially those oil importing ones should focus on compressed natural gas as the fuel for vehicles for minimization of fuel and maintenance costs for the fleet vehicles and for the safety and necessity of human health and environment.

References

Birol, F. (2005). The Investment Implications of Global Energy Trends. *Oxford Review of Economic Policy*, 21(1), 145.

Catania, A.E., Misul, D., Spessa, E. and Vassallo, A. (2004). Analysis of combustion parameters and their relation to operating variables and exhaust emissions in an upgraded multivalve bi-fuel CNG SI engine. *SAE Technical Paper 2004-01-0983*. Retrieved from *http://cat.inist.fr/?aModele=afficheN&cpsidt=16973645*.

Cohen, T. J. (2005). Diesel vs. compressed natural gas for school buses: a cost-effectiveness evaluation of alternative fuels. *Energy Policy*, 33: 1709-1722.

Davis, S.C. & Diegel, S.W. (2006). Transition strategy of the transportation energy and powertrain in China. *Energy Policy*, 35(4): 2313-2319.

Flynn, C. P. (2002). Commercializing an alternate vehicle fuel: Lessons learned from natural gas for vehicles. *Energy Policy*, 30(7): 613-619.

Frick, M., Axhausen, K.W., Carle, G. & Wokaun, A. (2007). Optimization of the distribution of compressed natural gas (CNG) refueling stations: Swiss case Studies. *Transportation Research Part D*, 12: 10-22.

Goyal, P. & Sidhartha (2003). Present scenario of air quality in Delhi: a case study of CNG implementation. *Atmospheric Environment,* 37: 5423–5431.

IANGV, 2006a. Latest International NGV Statistics, /http://www.iangv.org/content/view/17/35/S.

Kazimi, C. (1997). Evaluating the environmental impact of alternative-fuel vehicles. *Journal of Environmental Economics and Management*, 33, 163-185.

Murphy, J. M., Noramn, H. K. & Phani, K. R. (1995), Summary Assessment of the Safety, Health, Environmental and System Risk of Alternative Fuels. *U.S. Department of Transportation Federal Transit Agency*, 1-144.

O'Connor, L. (1993). Clearing the air with natural gas engines. *Mechanical Engineering,* 115(10): 52-56.

Painuly, P. J. & Parikh, J. (1993). Policy analysis of oil substitution by natural gas in India Transport and industry sectors. *Energy Policy*, 21(1): 43-52.

Reynolds, C. C. & Kandlikar, M. (2008). Climate Impacts of Air Quality Policy: Switching to a Natural Gas-Fueled Public Transportation System in New Delhi. *Environmental Science & Technology*, 42 (16), 5860-5865.

Schlesinger, B. (1995). Natural Gas Vehicles: Quit Complaining and Go Get the Market. *Natural Gas & Electricity*, 12(5): 21-25.

Shashikantha, M. (1999). Spark ignition producer gas engine and dedicated compressed natural gas engine-Technology development and experimental performance optimization. *SAE Technical Paper 1999-01-3515*. Retrieved from http://www.sae.org/technical/papers/1999-01-3515.

Topolansky, A. (1993). Alternative fuels: Challenges and opportunities for the global automotive industry. *Columbia Journal of World Business*, 28(4): 38-47.

Turrio-Baldassarria, L., Battistellia, L.C., Contia, L., Crebellia, R., Berardisa, D. B., Iamicelia, L., A., Gambinob, M. & Iannaccone, S. (2006). Evaluation of emission toxicity of urban bus engines: Compressed natural gas and comparison with liquid fuels. *Science of the Total Environment*, 355: 64-77.

Tzeng, G.H., Lin, C.W. & Opricovic, S. (2005). Multi-criteria analysis of alternative-fuel buses for public transportation. *Energy Policy*, 33: 1373–1383.

World Bank (1999) Environment Matters, September 1999 *(www.essd.worldbank.org/)*

Yeh, S. (2007). An empirical analysis on the adoption of alternative fuel vehicles: the case of natural gas vehicles. *Energy Policy*, 35: 5865-5875.