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Opportunities, Challenges and Future Developments of CNG (Compressed Natural Gas) Sector in Bangladesh

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Abstract

Human society is keen interested in making policies to minimize energy crisis. In this case Natural Gas is the best alternative. This paper presents opportunities, challenges and future developments of CNG sector in Bangladesh by using secondary data collected from different sources. CNG sector is now full of opportunities because of the user friendliness and environment friendliness. The economic & market opportunity is also very good, since it attracts the investors to develop infrastructures throughout the country. On the other hand, with the growing market of CNG sector some challenges came along. These challenges are high set up cost of station and conversion of tank, tank explosion, safety, and inadequate supply and distribution network. Providing cost effective equipment, using proper CNG tank, obeying the rules, maintaining a good distribution network, developing better infrastructure can meet these challenges. Another way to face this challenges is to introduce LNG.

Keywords: Natural Gas, CNG, Vehicle, Cylinder explosion, Bangladesh.

1. Introduction

Energy is considered as the driving force of socio-economic development of a country. Economic development largely depends on reliable energy supply [1]. Due to a rising trend in price of gasoline and petroleum based energy, a widespread research is carried out to investigate that CNG is good for the customer and kind to the environment, while making the country into more fuel sovereign state. CNG is made by compressing natural gas (which is mainly composed of methane, CH_4), to less than 1 percent of the volume it occupies at standard atmospheric pressure. It is stored and distributed in hard containers at a pressure of 20–25 MPa (2,900–3,600 psi), usually in cylindrical or spherical shapes [2]. CNG vehicles produce no evaporative emission because CNG fuel system is completely sealed [3]. However, CNG vehicles release about one quarter to one third less CO_2 than petroleum fuels [4]. During operation, CNG vehicles emit 20-45% less smog producing pollutants, such as particulate matter [5]. Although there are additional costs associated with CNG conversion systems, there are substantial savings to be attained in the operation of the vehicles. The fuel cost of CNG is cheaper with respect to other fuels like petrol, diesel and propane, approximately one quarter of the cost of the pump price of gasoline and diesel fuel [6]. The development and construction of the CNG refueling station infrastructure is a pivotal change that would initiate the long term transition from liquid fossil fuels to cleaner gas-based transportation fuels, potentially facilitating a future transition to hydrogen fuels by way of on-site steam methane reformation [7].

CNG is used in traditional gasoline/internal combustion engine automobiles that have been modified or in vehicles which were manufactured for CNG use. CNG as a fuel are increasingly used in Iran, Pakistan, the Asia-Pacific region, Indian capital of Delhi, and other large cities like Ahmedabad, Mumbai, Pune, Kolkata etc. Its use is also increasing in South America, Europe and North America because of rising gasoline prices. The entire credit for this goes to New Zealand, which in 1980s launched CNG programs on a commercial scale successfully [8]. It has seen that CNG is the answer to the world, in the hunt for alternative transportation fuel. Today CNG programs are being pursued in more than 108 countries [9].

Bangladesh is blessed with natural gas resources and at present natural gas is the main source energy. For maximizing the use of natural gas to reduce the air pollution and decrease the import of liquid fuel, Government of Bangladesh has undertaken the business of Compressed Natural Gas (CNG) in transport sector. CNG was first familiarized through a project under Bangladesh gas, oil and mineral corporation (Petrobangla) with the financial assistance of World Bank in early eighties. Rupantarita Prakitik Gas Company Limited (RPGCL), an enterprise of Petrobangla, is entrusted to convert the petrol vehicles to run by CNG and to install CNG refueling

Station. Government has given permission to the private sector entrepreneur to install CNG refueling station and to establish of CNG conversion workshop. Government has also provided land to some private entrepreneurs for establishment of CNG conversion workshop and CNG refueling station [10].

Considering the emerging socio-economic conditions of the world it is the challenge for scientists and researchers to deal with increasing demand of the natural gas. The study focuses on identifying opportunities to reduce market barriers in order to make the compressed natural gas vehicle market more efficient. There are some limitation in CNG sectors. The CNG sector is running into crisis. This study addresses the challenges facing by CNG sectors and will discuss about future development in this sector.

2. Statistics of Bangladesh's CNG industry

Due to Government's consumer friendly policy, ample regulatory framework and extensive efforts, CNG industry has developed significantly at an unprecedented rate of around 12.19% per annum during the last few years. Currently the country has 2.71 million (approx..) total number of register vehicles [11], out of which there are 0.3 million (11%) vehicle has been running on CNG while the rest, which includes buses, trucks, and two wheelers, three wheelers etc. are using gasoline and diesel. The summary statistics of CNG are shown at Table 1.

Table 1: Statistics of Bangladesh's CNG Industry [12].

Total NGVs	LD+MD +HD Vehicles	LD Vehicles	MD+HD Buses	Others	% of total NGVs vehicles in the country	Total number of CNG station	Total number of CNG conversion center	Date
2,98,000	287035	276000	11035	10965	11%	587	180	Feb,2017

2.1. Natural gas consumption at CNG sectors

Compressed natural gas (CNG) as a vehicle fuels was first introduced to Bangladesh in 1982 through a World Bank pilot project. CNG was promoted by the government in 2005 to address the severe air pollution in Dhaka during the 90's. It had a modest beginning with only 1.3% natural gas consumption in the initial year, but quickly became popular and increased to the current level of 5.3% rapidly. Its growth surpassed all predictions [10]. Though CNG sector is still rising, it is expected to come to a steady position within a few years due to market saturation, price hike and restriction on dispensing time.

3. Opportunities of CNG sector

3.1 CNG as an alternative fuel

CNG vehicles (CNGV) are similar to gasoline or diesel vehicles with regard to power, acceleration, and cruising speed. In contrast to gasoline/diesel fuel, CNG has a narrow range of flammability, 4.3–15.2 % by volume in air. CNG has a high auto-ignition temperature of 813 K (540 °C) compared to 531 K (258 °C) of gasoline and 316 °C of diesel [13]. The high ignition temperature and limited flammability range make accidental ignition and combustion of CNG unlikely. CNG is lighter than air so in the event of accidental leakage, CNG would rise and disperse into the air rapidly instead of forming pools on the ground as in the case of diesel and gasoline. CNG cylinders are designed and built of special materials to withstand high pressures with a factor of safety that is typically greater than two, therefore, safer than ordinary petrol tanks [14].

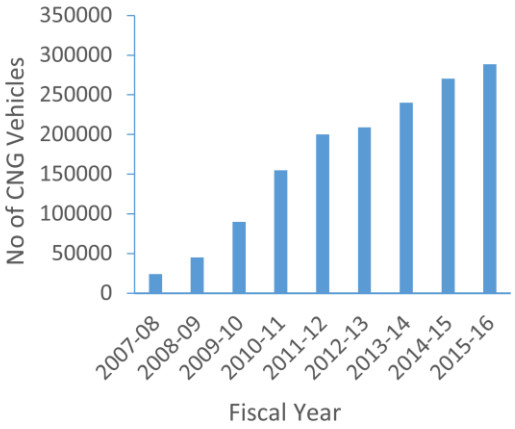

Fig. 1. CNG vehicles in Bangladesh during last decades [12]

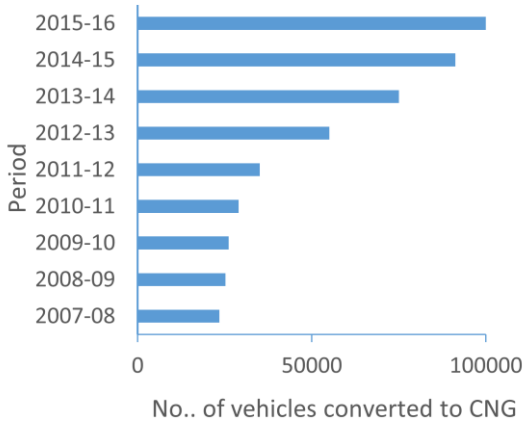

Fig. 2. Vehicles conversion to CNG during last decades [12].

3.2 Conversion to CNG vehicles

The number of CNG converted vehicles are increasing day by day. People are using CNG vehicles because of its vast economic benefits, safety, ease of use & environmental issues. In Bangladesh there are 180 CNG conversion centers & people are converting vehicles to CNG from diesel or petrol engines [12]. Now bus, truck, motor car, auto-rickshaw, van, microbus, human hauler and all other forms of vehicles are converting to CNG running engines. CNG vehicles implies a cheap fuel rate for transportation of people and goods. So the conversion rate is literally high. As shown in figure 2, a large number of vehicles were converted into CNG during 2015-16 period and day by day it is increasing because of low fuel price.

3.3 Fuel cost

The growth of CNG vehicles is mainly due to the cost benefits of CNG over gasoline/diesel fuel. In Bangladesh CNG is much cheaper compared to petrol and diesel. The cost for the operation of CNG vehicles vis-a-vis its operation on gasoline/diesel has been carried out at the current fuel prices in the country. Consider the case of Honda Civic 1.8 L Car, in general this car with a fuel consumption rate of 17.5 km per liter of gasoline on the highway. If the said car traveled a distance of 1000 km, it will consume 57 L of gasoline or 41 kg of CNG. Therefore keeping in view the current market prices, CNG allows significant fuel savings of about 50% compared to gasoline or diesel. In addition, the CNG has substituting at least 6.2 billion gallons of gasoline each year and save foreign exchange amounting to billions of dollars. The activities in this industry have created more than 121,000 cumulative (direct and indirect) job opportunities.

3.4 Vehicle cost & Conversion cost

NGVs generally have longer engine life compared to most gasoline powered vehicles. So these vehicles use less power to run. Besides these vehicles are now cheaper than any other vehicles. So the owners are now being interested to buy these vehicles for cost effectiveness and better engine performance. Again, the conversion cost of these vehicles is also lower. Gasoline and petrol engine can be converted to CNG-engines with minimum cost. The maintenance cost & re-testing cost of these converted engines are easy and cost effective.

3.5 CNG are environment friendly

The emission of air pollutants is directly related to fuel consumption. Consumption of petroleum products in Bangladesh growing at an annual rate of about 6%, almost half of them consumed in the transport sector. The major agents of the vehicle emission in Bangladesh are CO_2, CO, NOx and PM. In Bangladesh transport sector makes up 70% of CO_2 emissions. CNG has the lowest carbon-to-hydrogen ratio than either gasoline or diesel fuel. This led to the lower emission of CO_2 for the CNG than the gasoline or diesel fuel. Additionally, the emissions of CO_2 from a CNG engine can be decreased by more than 20% compared to that of a petrol engine with the same load due to the high hydrogen content of natural gas fuel [8]. Due to excellent lean flammability limit of CNG, it produces lean burning operation which conduces to the reduction of carbon monoxide [8]. As combustion of CNG takes place at a lower flame temperature than gasoline/diesel fuel, which results in low NO_x emissions [8]. As CNG does not consist of any sulfur content thus lower the emission of sulfate PM from all vehicles, and decreases maintenance costs, as high sulfur levels cause corrosion of fuel injector and piston rings, oil acidification and overall engine wear [8]. CNG vehicle releases very small amounts of particulate matter because CNG does not contain aromatic compounds such as benzene.

4. Challenges of CNG sector

4.1 High cost of setting up CNG stations

Beyond the purchase or conversion of fleet units and the building of fueling stations, capital expenses include modifications to maintenance facilities, backup fueling stations, and station upgrades. Costs for the facility upgrades will vary dramatically, depending on the size of the facility, its age, and its current configuration [26]. CNG is not like liquid fuels that can actually be pumped with a hand-operated crank when the power goes out. To avoid downtime, it's important to have a workable contingency plan in place early. A nearby public fueling station can be used as a backup. Unfortunately, CNG compressors don't last forever, but they should have a predefined life cycle. As such, it's important to plan ahead for those costs. CNG fueling systems are complex - which means an investment in training for fleet technicians is a must. It's important to set up the training immediately and have it completed before implementing CNG equipment purchasing or conversion program. When a fleet owner installs the fleet's own fueling infrastructure, it's important to account for the costs to operate, maintain, and eventually replace the equipment [15].

4.2 High Price of Conversion of Engine & Lack of CNG conversion item

Quality kits or cylinders compatible with the different types of vehicles used in Bangladesh are not easy to find. Regarding safety standards, a consistent policy is not available for the CNG conversion items. The addition of CNG fueling equipment to the existing petrol filling stations is problematic, because a large part of them are not having disposition over enough ground space to accommodate a safe CNG compressor, dispenser and high pressure gas storage installation. Recently, Government of Bangladesh has imposed VAT on the CNG conversion items as a result the price of the CNG conversion increases.

4.3 Frequent Explosion of CNG tanks

As the number of CNG driven vehicle are increasing, the risk is also growing up. Now a days, in Bangladesh the explosion of CNG tanks are occurring frequently. There are more than 400 CNG tank explosion takes place in recent 6 years in Bangladesh. From those accidents more than 250 people have lost their lives, and more than 700 people were injured, 150 vehicles were fully incinerated and more than 300 vehicles damaged slightly.

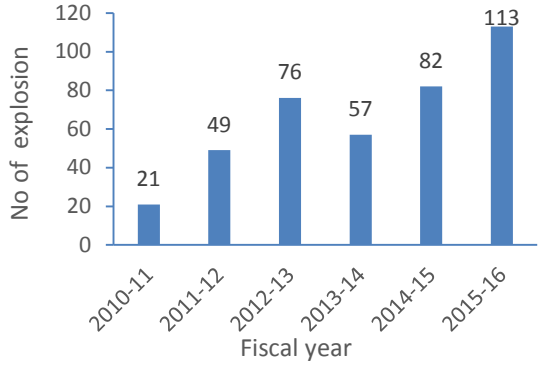

Fig. 3. Statistics of CNG-cylinder explosion in recent years [16].

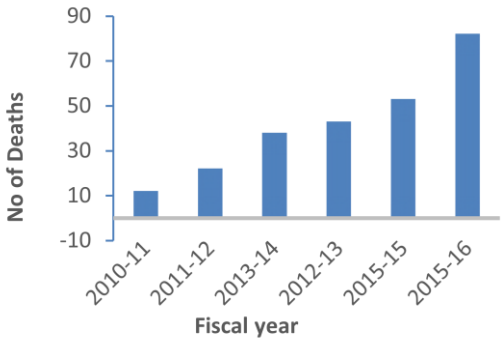

Fig. 4. Fatality in recent years due to CNG explosion [16].

(a)

(b)

(c)

(d)

Fig. 5. Some snapshot of CNG cylinder explosion.

In figure 3 some statistical data are provided about recent CNG tank explosion. From the figure we can see that, CNG explosion occurred more in recent year 2015-16 and it gradually increasing. Lots of reasons are behind this explosion notably using defective CNG tank, does not maintain the log book when refueling, electric short circuit etc. From the statistics of BRTA and RPGCL, more than 88% of running CNG vehicles are expired. There are 300,000 CNG cylinder now being used all over the country. For these only 11 re-test centers are available in the country. So it is almost impossible for them to re-test 298,000 CNG driven vehicles. Although there is a provision that such cylinders have to be tested every five years, the transporters in the region are not following this directive as the authorities are not monitoring the situation properly. As a result, the vehicles, along with the risky cylinders, are plying freely on different routes of the region every day. 54,000 vehicles are tested till now, which is only 12% of the total number. Almost 90 percent of these vehicles are now using the risky cylinders in their vehicles as there is no monitoring. There are 200,000 CNG cylinders were legally attached to the vehicles, but they are now expired, even then they are running.

During CNG conversion, high pressure shutter, switch meter wiring, clump, clip, tuning relay should be attached. But after using so many times, these can be fluctuated and cause serious explosions. The explosion can be stronger than a regular bomb. And from these accidents, innocent people are losing their lives. This is another serious challenge for this sector. In figure 4, some statistical data are provided about people's death in recent years. Lots of peoples died due to CNG tank explosion during 2015-16 and day by day it is increasing an alarming number. Figure 5 highlights some of the CNG vehicles accidents due to cylinder explosion.

For preventing these explosions, CNG–tank vendors and drivers must not be using old and unsafe cylinders. Proper safety system should be provided in the cylinders. Govt. should monitor if there is using any expired CNG-tanks and protective measures to stop it. And proper law and policy should be made and it should be maintained by the law-enforcement agencies. At last, people should be aware about the using of safe CNG-cylinders.

4.4 Controversial strategies from the Government

The Government served double blow to CNG by almost doubling feed gas price to CNG and increasing CNG price significantly in one step. At the same time, the government has banned CNG stations from selling CNG from 5 PM to 9 PM. This has created long queues in the filling stations forcing many vehicle users to opt for gasoline consumption instead. And it is huge time consuming for the passenger as well as the drivers. So this could create a total chaos in the CNG market. Recently, the Owners of CNG refueling stations have protested the move of Petrobangla to raise the CNG price by sending a proposal to the Bangladesh Energy Regulatory Commission (BERC). The price rise is from Tk 35.50 per cubic meter to Tk 38 per cubic meter in July, 2015. They had gone for strikes almost 2 days. Govt. has decided that, the price will be Tk 40 per cubic meter from June, 2017. In this circumstance, the common citizen has suffered and more and more people switch back to gasoline which will be a sad ending to a happy story.

5. Future Direction

Industry and regulators are increasingly looking at the possibilities of coupling other viable gas based projects that can make stand-alone CNG program viable. Bio-methane from garbage, sewage treatment, and other agricultural sources, can be a good supplement to the CNG programs in Bangladeshi cities and can be a local stand-alone operation, employing local people, etc. Bangladesh has a valuable opportunity to solve two problems at once by turning trash into treasure. Garbage could become a commodity by collecting it and processing it to fuel buses and trucks. Sweden has a very aggressive bio-methane program that is leading them towards becoming independent of oil imports by 2020.

In Bangladesh there is deficit of gas by 600 million cubic meter despite production of around 2700 million cubic meter daily [17]. There has been a crisis of gas supply for long in the country's industrial belt. Severe crisis of gas in the near future has been predicted due to depleting reserves at gas fields. The country is currently producing 2,700 MMCF of gas per day, but the demand exceeds 3,500 MMCF. After five years, the demand for gas will be double. Liquefied Natural Gas (LNG) can be a potential source of alternate energy resource for the nation. The use of LNG in Bangladesh is yet to make its way forward in spite of measures taken to introduce LNG in the national energy policy of the country [17].

Liquefied natural gas (LNG) is natural gas (predominantly methane (CH_4), with some mixture of ethane (C_2H_6), that has been converted to liquid form for ease of storage or transport. It takes up about 1/600th the volume of natural gas in the gaseous state. The government of Bangladesh decided to import LNG to meet growing demand for gas, worsened by the failure to discover large new gas reserves. In 2011, Bangladesh government has decided to set up two planned land-based LNG terminals at Maheshkhali Island and Kutubdia island in Cox's Bazaar and Paira in Patuakhali [18]. Petro Bangla is planning to import 500 mmcf of LNG at a

daily basis. The price of LNG will be at least 3 times higher than that of natural gas; as a result the government is planning to waive taxes at importing LNG.

As a fuel for vehicle or power generation LNG is much better than coal. LNG produces less short-term climate change than coal only if there is little methane leakage associated with its extraction. It also shows that natural gas cannot deliver the depth of cut in emissions that's needed to avoid a big contribution to global warming, unless carbon-capture is employed [19]. So, LNG instead of other fuel can be given priority to import and it will reduce the pressure from CNG.

6. Conclusion

Bangladesh has significant natural gas reserve. Various sector of Bangladesh are now using Natural Gas for its availability and cost effectiveness. Out of 1800 mmscfd of being marketed over the country, approximately 72 mmscfd is being used in the CNG sector. The projected demand of gas in CNG sector in the next 5 years will be around 130-150 mmscfd. So, this sector is going through a significant change of development. The opportunities in the market-place with the development of CNG-kits is growing up. The creation of new job opportunities as a result of establishment of large number of CNG conversion stations. There is also a positive impact on the country's balance on payment with a substantial reduction of the annual import bills of liquid petroleum as well as reducing the environmental pollution. So, it is evident that CNG has a great impact on our economy. With the market opportunity, some challenges are also threating this sector. The high price of CNG conversion, high set up cost, cylinder explosions, lack of safety kits and improper policies are the main barriers of development in this sector. So the challenges of this sector must be full fill by creating proper policy and executing them perfectly by the government as well as the people. Bio-methane from garbage, sewage treatment, and other agricultural sources, can be a good supplement to the CNG programs to make stand-alone CNG program viable in future. Moreover LNG can be used in the vehicle along with CNG.

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