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FORECASTING NATURAL GAS DEMAND, PRODUCTION AND ANALYZING THE FUTURE OF CNG & LPG AS AN ALTERNATIVES FOR VEHICLES FUEL IN BANGLADESH

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ABSTRACT

Natural gas is one of the primary energy sources of Bangladesh. Demand of natural gas in Bangladesh increasing day by day in various sectors. But, due to limited resources, energy crisis increasing gradually. This research work deigned to find out the natural gas crisis via forecasting gas demand and production. At the end, it also analyzed the future of CNG and LPG based vehicles in Bangladesh as an alternative of natural gas dependency. The prediction of gas demand and production has been conducted based on the data from Petrobangla. And the future of CNG and LPG based vehicles were analyzed based on different CNG & LPG conversion company data. Demand forecasting presented three scenarios; “scenario A, scenario B and scenario C” and production forecasting has been displayed as three cases; “case A, case B, case C”. The Comparison of CNG and LPG has been made based on different parameters like conversion cost, calorific fuel value, fuel cost, mileage, risk of explosion of fuel cylinder, carbon emission etc.

The outcomes of gas demand forecasting represented that gas demand is growing in every scenario. The results of production forecasting denoted as existing gas fields production are decreasing gradually. It also indicated, if new reserves would be discovered, then the production will be maximized. On the other hand, CNG conversion rate will be declined due to the shortage of natural gas. In conclusion, the investigation of different parameter of CNG & LPG confirmed, LPG is suitable for cope up with the future crisis. Hence LPG based vehicles need to take place of CNG based vehicles.

Keywords: Natural Gas, Gas Demand Forecasting, Production Forecasting, LPG, CNG

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1. INTRODUCTION

Bangladesh is one of the most populous countries and the energy crisis is the most important question. Government of Bangladesh is struggling to overcome the energy crises from the beginning of the country. Daily gas demand in our country is around 4000 MMCF, but daily gas supply is around 3000 MMCF (Govt. Bangladesh, 2019). There exists a large gap between demand and supply as Bangladesh has limited gas resources to meet up the demand. On the other hand, the Bangladesh government has announced “Vision 2041”. To achieve “Vision 2041” one of the most important sectors is the energy sector (BD News, 2021). As gas is the leading fuel of energy of this country so to reduce the difference between demand and supply of gas Bangladesh government has taken many steps. One of these is new gas reserves searching on offshore and onshore. There is a huge possibility to find new gas reserves on our offshore.

On the other hand, according to the spirit of the age, conversion of vehicles into LPG vehicles is the best decision (Gazco,2021). Even though CNG as a vehicle fuel is more popular for all but it is not suitable for us at this time because of the upcoming energy crisis (Bronson,2021). Following the government policy, Private Companies and local people are changing the policy in their energy consumption. So, to make a reliable policy for achieving the goal “Vision 2041”, it is important to make a reliable energy modeling for the energy sector. In energy modeling, it is very important to comprehend the future conditions of the energy sector. Thus, in describing the future state, the forecasting model is most effective by taking into account different scenarios and different parameters depending on the sector of energy consumption. This research has been conducted to analyze the future energy crisis and the source of future potential energy. This study has been designed to forecast future gas demand, gas production and alternative sources of vehicle fuels. At the end, comparing among different types of vehicle fuels, suggested the better options.

2. METHODOLOGY

The methodology includes data collection from different sources. Data analyzed with software applications to find final output. Data was collected from Navana CNG Ltd., Toma CNG Ltd, Petrobangla’s website and from Internet. Navana CNG Ltd, Toma CNG provided verbal data instead of official data. Data was collected from two CNG conversion centers in Sylhet, CNG

and LPG Conversion centers in Dhaka. After collecting all of the data were analyzed by using MS Excel 2016. The flowchart (Fig-1) represents the methodology in details.

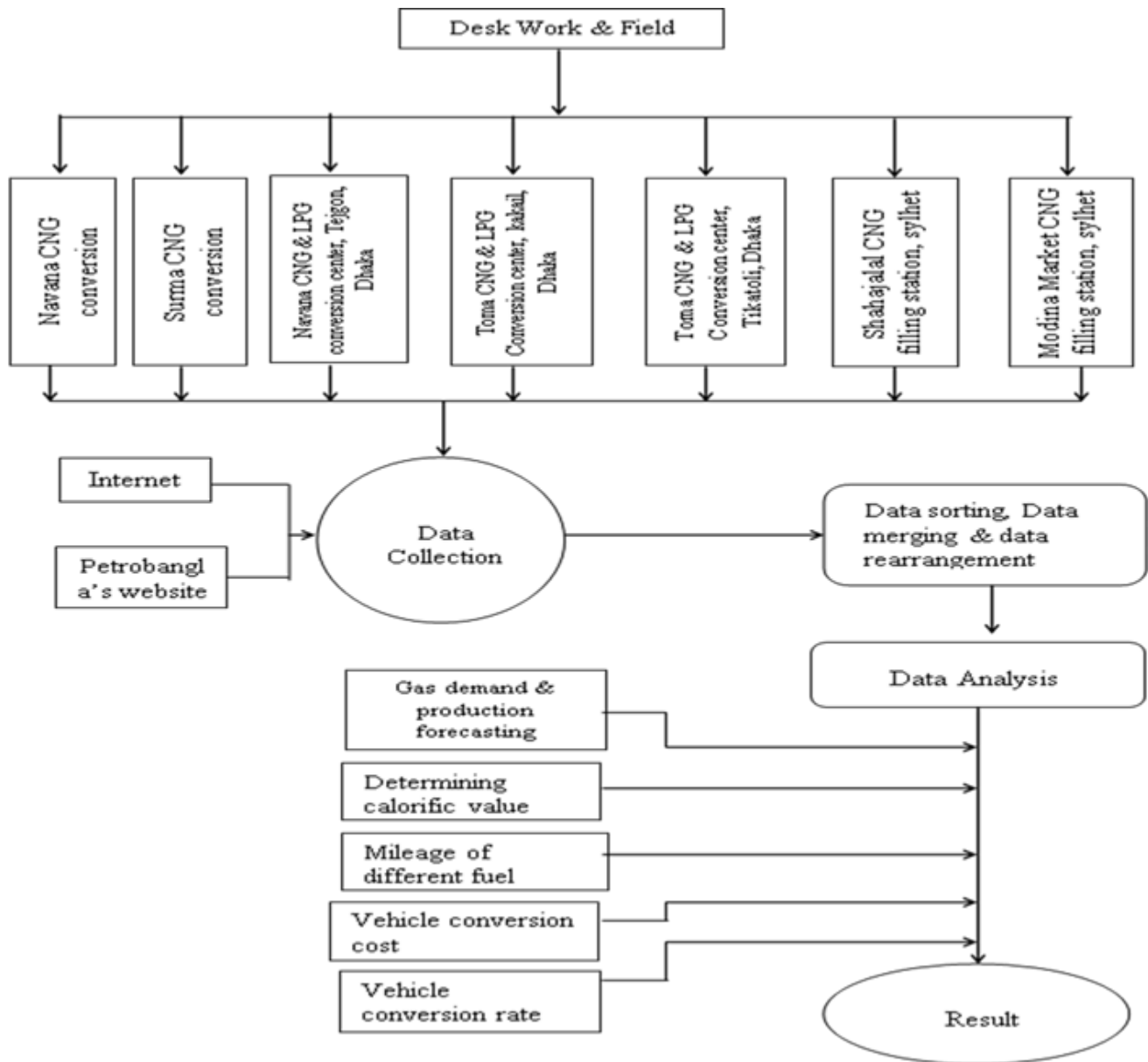


Figure-1: Methodology of the study.

3. RESULT AND DISCUSSION

3.1 Future Gas Demand Forecast

The forecast of future gas production has analyzed based on the three scenarios A, B and C.

3.1.1 Scenario A: Modified PSMP 2016

In this scenario, it assumed that GDP development rates at that point decay continuously from 8% in 2020 to 4.3% by 2041 (Petrobangla, 2018). Scenario A also undertakes as similar demand forecast for overall power generation as like as PSMP 2016 (Petrobangla, 2018). Within the short-term, gas request from the control segment will increase unassumingly – instead of drop strongly. Nevertheless, the gas penetration in the power system is confirmed in Scenario A to decrease progressively yet significantly over the prediction period.

3.1.2 Scenario B: High Growth

This situation accept that Bangladesh will be fruitful in seeking after an export-led financial development model, as specified in the 7th five-year plan. As such, this situation expect that the 7th five-year plan's short-term development targets will be accomplished which the GDP development rates at that point keep up at 7% from 2021 to 2041 (Petrobangla, 2018). Scenario B is too inferring a solid universal environment for exchange, recommending that Bangladesh can secure sufficient gas moment through pipeline associations from Asian nations as well as LNG from indeed more extensive worldwide sources.

3.1.3 Scenario C: Climate Change

This scenario is called a climate scenario. The Climate Change Scenario can expand if a speedy change in climate, or understanding of the climatic growth, takes place. For situation C, only a couple of coal-fired power plants will be created, whereas there will be solid improvements in renewables characteristic gas, atomic, and hydropower imports (Petrobangla, 2017). This scenario moreover expects that the taken a toll of such a cleaner vitality arrangement will have an effect on Bangladesh's economy.

3.2 Bangladesh Historical Gas Consumption

The utilization of Natural Gas in Bangladesh has expanded significantly from 698 mmcf/d in 1995/96 to 2,645 mmcf/d in 2015/16, nearly 4 times increment over 20 a long time (Petrobangla 2021). So, it is clear that gas consumption is increasing day by day (Figure-2).

3.3 Gas Demand Forecast

The future gas demand forecasting of near future for each sector has been analysis here (Figure-3) and the analysis correlated with three different scenarios (A, B and C) which has been

introduced earlier. It has been long-established that gas demand is increasing in each and every sector. At scenario-A, gas demand is increasing in the power sector up to 2020, after that, it is decreasing because in that time government will start getting power from another source like a nuclear power plant, biofuel, coal-based thermal power plant etc. In case of scenario-C, GDP growth is the same as “Scenario A” that’s why the forecasting results are similar as “Scenario A” except Power sector. In case of power sector gas demand is higher than “Scenario A”. The reason behind it is, GDP growth rate is considered the same for “Scenario-C”, but at the same time focused on clean energy. So, decreasing the coal-based power plant, whereas increasing the gas-based power plant. Scenario-B maintains the increasing gas demand which is similar to the “Scenario-A”, but dissimilarities are value of quantity of gas consumption. Here, it is observed a high demand value over time. Because "Scenario B" assumed high growth of GDP, that is why the graph is steeper. As it assumed that the growth rate is high for scenario-B, so more power is needed for achieving a high growth rate.

The gas demand in industry, domestic and transportation, same trending graph can be obtained in Scenario A, B, C but only deference is in value. Day by day household new gas users are growing, rural people who use wood cow dung for cooking and the gas are using in the transportation sector, the number of CNG base vehicle is increasing day by day.

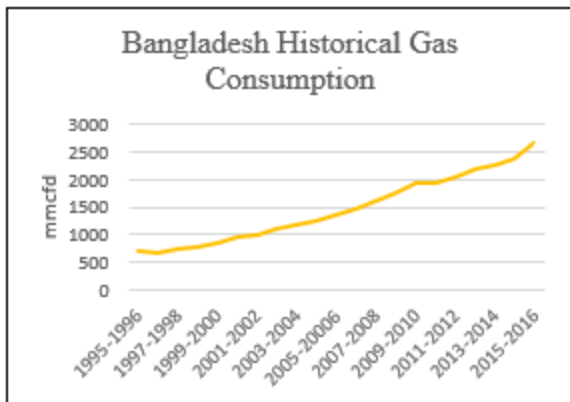


Figure-2: Bangladesh Historical Gas Consumption

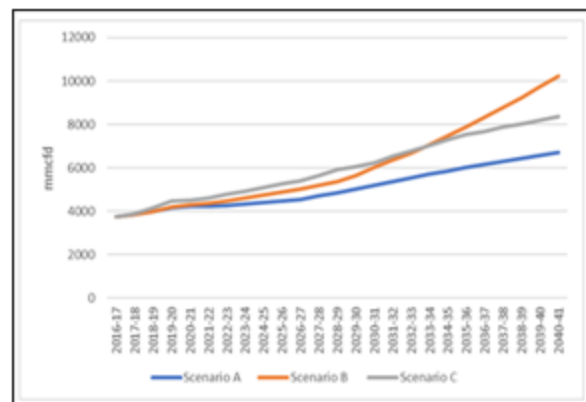


Figure-3: Gas Demand Forecast

3.4 Future Gas Production Prediction

Three gas production scenarios are presented here to analyze the future predicted value of gas production in Bangladesh.

3.4.1 Case A: Proven, Probable and Possible (3P) Reserves

Case-A characterized best utilize of existing areas with no extra assets found. The prediction of production for the period 2016-2041 uncovered that the production of gas per day is 2500 mm cf up to 2022 where it rapidly declining (Petrobangla, 2021, 2018, 2017). Figure-4 illustrated the results.

3.4.2 Case B: Proven, Probable and Possible (3P) Reserves with YTF Contribution:

Case-B displayed best utilization of remaining fields with an Yet-to-find (YTF) contribution of 6.4 tcf. The YTF commitment has been given to the Specialists as BAPEX unused, Shallow sand Deep offshore (Petrobangla, 2018, 2017). Production of onshore and shallow offshore and deep offshore areas from "yet-to-be-found" reserves has been predicted based on expectations in future exploration. It is expected that the YTF's contribution will give 2.6 tcf from modern inland areas and 2.1 and 1.7 tcf for shallow seaward areas and profound seaward areas, separately (Table-1).

Table-1: Characteristics of 7 YTF (Yet to find) areas in Bangladesh (Petrobangla 2021; Imam,2013; Energy & Power Magazine,2021)

Area	Priority	Location	Petroleum system risk	Exploration Company	Expected Yet to Find	Expected time development (Year)
A	High	Onshore	Proven petroleum system low risk	IOC, BAPEX mixed	3-5 TCF (Thin beds 1-3 TCF)	5-10
B	Medium	Onshore	Proven petroleum system low risk	BAPEX only	4-6 TCF (Thin beds 1-3 TCF)	7-12
C	High	Offshore Shallow	Proven petroleum system medium risk	IOC licenses	4-6 TCF	5-15
D	Medium	Onshore	Proven petroleum system medium risk	BAPEX only	4-6 TCF	10-20
E	Low	Onshore	Proven petroleum system medium risk	Very Few Licenses Currently	4-6 TCF	15-25

F	Low	Offshore Shallow	Not proven petroleum system high risk	No license currently	2-3 TCF	15-20
G	High	Offshore Deep	Discovery medium risk	IOC license	No information	10-25

3.4.3 Case C: Proven, Probable and Possible (3P) Reserves with an additional YTF

Contribution

Case-C denoted, the best utilization of present fields with a YTF contribution based on the description from Gustavson (2011), while it is expected that around 16-17 tcf can be created until 2041 concurring to the Experts examination (Petrobangla, 2018). There's a noteworthy YTF resource accessible within the nation. The asset is accessible both as ordinary gas but moreover thin-bed assets at existing areas. The presence and advanced geological assessment by Gustavson (2011) of two autonomous sources "USGS-Petrobangla Joint Study of 2001" and "Final Updated Report on Bangladesh Petroleum Potential and Resource Assessment 2010" enable the Consultants to evaluate the yet to be found resources. The USGS-Petrobangla (2001) learning may be a precise and broad consider that speaks to the most punctual and best ponder to survey the Bangladesh's unfamiliar gas asset potential. This consider decides that the unfamiliar gas assets of Bangladesh extend from 8 tcf (95% likelihood) to 66 tcf (5% likelihood) with a 50% likelihood of finding 29 tcf and a cruel of 32 tcf (Petrobangla, 2018). According to the Gustavson (2011) and the current exploration activities, Bangladesh has been divided into 7 sectors. The Proven, Probable and Possible (3P) reserves production forecasted value in case C illustrated in Figure-4.

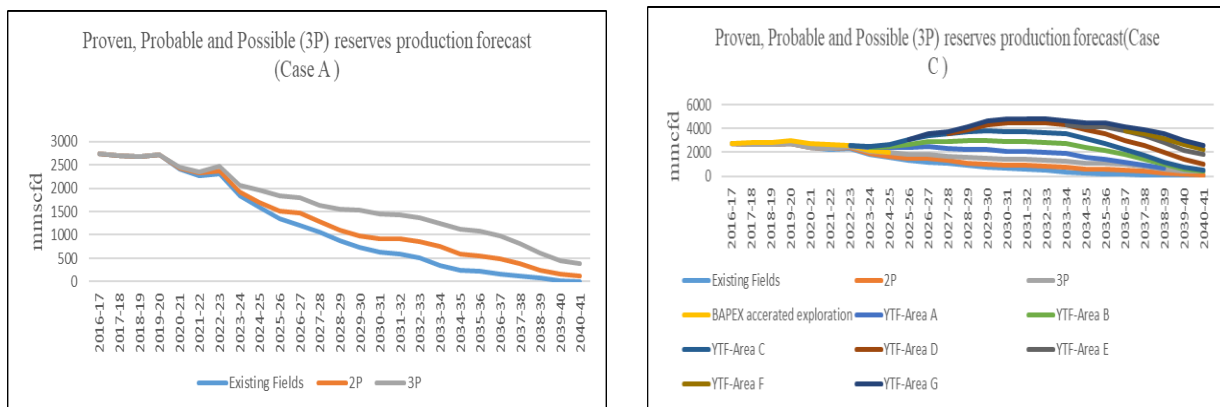


Figure-4: Proven, Probable and Possible (3P) reserves production forecast.

4. CNG (COMPRESSED NATURAL GAS) AS VEHICLE FUEL

4.1 Composition of CNG

Typically, CNG is over 90% methane and little sums of ethane and other hydrocarbons. CNG may contain nitrogen, carbon dioxide, and follow sums of water vapor. For the use of CNG as a vehicle fuel, CNG is removed from a gas delivery scheme at pressures extending from 0.3 to 1 MPa, compressed at a fueling station, and stockpiled in vehicle cylinders at pressures of around 20 MPa (Demirbas,2002; Bronson,2021). There is currently no uniform CNG pressure from the global NG vehicle industry.

4.2 Conversion to CNG Vehicles

The number of CNG changed over vehicles are expanding day by day. Individuals are utilizing CNG vehicles since of its endless financial benefits, security, ease of utilize and natural issues. Presently transport, truck, engine car, auto-rickshaw, van, microbus, human hauler and all other shapes of vehicles are changing over to CNG running motors. CNG vehicles infer a cheap fuel rate for the transportation of individuals and products (Momin et al,2016; Wadud & Khan, 2011). As shown in figures 5, many CNG vehicles were during the 2015-16 period because of low fuel price. But after that, the ratio of CNG vehicles decreased gradually. On the other hand, the conversion rate of vehicles into CNG is decreasing day by day because of the gas crisis in Bangladesh. Now people are interested to convert their vehicle into LPG instated of CNG (Rezwanul 2021; Uddin et al, 2017).

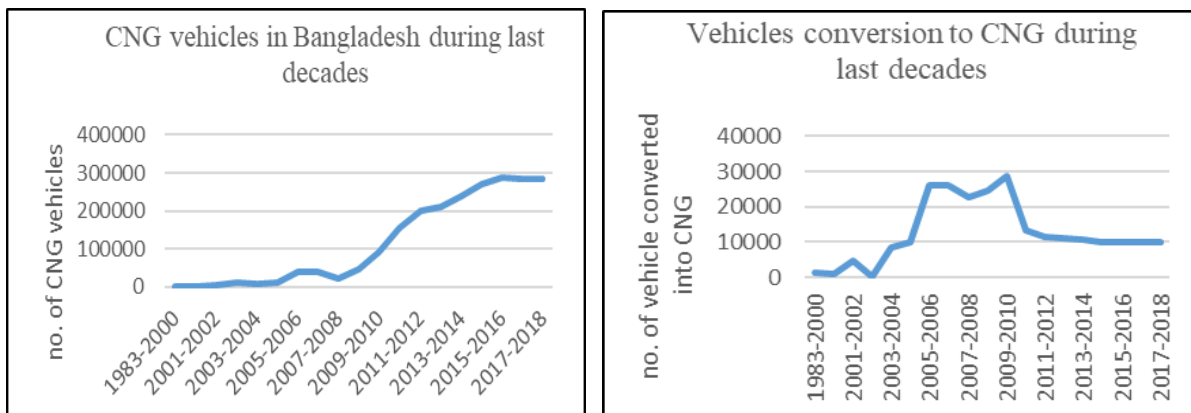


Figure-5: CNG vehicles in Bangladesh last decades(Uddin et al, 2017). Figure-6: Vehicles conversion to CNG last decades (Rubel, 2017).

4.3 Cost for using CNG

CNG fuel price is lower than the petrol & diesel. CNG vehicle cost is normally a little bit greater than the petrol engine. Because it needs some extra kits for using CNG (Table-2).

Table-2: CNG Conversion Cost

CNG Conversion Cost				
Type\Size	60 Liter	90 Liter	100 Liter	140 Liter
Sequential	50000 taka	52000 taka	58000 taka	65000 taka

5. LPG (LIQUEFIED PETROLEUM GAS) AS VEHICLE FUEL

5.1 Composition of LPG

Liquified Petroleum Gas is a combination of commercially generated petroleum gases that are deposited under high pressure to maintain in a liquid state. LPG has a raised start temperature of roughly 755 K compared to 533 K and 589 K separately for gasoline and diesel. LPG is about inviting in discussing the levels of 2 to 10 percent (Gazco, 2021). Gasoline is naturally neighborly at a concentration of 1.5% (Demirbas, 2002). Care must be practiced when refueling with LPG to avoid freeze burns due to the cold temperature of LPG when it shifts from liquid to gas.

5.2 Conversion to LPG Vehicles in Bangladesh

Concurring to the insights of the Bangladesh Street Transport Specialist (BRTA), there are a few 10,000 LPG-run vehicles on the country’s streets. Each month, around 90–100 modern vehicles are being changed over to run on LPG (Momin et al, 2016). Figure-6 represents the results.

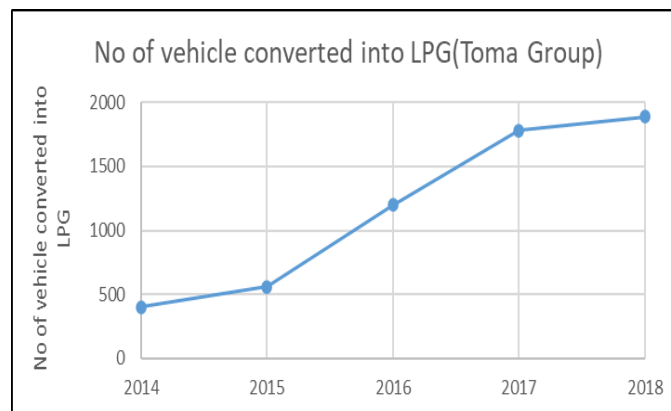


Figure-6: No of vehicle converted into LPG (Toma Group)

5.3 Cost for LPG

LPG fuel price is lower than petrol and diesel but little higher than CNG. It is about 48 taka per liter. LPG fuel base vehicles are relatively costly than diesel and petrol base vehicle. Because, it's needed some extra parts to burn LPG. On the other hand, to convert the current diesel and petrol base vehicle to LPG fuel base Vehicle need some kits which price vary with the volume of the cylinder (Indian Oil, 2021). Price of conversion of different size cylinder presented in Table-3.

Table-3: LPG Conversion cost list

LPG Conversion Cost				
Type\Size	60 Liter	90 Liter	100 Liter	140 Liter
Sequential	54500 taka	58500 taka	63500 taka	73500 taka

6. COMPARISON BETWEEN CNG, LPG, PETROL AND DIESEL

Table-4 & Table-5 provided a general comparison among different types of vehicle fuel (Kollamodi et al, 2008; Lane, 2021; Norris et al, 2009; Semantic Scholar, 2021; Pikalu et al, 2008).

Table-4: Fuel comparison between CNG, LPG, Petrol, and Diesel (With the prospective of BD)

Fuel	CNG	LPG	Petrol	Diesel
Availability	Available in 36 cities	Available in 14 cities	Almost all cities	Almost all cities
Infrastructure	Pipeline network	Fuel station	Fuel station	Fuel station
Storage pressure	3000 psi	70-80 psi	Normal-pressure	Normal-pressure
Fuel type	Compressed gas	Liquid when stored under pressure	Liquid	Liquid
Octane rating	120	112	80- 90	40- 55
Calorific value	52.5 MJoule/Kg	50.02 MJoule/Kg	44- 46 MJoule/Kg	42- 46 MJoule/Kg

Table-5: Comparison between CNG & LPG, Petrol, Diesel

Feature	CNG	LPG	Petrol	Diesel
Components	The primary component is methane	Propane and Butane are Primary components	Higher Hydrocarbon	Higher Hydrocarbon
Source	Natural gas and condensate wells	Wet gas or petroleum	Crude oil	Crude oil
Environmental effects	Lesser GHG releases	Releases CO ₂ which is GHG but is cleaner	Release more CO ₂ than CNG and LPG	Release more CO ₂ than other vehicles
Properties	It is lighter than air and hence disperses quickly	It is heavier than air and hence disperse slowly	It is heavier than air and hence disperse slowly	It is heavier than air and hence disperse slowly
Space	CNG need more space than others	LPG needs less space than CNG but more space than petrol and diesel storage	No extra space requires	No extra space requires
Power loss	Power loss is More than LPG vehicles	Power loss is less than CNG vehicles	Less than others	Less than CNG and LPG but higher than petrol
Modification cost (taka)	50000-65000	54500-73500	N/A	N/A
Vehicle weight	Heavier than other fuel-based vehicles	Lighter than CNG vehicles but heavier than petrol and diesel vehicles	Lighter than CNG and LPG	Lighter than CNG and LPG
Mileage (Km/Kg)	36.8	26.5	33.16	28.09

Use	CNG is used all types of vehicles	LPG is used mainly micro and private cars	All types of vehicles	All types of vehicles
Fuel Price	42- 45 taka/m ³	48 taka/liter	60 taka/liter	83 taka/liter
Safety	Easily disperse, hence has risk of CNG storage tank explosion and fire	Since LPG is difficult to disperse so lesser risk of LPG storage tank explosion and fire than CNG	Fuel tank explosion is low	Fuel tank explosion is low
Pressure	CNG pressure is around 3000 psi	LPG pressure is 70-80 psi	Normal pressure	Normal pressure

7. CONCLUSION

Throughout the above study, it can be concluded as:

- Natural gas demand in Bangladesh is growing day by day. But the ability of supply will be reduced with time due to shortage of reserves.
- In "Scenario A", the gas demand inclining gradually in case of each sector and franchise. Although it is considered that the decrease of growth rate in 4.3% for this instance but the economy is expanding over the country and that's why demand is enhancing.
- In "Scenario B", High growth rate is considered. It means economy is expanding largely. So remarkable development needs to occur in every sector. So, the gas demand will become larger than "Scenario A".
- In case of "Scenario C", it has been focused on climate change. So, here it has been tried to depend on clean energy or green energy. That's why, natural gas demand not follow the "Scenario B" trend.
- The production forecasting also analyzed in three cases. "Case A" described the production trending to decline over the year. Here, only taken existing field by

considering no single gas reserve will be discovered. Afterthought, “Case B”, forecasting described a better production rate because here it is considered as to add 6 tcf. And last one, "Case C" prediction almost covered the demand. Because in "Case C" it has been assumed a huge amount of natural gas reserve will be found in both offshore and onshore.

- CNG base vehicle increasing day by day, but the fuel is decreasing day by day, because of the shortage of natural gas in the near future.
- On the other hand, LPG vehicle conversion rate is increasing day by day, because people now are interested in converting their vehicle into LPG for the gas crisis in Bangladesh
- Though the conversion cost of LPG is higher than CNG conversion, LPG is the best option as vehicle fuel in this present situation.

Acronyms

BD=Bangladesh

BRTA= Bangladesh Road Transport Authority

CNG= Compressed Natural Gas

GDP=Gross Domestic Products

Govt.= Government

LPG= Liquefied Petroleum Gas

MMCF= Million Cubic Feet

MMCF/D= Million Cubic Feet Per Day

Petrobangla= Bangladesh Oil, Gas & Mineral Corporation

PSMP=Power System Master Plan

YTF= Yet-To-Find

3P= Proven, Probable and Possible

REFERENCES

- BD News (2021). Gas cylinders not tested in 250,000 CNG-run vehicles. (2021). Retrieved 30 April 2021, from <https://bdnews24.com/bangladesh/2018/10/17/gas-cylinders-not-tested-in-250000-cng-run-vehicles>
- Bronson, J. (2021). A Natural Gas History - CNG COMPLETE. Retrieved 30 April 2021, from <http://www.gastocngutah.com/natural-gas-history-vehicles/>
- Demirbas, A. (2002). Fuel Properties of Hydrogen, Liquefied Petroleum Gas (LPG), and Compressed Natural Gas (CNG) for Transportation, *Energy Sources*, 24:7, 601-610, DOI: 10.1080/00908312.2002.11877434.
- Energy & Power Magazine. (2021). Retrieved 30 April 2021, from <https://ep-bd.com/view/details/article/MzIwNA==/title?q=sustainability+of+lpg+industry+in+bangladesh>
- Gazco. (2021). History of LPG - the first 100 years | gazeo.com. Retrieved 30 April 2021, from <https://gazeo.com/up-to-date/news/2013/History-of-LPG-the-first-100-years,news,6662.html>
- Gov Bangladesh (2019). Energy Scenario Bangladesh 2017-18 [Ebook]. Energy and Mineral Resources Division Ministry of Power, Energy and Mineral Resources, Bangladesh Government. Retrieved from https://emrd.portal.gov.bd/sites/default/files/files/emrd.portal.gov.bd/publications/30e4494d_95a8_4e70_bb1f_98cbe5816d48/25102018%20Energy%20Scenario%202017-18_Final.pdf
- Imam, B., 2013, Energy Resources of Bangladesh, Second edition, University Grants Commission of Bangladesh.
- Indian Oil. (2021). Auto Gas | Auto Gas Price India | Auto LPG Gas: IndianOil. Retrieved 30 April 2021, from <https://iocl.com/Products/Autogas.aspx>
- Kollamthodi, S. et al. (2008). Transport technologies marginal abatement cost curve model - technology and efficiency measures, AEA Technology, ETSAP Semi-annual Workshop, IEA – Paris, 3-4/07/2008.
- Lane, B. (2021). Fuel efficient cars UK - Guide to petrol and diesel cars 2021. Retrieved 30 April 2021, from <http://www.whatgreencar.com/cng.php>
- Momin, MSA., Dutta, M., Kader, M.G., Iftakher, SM. (2016). Study of LPG (Liquefied Petroleum Gas) And CNG (Compressed Natural Gas) Vehicles and It's Future Aspects, International Conference on Mechanical, Industrial and Energy Engineering, 26-27 December, 2016, Khulna, BANGLADESH.
- Norris, J. et al. (2009). Light Goods Vehicle - CO₂ Emissions Study: Task Report for Task 5 - Assessment of the potential for CO₂ emissions reductions, Report to the Department for Transport, AEA, Harwell, Didcot.
- Petrobangla (Bangladesh Oil, Gas & Mineral Corporation). (2021). Retrieved 30 April 2021, from http://www.petrobangla.org.bd/site/view/annual_reports/

- Petrobangla. (2018). Gas Sector Master Plan Bangladesh 2017, Petrobangla, PowerCell, 28 February 2018
- Petrobangla (2017). Petrobangla Annual Report, 2017
- Pikula, B., Mešić, E. & Hodžić, M. (2008). Determination of air drag coefficient of vehicle models, International Congress Motor Vehicles & Motors, Kragujevac, October 8th-10th, 2008.
- Rezwanul (2021). CNG losing its potential as fuel alternative in Bangladesh. Retrieved 30 April 2021, from <http://rezwanul.blogspot.com/2010/10/cng-losing-its-potential-as-fuel.html>
- Rubel, R.I. (2017). Natural Gas Driven Vehicles Safety and Regulatory Regime –Challenges in Bangladesh, Journal of Materials And Engineering Structures, 4, 113–120.
- Semantic Scholar. (2021). LPG engine efficiency; <https://pdfs.semanticscholar.org/055d/88887123275e802183a568845b7e0e8acc91.pdf>
- Uddin, S., Khan, R., & Sakib, M. (2017). Retrieved 30 April 2021, from <http://icmime-ruet.ac.bd/2017/DIR/Contents/Technical%20Papers/Energy%20Technology/ET-33.pdf>
- Wadud, Z., & Khan, T. (2011). CNG Conversion of Motor Vehicles in Dhaka: Valuation of the Co-benefits. Retrieved 30 April 2021, from https://www.academia.edu/5402318/CNG_Conversion_of_Motor_Vehicles_in_Dhaka_Valuation_of_the_Co_benefits