# Fuel consumption of transport sector: how the people of Dhaka City will be moving in the future?

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## Abstract

Even though Dhaka is one of the least motorized cities of the world, the rate of increase of vehicles in recent years is significant and consequently national consumption of transport energy in each year is increasing heavily. Except CNG all other fuel for motor vehicles in Bangladesh is imported from abroad, which drains large amount of money each year. Because of unaffordable and inaccessible public transport, most of the city dwellers are dependent on walking and rickshaw for their travel because there is not available any other accessible and affordable mode and some areas are served only by rickshaw. However, trip cost of rickshaw is much higher than bus. Despite these, national transport policies are more concentrated with MT where transport policy of Dhaka City reflects the negligence on NMT and there is no restriction on car use. Such an approach is completely inconsistent with the realities of transport situation and travel pattern of the city where about half of the city dwellers are below the poverty level and majority of the trips are either walking or NMT.

The projected population of the city is to be around 19.8 million by the year 2024 with an estimated person trips of 70 million per day will make the transport situation more critical. It is anticipated that despite the number of private car may rise, a great part of the population will remain dependent on public transport. Considering the socio-economic condition, existing transport system and travel pattern, possible future travel scenario, and future energy demand, transport of Dhaka City needs to move towards promoting NMT and energy efficient mass public transport and restrict small occupancy car use. Transport policy should be directed towards the environmental sustainability and affordability; thus need to promote walking and cycling along with low-cost mass transit or bus services accessible for all and restrict small-occupancy vehicles for efficient road use.

## Introduction

Dhaka, the capital city of Bangladesh is a metropolis of about 1,529 sq. km with a density of over 6,545 persons per sq. km (GoB, 2000). Total population of the city was 10 million in 2004 and projected to be 14.1 million by 2014 and 19.8 million by 2024 (STP, 2005; GoB, 2000). The average household income in 2004 was Tk 1500 ($253) per month with 4% of households in the 'high' income level exceeding Tk 55,000 ($920) per month, 45% of households in the 'low' income level below Tk 12,500 ($110) per month, and 51% of households in the 'medium' income level Tk 12,500 to 55,000 ($420) per month (STP, 2005). Dhaka is the administrative, commercial and cultural centre of the country and due to concentration of major socio-economic activities and facilities as well as employment opportunities, many people migrate regularly in Dhaka from different parts of the country. Consequently, the city grew largely towards the north and northwest and it is expected that the expansion will continue in same direction in the future. The topographic factors encourage growth of the city toward the north and beyond the bounds of the city along the corridor to Mymensingh.

Transport environment of the city is characterised by traffic congestion and delays, inadequate traffic management, unaffordable and inaccessible public transport for the majority of

the people, high accident rates, and increasing air pollution problems (Rahman, 2007). Mixed traffic flow, poor driver behaviour and road blockage by haphazard parking, insufficient transport capacity and insufficient operation are the major causes of congestion (DDC, 1998). The crisis in transport systems of the city is largely the result of growing concentration of population and economic activities, and inadequate public transport systems. Existing poor transport systems are unable to cope with the expansion of city and thus increased travel demand. Moreover, private car ownership is steadily increasing because of increased growth or income level. Inadequate traffic management, inefficient road use, and poor operating conditions waste up to 50% capacity of the roads (STP, 2005). Because of inadequate and disorganized bus service most of the middle and lower-middle income groups are dependent on about 600,000 rickshaws of the city (which accounts about 65% of the total vehicles) available for hire (BRTA, 2003; Rahman, 2007). Consequently, majority of the trips in Dhaka City is walking and rickshaw trips. However, in terms of passenger km travelled, the share of bus is 30.6% whilst rickshaw and walking are respectively 21.7% and 17.7% (DUTP, 1998). Whatever, trip cost of rickshaw is significantly expensive than other public transport such as bus or tempo (Rahman, 2003). Travel time and accident risk of rickshaw is also very high compared with other public transport mode. Even though bicycle is very cheaper and healthy mode, because of safety and other problems it is rarely found in the streets of Dhaka City.

Considering all types of motorised vehicles, there are only about 30 motorised vehicles per 1000 population plying in Dhaka City, of which almost 70%-80% are old age and defective (BRTA, 2003; DUTP, 1998). However, the vehicle fleet of the city is growing at an accelerating rate which in turn contributes to higher rates of energy consumption and the corresponding greenhouse gases (GhG) emissions. Most of the MVs plying are old, defective, poorly maintained, less fuel-efficient and consequently emit high rate of pollutants. Except CNG, quality of other fuels (i.e. petrol, diesel, etc.) used for MVs in Bangladesh is not good enough compared with other developed countries. As a result, despite having a very small number of MVs, Dhaka is one of the most polluted cities in the world. About 1000 MT of pollutants are pumped everyday into the air of Dhaka, of which 70% comes from transport sector (STP, 2005; Khuda, 2001). The city has very few buses as public transport of which only a portion is of improved quality. It is anticipated that despite the number of private car may rise in the future, a great part of the population will remain dependent on public transport modes for their trip (Rahman, 2008a).

Based on secondary information the paper aims to explore the development of fuel consumption of the transport sector in Dhaka City in the next two decades. Data on fuel (i.e. petrol, diesel, octane, CNG, etc.) consumption by transport sector had been collected from Bangladesh Petroleum Corporation (BPC) and Rupantarita Prakritik Gas Company Limited (RPGCL). Related journals, published and unpublished materials of different agencies also have been studied and evaluated. Based on the information, the paper provides some guidelines how people of the city will be moving in the future to tackle the upcoming crisis of rapid increasing MVs and thus fuel demand.

## Vehicle Fleet and Growth Rate

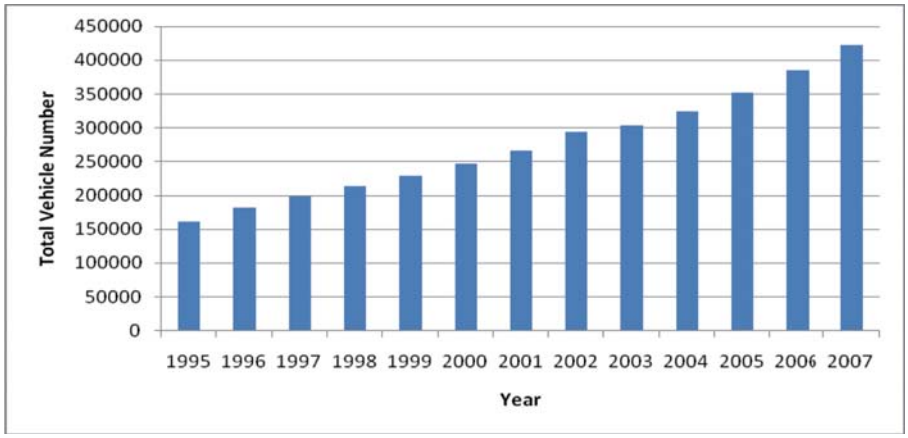
Annual registration data of Bangladesh Road Transport Authority (BRTA) shows that 4,22,370 units of MVs are plying in the roads of the city (Figure 1). However, BRTA information does not include the number of vehicles that are retired from the fleet each year. Figure 2 reveals that at present vehicle pattern of the city is mainly consisted of small occupancy vehicles like – motorcycle, car, jeep/microbus, etc. whilst large transit vehicles like bus remains at lower number. Everyday about 50 new cars are adding in the total number of fleet size of the city (Prothom Alo, 2008).

The vehicle population of Dhaka City had been growing at an accelerating rate for the last several years. Figure 1 depicts that the total number of MVs in 1995 became almost 3-fold in 2007. Growth rate of MVs is much higher than that of population growth (Rahman, 2007). Between 1992 and 1999 the population of the city grew at an annual rate of 6.4% whilst growth of vehicle population was even faster, a rate of 8.9% per year (ESMAP, 2002).

The city has a high number of car, motorcycle, and 3-wheeler auto - all with very small passenger carrying capacity; whilst a very few number of buses (Rahman, 2007). Fare for each km travel in 2004 value was Tk 5 ($0.08) on rickshaw, Tk 8 ($0.13) on taxi, Tk 5 ($0.08) on three-wheeler auto-rickshaw, and Tk 0.08 ($0.014) on bus depending somewhat upon the type and quality of service (STP, 2005). Figure 3 shows the growth of MVs has largely dominated by small occupancy vehicles (i.e. car, van/pickup, motorcycle, etc.) where as bus and minibus have increased at a lower rate. Unlike the figure there is not so many motorcycle found in the streets of the city. Being a small number of motorcycle plying on streets reflecting a very high number because almost all motorcycle of the country are registered in Dhaka (Rahman, 2007). Despite private car has lower passenger car unit (PCU), these have increased at a higher rate, 23% and 12% respectively during 1999-2003 and 2003-2007. On the other hand, though higher PCU for bus and minibus they had a lower growth rate, only 3% and 1% respectively during the same period (BRTA, 2008).

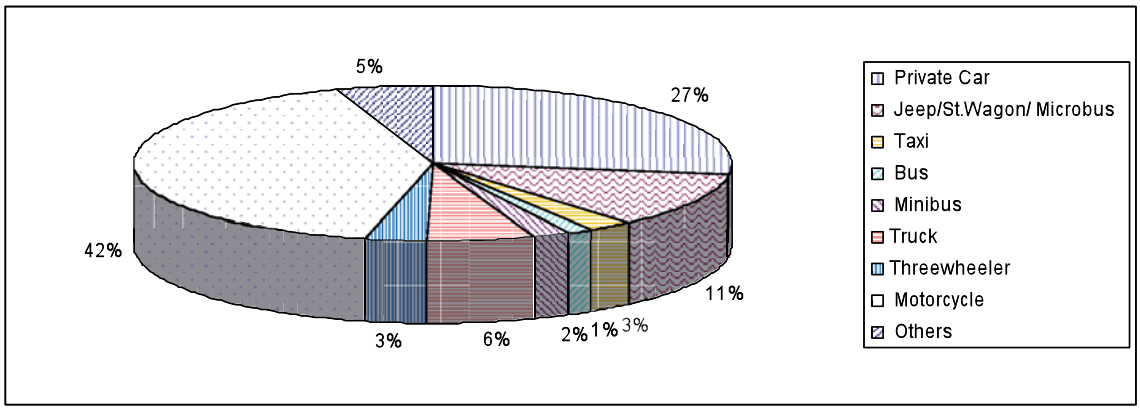
### MODAL SHARE OF TRIP

Majority of the trips, more than 55% of the total, in Dhaka City are walking and NMT trips. High dependence on walking and rickshaw in Dhaka is not for physical health or environmental benefits; but for unaffordable and inaccessible public transport service (Rahman, 2007). Some areas have no formal public transport service and accessible only by rickshaw. Sometimes, buses are so crowded that people cannot find any room to get in, especially the women and children or aged people. And, the poor people cannot afford the taxi or auto-rickshaw. There is no MRT, LRT, or BRT systems and water transport facility within the city. Data from a sample survey of STP conducted in 2004 reveals about 44% trips are on bus or minibus and 34% on rickshaw whilst the remaining are walking and other motor car trips respectively 14% and 8%. Interestingly, average trip length of rickshaw trips is only 2.34 km and about 61% of all rickshaw trips are made by people in the 'medium' income level (STP, 2005). However, a lot of researcher and residents of this city might argue about the validity of this information as everyday a lot of people are walking for their travel. Moreover, trip



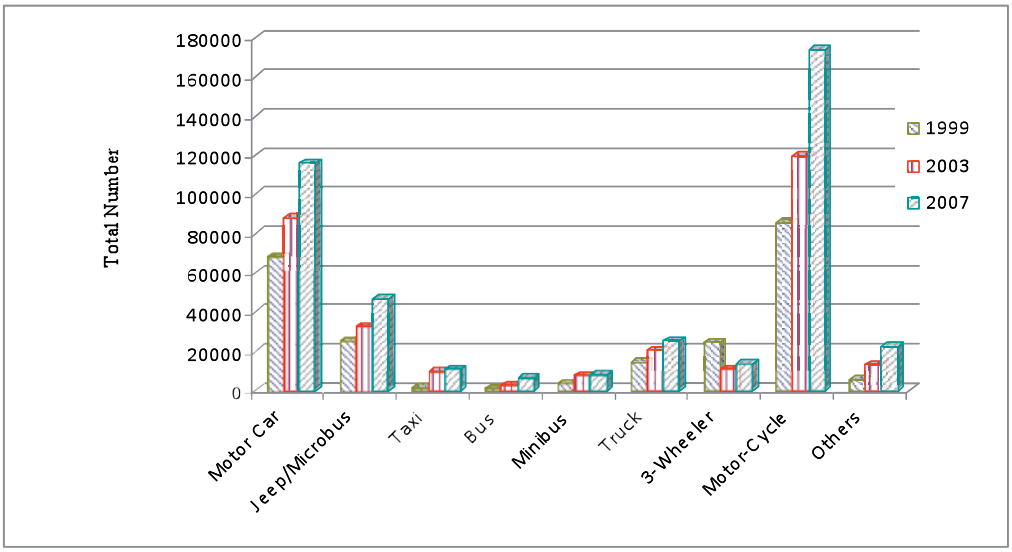

*Source: BRTA, 2008*

*Figure 1. Motorized vehicle population in Dhaka City (1995-2007)*



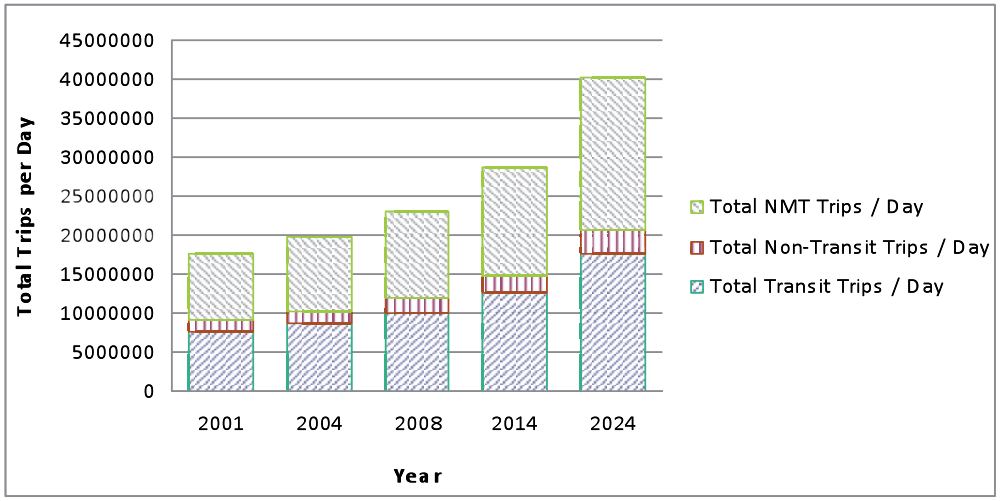

*Source: BRTA, 2008.*

*Figure 2. Fleet share of motorized vehicles in Dhaka City in 2007.*



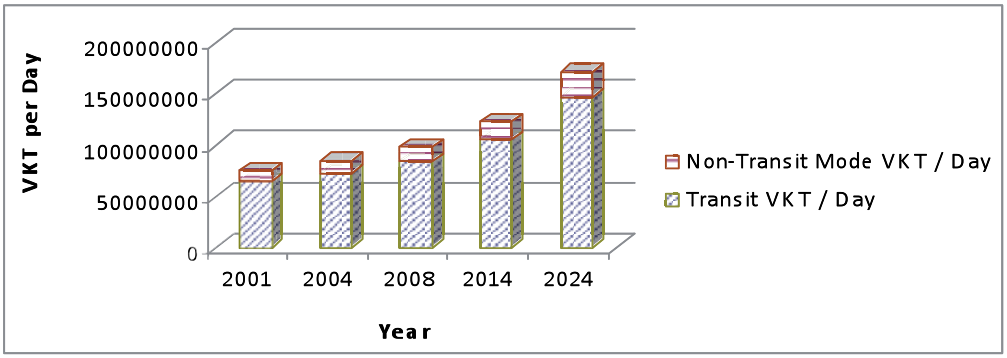

*Source: BRTA, 2008*

*Figure 3. Pattern of Different Type of Motorized Vehicle in Dhaka City*




*Source: STP, 2005 and Rashid, 2008.*

*Figure 4. Future trend of total trips per day in Dhaka City*




*Source: STP, 2005 and Rashid, 2008.*

*Figure 5. Future trend of vehicle kilometer traveled (VKT) per day in Dhaka City*

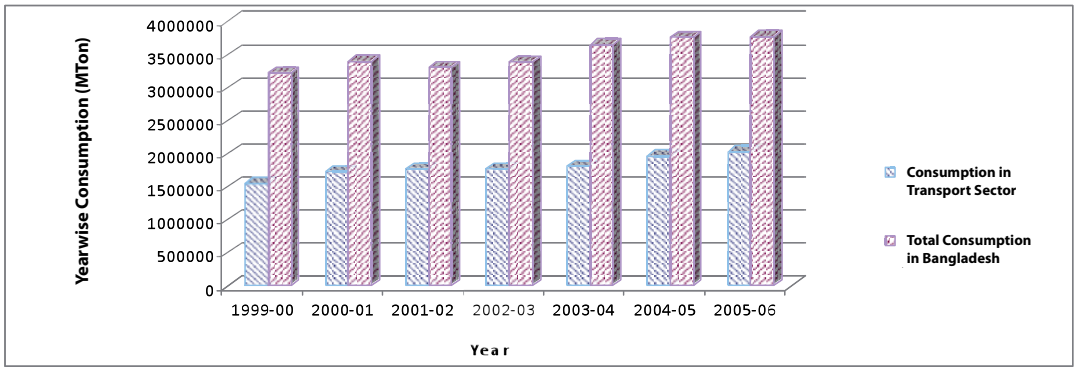
share data in 1990 revealed about 40% walking trips. However, in terms of passenger km travel, share of bus is highest (46%), followed by rickshaw (16%), walking (12%), and private car (8%) (Monayem, 2001). The role of 3-wheeler auto is relatively minor (about 4%) in terms of passenger km travel of the city.

From the travel demand forecasting of trips in STP it is found that in year 2024 total trips of the city will be about 4,01,81,572 per day of which almost 48% will comprise NMT, 44% motorized transit and only 8% of other motorized vehicles (Rashid, 2008). Among the motorized trips, total vehicle km travelled (VKT) by the year 2024 will be about 17,17,22,328 km per day of which almost 86% will be on bus or minibus and the remaining only 14% will be on car other MVs (Figure 5).

Even though it is expected that a large number of the city dwellers will be travelling with NMT or walking in the future, the provision of on-route facilities for these are not enough. Moreover, cars and small vehicles are rising heavily but their contribution on trip or VKT will be very minimal; which means a huge demand of energy fuel consumption for a very limited amount of trip or VKT. Thus, a restriction on cars or small-occupancy vehicles should be imposed. Otherwise, roads of the city will be much more clogged in the next 10 or 15 years from now. Along with this it is needed to promote mass public transport facilities.

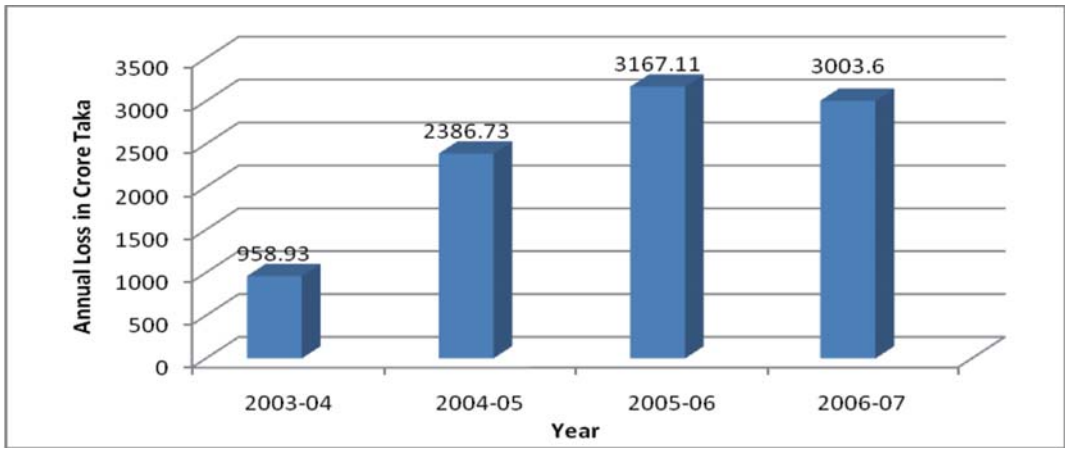
## Fuel Consumption of Transport Sector

Globally motorized transport consumes more than a quarter of world's commercial energy use (Rahman, 2008b). Transport sector is one of the large contributing human activities that accounts about 14% of total greenhouse gas (GhG) emissions (Olivier, et. al. 2005). The phenomenon, global warming, is mainly attributed to the increase in atmospheric carbon dioxide ($CO_2$) due to the burning of fossil fuel. Energy sector contributes about 54% of GhG emissions (Rahman, 2008b). According to the information of BPC, total annual consumption of petroleum products in Bangladesh is about 3.78 million metric ton (MT) of which 2.03 million MT is for transport sector. The share of transport sector in the total consumption of petroleum products is about 54%, which is about 2.5 times higher than the agricultural sector or 18 times higher than the industrial sector (BPC, 2008). Figure 6 reveals the sale of petroleum products in the country was 3.23 million MT in 1999-2000, which has increased to 3.78 million MT in 2005-06. The




*Source: BPC, 2008*

*Figure 6. Annual consumption of petroleum products in Bangladesh (1999-2006)*




*Source: GoB, 2008*

*Figure 7. Annual loss of Bangladesh Petroleum Corporation (BPC) from 2003 to 2007.*

demand increased at an average 2.43% per year during the period 1999-2006. On the contrary, the demand for petroleum products in the transport sector for the same period has increased at 5.09 % per year (BPC, 2008). The demand for petroleum products in the transport sector was 1.56 million MT in 1999-2000, which has increased to 2.03 million MT by the year 2005-06. Though the country has initiated a major drive to switch to compressed natural gas (CNG), cars driven by CNG has increased from 4.59% per year in the period 1999-2003 to only 4.62% per year in the period 2003-2006 (BPC, 2008). However, nationwide consumption of CNG for transport sector rose from 0.23 billion cubic feet (BCF) in 2002-03 to 11.99 BCF in 2006-07 (GoB, 2008).

For the transport sector of Dhaka City, the daily consumption petroleum products has been reported as diesel 526.04 thousands liter, octane 175.97 thousands liter and petrol 23.12 thousands liter (BPC, 2008). Though the authority has initiated a major drive to switch CNG driven cars, the demand of petroleum products is still high.

Except CNG, all other forms of fuel for motor vehicles in Bangladesh is imported from abroad, which drains a large amount of money each year. BPC incurred a loss of Tk 958.93 crore (Euro 95.8 million) during fiscal year 2003-04 from marketing of imported POL products. Such loss resulted from lower local sales price (transfer price) against higher purchasing cost not commensuration each other. Annual loss of BPC was about Tk 3167 crore (Euro 316.7 million) and Tk 3003 crore (Euro 300.3 million) respectively in the fiscal year 2005-06 and 2006-07 (GoB, 2008). As the demand for petroleum products is getting higher, the loss of BPC is also getting higher and creating tremendous pressure on energy sector and, thereby, hindering the economic progress of the country.

Natural gas is one of the important sources of energy in Bangladesh that accounts for 73% of the commercial energy of the country. On a cost per km basis, depending upon the size of the engine, petrol engine vehicles average about Tk 4 to 6 (Euro 0.063) per km, diesel engine vehicles average about Tk 2 to 3 (Euro 0.032) per km, and CNG vehicles about Tk 1.5 to 2 (Euro 0.025) per km (STP, 2005). This reveals that fuel costs are substantially lower for CNG-fuelled vehicles than petrol-fuelled vehicles. Vehicle conversion to CNG is well underway and promotion of this mode of fuel is being encouraged. Though the present demand for CNG is very low compared with total consumption of natural gas, but the demand of it in the transport sector is rising at an accelerated rate, which was 78.69% during the fiscal year 2006-07 (GoB, 2008).

### FUEL QUALITY

Diesel, octane, petrol used in Bangladesh is not cleaner as in other developed countries. The lead concentration of gasoline in Bangladesh is 0.84 gm per litre; which is mixed at refineries to enhance the anti-knock performance, contributes primarily to lead pollution. Sometimes 3-wheeler auto and motorcycle uses a blend of gasoline and lubricating oil which increase air pollution by rising CO, $CO_2$, $NO_x$, $SO_2$, unburned HC and other form of carbon particles concentration in the air. High sulphur concentration in petroleum, poor fuel quality and extensive diesel use creates high $SO_x$ emissions from automobiles. Usually, CO is produced by the incomplete combustion of carbon containing fuels. Automobiles in Dhaka City are responsible for one-half of all man-made $NO_x$ emissions and a greater proportion of $SO_x$ and SPM through fuel combustion (CPD, 2004). Emissions of $NO_x$ have steadily increased over the period from 1989 to 1996 as the result of increased fuel combustion. About 50% to 90% of total emissions of lead in Dhaka City are from the automobile exhausts (Khuda, 2001). This is mostly because of the widespread use of lead containing gasoline and the absence of any emission control strategies. Although the developed countries have restricted the use of tetraethyle (TEL) in gasoline, the Eastern Refinery of Bangladesh Petroleum Corporation (BPC) was previously mixing 0.84 gm TEL per litre fuel. The BPC supplies sulphur free petrol but imports diesel containing 1% sulphur per litre although the international standard is only 0.2% (Khuda, 2001). The government is changing the policy since 2000 to adopt CNG as a cleaner fuel for the transport sector by converting diesel-engines with the aim of mitigating air pollution. However, did not achieve any remarkable results yet. Till a large number or motorized vehicles use high lead-content gasoline or impure diesel and thus increase the gaseous PM pollutant in the air. However, the government had come to an agreement for importing lead-free gasoline and presently the BPC is supplying the lead-free petrol and octane (Rahman and Nahrin, 2007). People are suffering for different health related problems resulting from air pollution because of poor fuel quality used in motorized vehicles and poor local air quality management. So, a strong policy guideline is necessary for local air quality management.

### PROJECTED DEMAND OF FUEL

As the number of motorized vehicles of Dhaka City is increasing very rapidly and in the future the trend is expected to be continuing, demand of fuel for transport sector will increase heavily. Consequently, import of petroleum products from abroad will increase and thus huge loss of BPC. As government is trying to shift CNG driven cars, it is important to think about the natural gas reserve of the country.

As per Gas Sector Master Plan 2006, the estimated proven recoverable reserve of the 22 gas fields was 15.188 trillion cubic feet (TCF). As of June 2007, total 7.054 TCF gas has already been produced leaving only 8.134 TCF recoverable gas. Moreover, 22 gas fields have reserves of 5.28 TCF under probable reserve category (GoB, 2008). If the present trend of consumption of natural gas continues, then the cumulative demand of natural gas will be 8.84 TCF by the year 2015-16 which is 0.71 TCF more than the total amount of recoverable gas. Furthermore, the cumulative demand of natural gas will be 24.79 TCF by the year 2024-25 which is 11.38 TCF more than the total amount of recoverable plus probable reserve gas. These mean that the total reserve of recoverable natural gas of the country will be finished within the next few years and the country is going to fall in a tremendous energy pressure.

## Discussion

The projected population of the city is to be around 19.8 million by the year 2024 with an estimated number of person trips of 70 million per day (GoB, 2000; STP, 2005). This growth will make the transport situation of the city more critical, if appropriate measures are not taken to somehow accommodate the rapid increase of the population and thereby of travel demand and fuel demand. Despite the sharp increase of motorized vehicles stock, continued wide spread poverty and very low car ownership, make it very likely that the greater part of the city population will remain dependent on public transport. Moreover, considering the financial loss and dependence on other countries for motor fuel, it would not be wise to de dependent heavily on motorized transport. We need a moment just to think -- if mobility of the city dwellers are mostly dependent on MT and in the coming age if cost of importing fuel is heavily increased that is no more affordable or there is no more fuel available to import then what will happen for our society? Where almost 50% of the residents of Dhaka City are living below the poverty level, having no food or utility services and living in slums or squatters, city government should put the resources for socio-economic development rather importing fuel for motor cars. However, transport planning policies and perceptions in Bangladesh are more concentrated on motorized traffic, whilst NMT is seen as hindering motorized traffic flows. Such an approach is completely inconsistent with the realities of transport situation and travel pattern of the city where more than half of the total trips are walking and NMT trips.

Considering the socio-economic condition, possible future travel or transport scenario and future energy demand, transport of Dhaka City needs to move towards promoting NMT and energy efficient mass public transport. Along with these NMT promotion and energy-efficient mass transport, the city also needs to restrict small occupancy vehicles or car use to kerbing high dependency on fuel. It is the car, which is the main culprit for congestion and consuming more energy and thus polluting more considering per person trip. Indeed, transport policy of this city should be directed towards the environmental sustainability and affordability; thus need to promote walking and cycling along with low-cost mass transit or bus services accessible for all. Facilities should be provided for safe and comfortable walking and cycling. Restricting small-occupancy vehicles will also able to ensure efficient road use and reduce the high increasing demand for fuel energy for transport sector. Subsequently, public transport should be given priority by improving the public transport infrastructure, optimizing the structure of public transport operation, priority use of road for public transport, and developing the sector reform. Moreover, vehicles should use cleaner or alternative fuels to reduce vehicle emissions and air pollutions.

## Conclusions

The increasing trend of energy consumption of the transport sector is creating energy pressure and contributing to climate change. This increasing trend of fuel consumption in Bangladesh and particularly in Dhaka City is the result of rapid increase of motorized vehicles and dependency on them for travel. Fuel dependency of transport sector is creating GhG emissions and thus contributing to global worming and drain huge amount of money every year. Increased energy efficiency of the road transport sector and reducing the GhG emissions are crucial to resolve the climate change issues. Dhaka City is trying to cope with the increasing energy demand of transport sector and oil prices, which is threatening to the economic growth and sustainability of the transport. Improved bus service facilities along with walking and cycling facilities the city might be able to tackle the upcoming problems of fuel crisis and also trigger the problems of congestion and air quality. Whatever, a major effort is needed from all the stakeholders for improved transportation systems and fuel diversity; and thus to have energy efficiency or reducing energy demand in transport sector.

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