Development of Cng Infrastructure in India with Special Reference to National Capital Territory of Delhi

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1. Concern for Pollution:

After Independence of India, Delhi, the capital became major centre of commerce, industry and education. Rapid growth of Delhi resulted in significant increase in environmental pollution. Based on the ambient air quality monitored by the Central Pollution Control Board in 1998, it was found that the contribution from vehicles to the ambient air pollution of Delhi was about 65% of total air pollution. This could be understood from the fact that vehicle population increased from a number of 2,35,000 in 1975 to 21,00,000 in 1991 and further to around 37,00,000 vehicles by 1st January 2004 in Delhi. The sector-wise emission of pollutants in Delhi can be seen from the Table.

SECTOR-WISE EMISSIONS* IN DELHI
(Metric Tonnes per Day)

POLLUTANTS	TRANSPORT	POWER	INDUSTRY	DOMESTIC	TOTAL
UHC	310	2	6	2	320
SPM	13	50	60	12	135
NITROGEN OXIDES	157	143	20	3	323
SULPHUR DIOXIDE	11	121	35	12	179
CARBON MONOXIDE	810	8	128	117	1063
TOTAL	**1301**	**324**	**249**	**146**	**2020**

*Source: Central Pollution Control Board (CPCB), 1998

The above situation had given dubious distinction to Delhi as one of the most polluted city of the world.

With the increasing number of pollutants in Delhi's air and with the background of increasing trend in the use of CNG in the other parts of the world, Public Interest Litigation (PIL) was filed in the Hon'ble Supreme Court of India in 1985 seeking intervention in this matter. The Hon'ble Supreme Court had directed the Government of India to take initiative in promoting the use of CNG, an established clean fuel in the world as transport fuel in Delhi to control the increasing levels of ambient air pollution.

2. What is CNG? Properties of Natural Gas:

CNG is the short form of Compressed Natural Gas. The Natural Gas has less energy density as compared to Liquid Fuel and hence it is compressed to over 200 Kg/cm² (g) pressure to make it CNG for use in the automobile sector. In its natural form it is colourless, odourless, non-toxic and non-carcinogenic. However, this natural gas is mixed with an odorant to add flavour similar to the odour of LPG from a domestic cylinder so as to facilitate detection of its leakage. The typical composition and physical properties of CNG (i.e. Compressed Natural Gas) is as follows:

Typical Composition:

Methane	:	88%
Ethane	:	5%
Propane	:	1%
CO_2	:	5%
Others	:	1%
Total	**:**	**100%**

Physical Properties :

Non-toxic – Natural gas being lead/sulphur free, its use substantially reduces harmful engine emissions. When natural gas burns completely, it gives out carbon dioxide and water vapour - the very components we give out while breathing!

Lighter than air – Natural gas being lighter than air, will rise above ground level and disperse in the atmosphere, in the case of a leakage.

Colourless – Natural Gas is available in the gaseous state, and is colourless.

Odourless – The gas in its natural form is odourless, however, ethyl mercaptan is later added as odorant so as to detect its leakage.

3. <u>Pilot project of GAIL</u> :

- **Objective**: A pilot project was initiated by GAIL (India) Ltd. in collaboration with Indian Institute of Petroleum, Dehradun to establish the feasibility of using CNG as an alternative to liquid fuels such as Diesel & Petrol used by buses & automobiles in 3 cities namely Delhi, Mumbai & Baroda.

<u>POLLUTION REDUCTION IN CNG FUELLED VEHICLES</u>

The use of CNG in vehicles has lead to considerable reduction in air pollution as is evident from the following data:

A. **Autorickshaw – Three wheelers:**

(Emission in gram/Km)

Bajaj Three wheeler	Pollutants	Petrol	CNG	% Reduction
	HC	3.26	1.26	63.19
	CO	5.48	1.57	71.35
	CO2	47.44	27.60	41.82
	NOx	0.25	0.20	20.00

Source: Bajaj Auto, the manufacturer of three wheelers

B. **Passenger Cars:**

(Emission in gram/Km)

	Pollutants	Petrol	CNG	% Reduction
Maruti Omni	CO	19.79	.55	97
	HC	1.14	1.02	11
Maruti Gypsy	CO	4.94	0.59	88
	HC	1.86	1.42	24
Premier Padmini	CO	18.38	0.94	95
	HC	2.83	2.03	28
Premier 118NE	CO	15.6	2.04	87
	HC	2.57	1.92	25
Ambassador	CO	52.16	0.78	98
	HC	6.37	4.33	32

Source: Emission tests conducted by GAIL (India) Ltd., one of the promoter companies of IGL and the supplier of Natural Gas

C. **Diesel Buses:**

(Emission in gram/KWH)

	Pollutants	Diesel	CNG	% Reduction
Ashok Leyland	HC	1.68	1.4	16.67
	CO	4.5	3.77	19.37
	NOx	13.73	8.0	41.77
	Particulate Matter	0.125*	0.0029*	97.68

** In gm / km*

Source: Ashok Leyland, the manufacturer of buses

- **Infrastructure of GAIL under pilot project**: 1 Mother station was initially put up at Ghaziabad which has since been shifted to Sarai Kale Khan. This mother station was feeding to 5 daughter stations in Delhi. 3 Nos. online stations were added making total 9 Nos. of CNG stations during the pilot phase of the project. The station design and safety norms followed were as per New Zealand standards.

4. Formation of IGL:

- **Supreme Court gave directive to GAIL in July'1998** to expand the CNG infrastructure and to increase the number of CNG stations from 9 to 80 by March 31, 2000 in Delhi. It also directed Delhi Govt. to convert entire city bus fleet, autos & taxies from liquid fuel to CNG/Clean Fuel.

- **Subsequently in Dec.1998 Indraprastha Gas Limited (IGL) was incorporated** as a joint venture company of GAIL, BPCL & Govt. of NCT of Delhi to implement the orders of Hon'ble Supreme Court with regard to the CNG expansion program in Delhi.

- **Issues of land allotment**: Govt. of NCT of Delhi holding 5% equity in IGL helped IGL in getting the allotment of lands, permissions for laying pipelines and in getting electricity connections.

- **Uncertainty on vehicles conversion**: While IGL was formed to install 80 CNG stations there was an apprehension whether the DTC buses would be available for CNG usage. Besides all the autorikshaws, taxis and private buses were also to be converted for CNG use. Tremendous efforts were required to convince DTC, Bus Operators

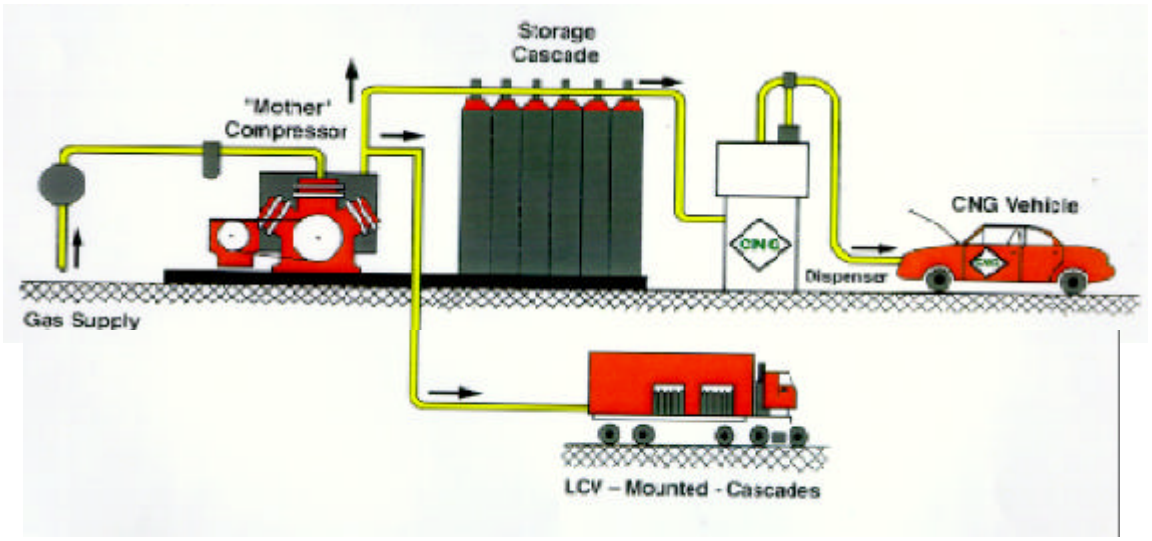
and Delhi Administration for the conversion of vehicles to CNG in such a short time. Today there are more than 87,000 vehicles in the NCT of Delhi, which are running on CNG.

5. Type of CNG Stations:

Four types of CNG stations have been developed in Delhi. These are as follows:

Mother Station: Mother stations are connected to the pipeline and have high compression capacity. These stations supply CNG to both vehicles and daughter stations (through mobile cascades). Typically they have the facility of filling all types of vehicles – buses/autos/cars. The Mother station requires heavy investment towards compressor, dispensers, cascades, pipelines, tubing etc.

TYPICAL CNG MOTHER STATION



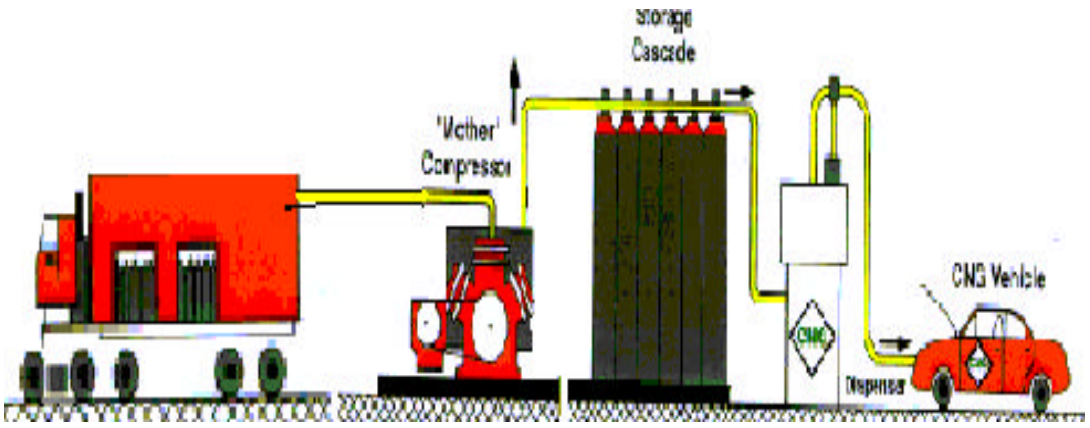
Online Station: CNG vehicle storage cylinders need to be filled at a pressure of 200 bars. "On line Stations" are equipped with a compressor of relatively small capacity, which compresses low pressure pipeline gas to the pressure of 250 bar for dispensing CNG to the vehicle cylinder. The investment in an online station is midway between daughter station and mother station.

Daughter Station: The "Daughter Stations" dispense CNG using mobile cascades. These mobile cascades at daughter stations are replaced when pressure falls and pressure depleted mobile cascade is refilled at the "Mother Station". The investment in a daughter station is least among all types of CNG stations.

There is reduction in storage pressure at daughter stations with each successive filling. Once the storage pressure drops, the refueling time increases, while the quantity of CNG dispensed to vehicle also decreases.

Daughter-Booster Station: Installing a booster compressor can eliminate drawbacks of daughter stations. The mobile cascade can be connected to the dispensing system through a booster. Daughter booster (compressor) is designed to take variable suction pressure and discharge at constant pressure of 200 bars to the vehicle being filled with CNG. The investment in daughter booster station is slightly higher than that of daughter station.

TYPICAL DAUGHTER BOOSTER STATION



6. Mega CNG Stations:

Mega CNG stations have been conceptualized to cater to a large fleet of vehicles, particularly the buses. The objective is to provide comfortable filling experience to the consumers when they come to the station for refueling. Mega CNG stations are constructed on much larger plot of land

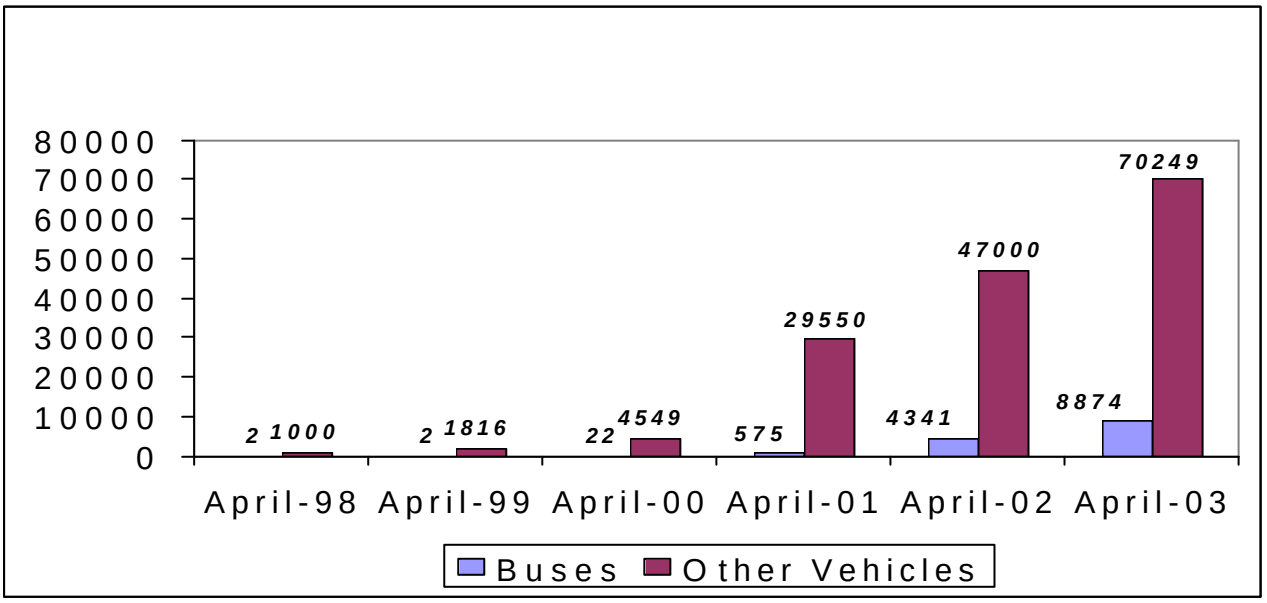
than that of conventional CNG stations, as a result of which more number of Compressors and Dispensers can be installed and more number of vehicles can be simultaneously refuelled at such stations. A Mega CNG station has been commissioned at Rohini, Sector 23 on July 13, 2003 and a similar station has been put into operation at Patparganj on June 30, 2003. At present, there are three Mega CNG stations in Delhi.

The CNG Mega station at Patpargang has been constructed at a cost of around Rs.13.5 crores (USD 3 MM) to simultaneously refuel five buses and eight other vehicles (cars, autos, mini buses etc.). Built on a plot of size 75 m X 40 m, it has the capacity to comfortably refuel CNG to 800 buses and over 1500 other vehicles daily.

7. Performance:

The growth in the CNG infrastructure and the performance of IGL since it's inception in December, 1998 is presented in the following bar charts:

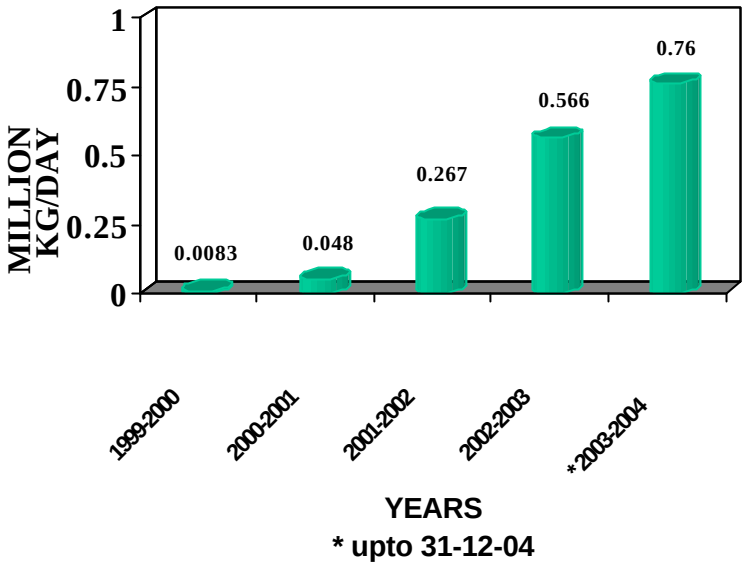
Growth in CNG vehicles:



** Source: Transport Department, Government of Delhi.*

- *Other Vehicles include private cars, taxis, three wheelers, mini buses.*
- As on December, 2003 the number of vehicles is **87026**. (Buses 9958, others 77068)

Growth in CNG Sales

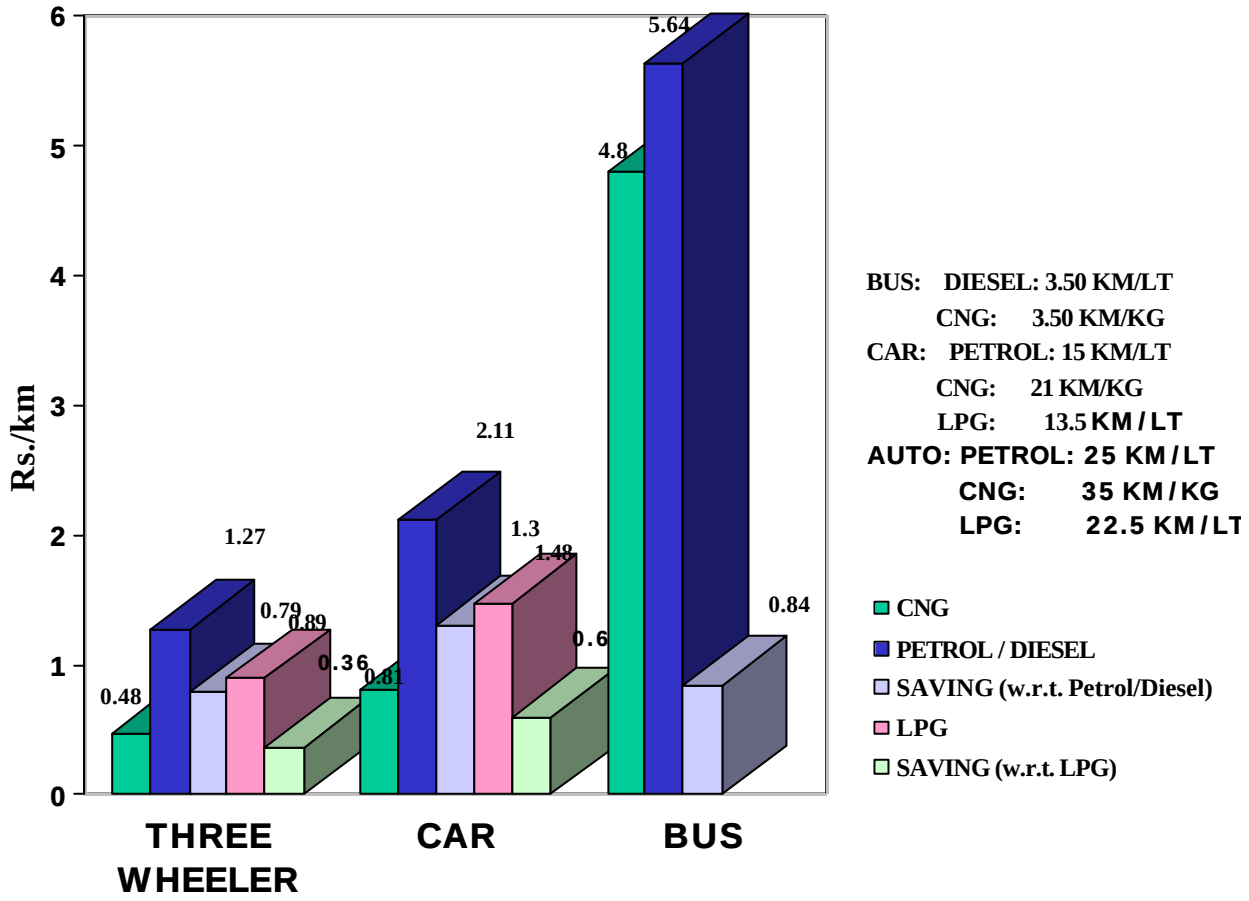


Geographical Distribution of CNG stations
(As of 01st January 2004)

Stations	East Delhi	West Delhi	North Delhi	South Delhi	Central Delhi	Total
Mother - IGL	2	10	8	14	3	**37**
Mother – DTC	2	8	3	5	1	**19**
Online	3	2	4	10	6	**25**
Daughter	1	1	0	2	2	**6**
Daughter Booster	7	2	4	10	7	**30**
Total	**15**	**23**	**19**	**41**	**19**	**117**

8. Economics of CNG

The growth of CNG vehicles in the year 2002 was primarily because of economic advantage of CNG with regard to petrol / diesel. The economics of running the CNG vehicles vis-à-vis its operation on petrol / diesel has been worked out at the current price of fuel. The results are reproduced in the form of the following bar graph:



CNG : 16.83 Rs/Kg PETROL : 33.70 Rs/Lt. DIESEL : 20.73 Rs/Lt.

LPG: 20.04 Rs/Lt

9. Cities where City Gas Distribution Projects being planned :

As per the directive of the Hon'ble Supreme Court of India dated April 5, 2002, in order to control heavy air pollution due to vehicular traffic, the following cities in India have been identified for developing infrastructure for distribution of alternative fuel:

Kanpur	Varanasi
Agra	Jodhpur
Faridabad Patna	Jharia

However, the study of air pollution indicated that the pollution in the cities of Jodhpur and Jharia is mainly due to dust pollution than vehicular emissions. Also, there are no trunk gas pipeline in the vicinity of Patna and Varanasi.

Subsequently, in August 2003, Hon'ble Supreme Court of India has issued a directive to the Union of India and the state governments to draw plans to introduce clean fuels in 11 cities apart from the existing cities of Delhi and Mumbai. These are:

Kolkata	Surat
Chennai	Lucknow
Bangalore	Kanpur
Hyderabad	Agra
Ahmedabad	Pune
Sholapur	

Under its Project Blue Sky, GAIL has already drawn plans to implement city gas projects in the five cities of Kanpur, Lucknow, Agra, Bareilly and Pune in phases at an estimated investment of Rs. 554 crores (equivalent to 118 Million USD).

CNG STATIONS IN INDIA AS ON JANUARY 1, 2004

Station Type	Delhi	Maha.	Gujarat				Grand Total
	IGL	MGL	Vadodara GAIL	Surat GGCL / GSPC	Ankleshwar GGCL	Total	
Mother	56	3	1	1	0	2	61
Online	25	46	0	2	0	2	73
Daughter Booster	30	15	0	0	0	0	45
Daughter	6	0	1	0	1	2	8
TOTAL	**117**	**64**	**2**	**3**	**1**	**6**	**187**

Item	Delhi	Mumbai	Gujarat				Grand Total
	IGL	MGL	Vadodara GAIL	Surat GGCL / GSPC	Ankleshwar GGCL	Total	
No. of vehicles							
Cars	15876	47870	450	663	123	1236	64982
Autos	56846	61497	16	429	0	445	118788
RTV / LCV	5164	7	0	0	0	0	5171
Buses	10075	47	0	0	0	0	10122
TOTAL	**87961**	**109421**	**466**	**1092**	**123**	**1681**	**199063**
Average Consumption						-	-
TPD	760.00	382.30	0.57	3.00	0.30	-	-
MMSCMD	**1.18050**	**0.54280**	**0.00073**	**0.00300**	**0.00030**	-	-

The total no. of CNG stations planned to be operational by the end of financial year 2003 – 2004 would be as follows:-

1) Delhi : 120
2) Mumbai, Maharashtra : 88
3) Gujarat : 6

10. Difficulties For Developing CNG Infrastructure

The following difficulties are faced in developing CNG infrastructure:

- Limited natural gas allocation leading to delay in management decisions on expenditure commitment
- Uncertainty about conversion of vehicles & CNG demand
- Lack of indigenous technology
- Capital intensive project - a mother station cost would be 5-6 times the cost of a petrol pump & pipeline need to be in place
- Infrastructural constraints (Electricity, land etc.)
- Delay in getting permissions from statutory authorities
- Objection from local people, encroachment
- Low storage capacity of on board cylinders, thus requiring frequent refills

11. Factors Influencing the Success of CNG Project:

- Government commitment to the program
- Sustainable economic advantage over liquid fuels
- Appropriate CNG technologies
- Appropriate program management
- OEM support
- Safety of CNG vehicles and CNG economic are key factors that determine the success of CNG program

12. Environment and Climate Protection

In India a new Auto Fuel Policy has been adopted in October'03 and the policy gives a roadmap for achieving various vehicular emission norms over a period of time and the corresponding fuel quality up gradation requirements. While it does not recommend any particular fuel or technology for achieving the desired emission norms, it suggests, taking into account security of supplies and existing logistics, perspectives, that liquid fuels should remain as main auto fuel through out the country and that the use of CNG/LPG be encouraged. The report also recommends measures for improving the present mechanism of checking pollution form in used vehicles.

The roadmap for vehicular ignition norm for new vehicles would be as follows:

Coverage	Cars, LCVs & Heavy Duty Diesel vehicles	2/3 Wheelers
Entire Country	Bharat Stage II: 1.4.2005 Euro III Equivalent: 1.4.2010	Bharat StageII:1.4.2005 Bharat Stage III: Preferably from 1.4.2008 but not later than 1.4.2010
11 Major cities (Delhi/NCR, Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Kanpur & Agra	Bharat StageII:1.4.2003 Euro III Equivalent: 1.4.2005 Euro IV Equivalent: 1.4.2010	

13. Lessons Learnt in Implementing CNG Program

IGL in a short span of five years has installed 117 CNG stations in NCT of Delhi in spite of various hurdles faced during implementation of the program. The following lessons have been learnt in implementing the CNG infrastructure development program:

- Study of geographical spread of CNG vehicles movement is a must to analyze the peak demand at individual CNG stations
- Pipeline distribution infrastructure needs to be in place
- Dedicated/adequate mobile cascade filling arrangement continuous supply of gas to daughter stations.
- Involvement of local government/transport authorities
- Genuine cylinder kits and spare parts be used for CNG vehicles to avoid accidents
- Suitable codes/standards are to be in placed for CNG kit fitment, testing etc.
- Safety and performance standards should be in place, monitored and enforced

- CNG stations need to be built in large open space to allow multi vehicle and multi point dispensing
- Development of CNG infrastructure needs to be in line with growth of CNG vehicles.
- Long term advance planning needs to be carried out
- Development of CNG station is time and d capital consuming activity.

14. Conclusion

Compressed Natural Gas has been accepted as an alternative fuel by the public at large. The stage is set for expanding the network to other cities. The success of CNG Expansion Program would depend on many factors. The key factors being the economy of CNG vis-à-vis other conventional fuels, adherence to safety guidelines and the Government Support.

Auto LPG is also launched on a large scale in the country. At the end of the day, it will be the quality of the fuel and economics which would be important parameters for the commercial success of auto fuel. The emphasis would be on fuels with lowest emissions. However, CNG is here for the time being till a better fuel is discovered offering better economics to the users.