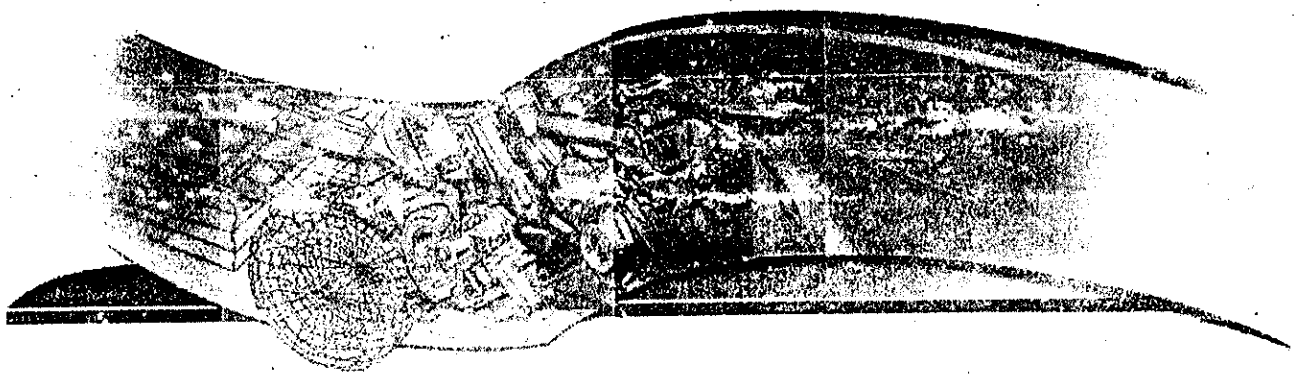
Gujarat State Petroleum Corporation



STUDY ON DEMAND AND FEASIBLE LOCATIONS FOR CNG OUTLETS ALONG NATIONAL HIGHWAY 8

FINAL REPORT

14/10

October 2002

TATA

TATA CONSULTANCY SERVICES

A Division of **Tata Sons Limited**
801 Sakar II Ellisbridge Off Ashram Road Ahmedabad- 380006

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Gujarat State Petroleum Corporation Ltd. (GSPC), a Gujarat Government undertaking is engaged in Exploration & Production of Oil & Gas. GSPC is also entering in the business of compressed natural gas distribution in various potential cities of Gujarat State. For implementing this project, a separate entity, Gujarat State Petronet Ltd (GSPL) was established. GSPL is instrumental in creating a high-pressure pipeline network for transportation of natural gas throughout the state of Gujarat. The pipeline will transport indigenous gas and imported liquefied natural gas.

Concurrently, a lot of outcry has been made over the pollution levels in the major cities of India. Consequently, Supreme Court has given a ruling for running buses, autos and taxis on Compressed Natural Gas (CNG) in Delhi. The implementation of this ruling also faced many problems like resistance from transporters, lack of infrastructure for refilling, lack of number of adequate kits for conversion etc. The state of Gujarat would also need to plan, in case such orders are required to be implemented in the state of Gujarat.

In view of the current situation, GSPC engaged TCS to explore the identify the demand and locations for setting up CNG outlets along National Highway No. 8, from Surat to Mehsana.

TCS collected primary as well as secondary data to analyze the traffic pattern on the *Surat-Mehsana* National Highway 8 stretch. Towns with population of more than one lakh were targeted for detailed analysis of the vehicle count. Data regarding the local vehicles has also been collected from various Regional Transport Offices (RTO). Data collected is based on passenger cars as well as heavy vehicles to study the traffic pattern. Registration-plate identification has been used for identifying state & non-state vehicles. Volume counts for the state based vehicles and other state vehicles are based on this survey.

There are few interesting case studies for CNG implementation. Prime among these are Argentina and New Zealand. These governments provided huge incentives to CNG vehicle owners and fuel stations. The New Zealand case shows the likely unsustainability of action to "kick start" the use of CNG unless the economics are fundamentally sound. Other international experience like Colombia indicates the need for a minimum threshold of demand to keep distribution costs and prices low. Lesson from Egyptian experience is scope for increasing the private attractiveness of gas by the development of financing mechanisms, which "variabilize" the capital costs of vehicle conversions.

The most important factor is the economic viability of CNG which depends on the equivalent pump price being no more than half that of the fuels with which it competes. CNG vehicles have found substantial markets in Italy, Argentina and Northern Colombia on that basis. The economic advantage is greatest for high mileage vehicles such as taxis and buses.

Currently there are only three cities in Gujarat where CNG outlets are present. Surat and Vadodara each have three CNG outlets and Ankleshwar has one CNG station.

The prices for CNG conversion Kit for car varies from Rs. 35000 to 55000 depending upon the make of the car and the tank size. CNG compares favourably when compared to other fuels. There is clear advantage in terms of economics, environment

friendly, flexibility, efficient and safer. The major issues that are related with CNG are luggage space, public awareness and distribution systems.

SWOT analysis for GSPC for setting up chain of CNG station shows that there are more opportunities than threats. The main opportunity is of the increasing environmental concerns and the Government / courts order which talk about implementing CNG as compulsory fuel for certain category of vehicles.

The demand estimation for CNG is based on the primary as well as the secondary data. The primary and secondary data have been used for the demand estimation for the highway traffic and city traffic respectively.

The demand projections have been made on various scenarios that could arise. These scenarios are: (i) Very optimistic scenario: Central Government / Court order for CNG vehicles on national level; (ii) Optimistic scenario: State Government / Court order for CNG vehicles on state / city level; (iii) Moderate scenario: Supply driven CNG transportation grows at high rate; (iv) Pessimistic scenario: Low CNG based vehicles

For projections and costing, the moderate scenario has been considered. It may be noted, that there could be 10% variation with the projected figures. The number of CNG stations required are in the range of 40 to 50 and the daughter station would be required within the range of 200 to 230.

The number of CNG stations required are as follows:

DISTRICT	MOTHER STATIONS	DAUGHTER STATIONS
Vadodara	4	32
Ahmedabad	17	80
Kheda	3	15
Anand	3	15
Valsad	7	28
Bharuch	2	20
Surat	8	25
TOTAL	44	215

The recommended locations for setting up CNG stations have been mentioned in the report. For locations, where it could be difficult to procure land, alternative location has been mentioned. Locations, where there is long stretch at which the CNG station could be setup, the alternative location is not required.

The indicative costing for the CNG stations has been worked on the basis of the vendor interactions and other information available with TCS databank. The total cost for setting up the chain of CNG stations would be between Rs. 310 crores to Rs. 370 crores approximately.

In case, the scenario becomes an optimistic scenario, the number of vehicles on CNG would be around 320% as that of projected and the demand would rise further to 340% of the projected demand under moderate scenario. (For "very optimistic scenario" these percentages are more than 500%)

This essentially means that for every planned station 2.4 additional CNG Stations would be required to be setup. Therefore, numbers of online stations in the range of 130-160 and daughter stations in the range of 600-700 would be required.

In case, the scenario becomes a pessimistic scenario, the number of vehicles on CNG would be just around quarter of projected and the demand would reduce to 20% of the projected demand under moderate scenario.

This implies that for every five station planned only one station would be utilized to its capacity. Therefore, numbers of online stations required would be in the range of 10-15 and daughter stations in the range of 40-50.

Apart from planning for demand and location, which has been considered in this study, various other factors would act as critical success factors for CNG implementation. Some of the important factors are as follows:

- Obtain Government directive / notification on CNG
- Take prior legal opinion on various issues that could arise; Conduct survey among vehicle owners
- Tie up with existing retail-fuelling stations
- Decide upon implementation model; a solution for this could be inviting private parties for taking up different geographical areas
- Pricing of CNG: consider the various costs and benefit associated with pollution and foreign exchange savings
- Availability of CNG Kits (discuss and negotiate with CNG kit manufacturers for purchasing kits in bulk, also start dealing with vehicle manufacturers for appropriate standardizations and norms)
- Planning for obtaining permissions from various agencies
- Phase wise implementation (cities and areas to be catered)

ABBREVIATIONS

AMTS	Ahmedabad Municipal Transport service
CNG	Compressed Natural Gas
CPCB	Central Pollution Control Board (Of India)
FCU	Fuel Car Unit
GDP	Gross Domestic Product
GSPC	Gujarat State Petroleum Corporation
GSPL	Gujarat State Petronet Limited
GSRTC	Gujarat State Road Transport corporation
ISO	International Organization For Standardization
Kg	Kilograms
Km	Kilometers
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
m^3 c	Cubic Meters
mg/m^3	Milligrams Per Cubic Meter
MMSCMD	Million Metric Standard Cubic Meter per Day
NG	Natural Gas
NGO	Non Government Organization
NGV	Natural Gas Vehicles
NH	National Highway
NOx	Oxides Of Nitrogen
NPV	Net Present Value
NSDP	Net State Domestic Product
NZ$	New Zealand Dollars
PCU	Passenger Car Unit
SCM	Standard Cubic Meter
TCS	TATA Consultancy Services
USD	United State Dollar
Lt.	Litre
RTO	Regional Transport Office
CCC	CNG Coordination Committee (in New Zealand)

1 INTRODUCTION

1.1 BACKGROUND

Gujarat State Petroleum Corporation Ltd. (GSPC), a Gujarat Government undertaking is engaged in Exploration & Production of Oil & Gas. Though exploration & production operations are its core focus, GSPC has plans of being a complete energy company right from exploration and production on one hand to generation of power and gas transportation on the other. GSPC is also exploring feasibility for entering business of compressed natural gas distribution in various potential cities of Gujarat State.

Gujarat State Petronet Ltd. (GSPL) is instrumental in creating a high-pressure pipeline network for transportation of natural gas throughout the state of Gujarat. It plans to construct a network of approximately 2500 Km. pipeline. The pipeline will transport indigenous gas and imported liquefied natural gas likely to be available from LNG terminals planned along the Gujarat coast.

During the past few years, there has been a lot of outcry over the pollution levels in the major cities of India. Consequently, Supreme Court has given a ruling for running buses, autos and taxis on CNG in Delhi. The implementation of this ruling also faced many problems like resistance from transporters, lack of infrastructure for refilling, lack of number of adequate kits for conversion etc.

The state of Gujarat would also need to plan for future, in case such a ruling is passed for individual cities or the state of Gujarat. In view of the current situation, GSPC is exploring possibility of setting up CNG outlets along National highway No. 8, from Surat to Mehsana.

Tata Consultancy Services (TCS) has been given the task of conducting a location and demand study for CNG outlets along National Highway No. 8 from Surat to Mehsana. The study would enable GSPC to decide on future course of action to be taken for setting up a chain of CNG stations.

1.1.1 GAS Grid

The total length of the gas Pipeline planned is 1200 Kms. The Project shall be implemented in two phases as per the details given below,

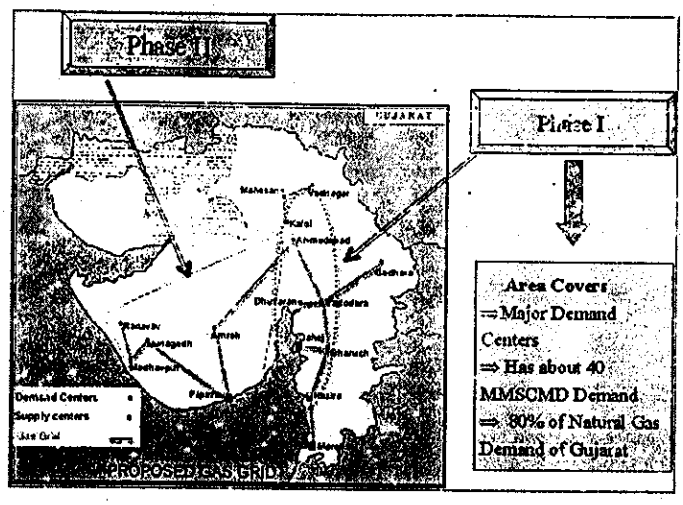


Figure 1-1 Gas Grid Plan

- Phase I: From Vapi to Vadnagar at an estimated cost of Rs. 1200 crore
- Phase II: Mainly in the Saurashtra Region at an estimated cost of Rs. 1300 crore.

The network as envisaged for this project is depicted in the map.

The total length / cost of pipeline Project in the two phases is as follows:

	Kms	Estimated Cost (Rs crore)	Completion schedule
Phase I	620	1200	2003-04
Phase II	580	1300	2005-06
Total	1200	2500	

Source http://www.gujpetronet.com

Presently, the Company is focusing its energy and core competence on development of Phase I of the Project in various sections.

1.2 SCOPE

The scope of this study is limited to the location identification and demand estimation for Chain of CNG stations on the Surat-Mehsana Highway and intermediate cities.

1.2.1 Terms of Reference

The terms of reference for the study are as follows:

- The Traffic density survey on and around National Highway No. 8, from Hazira, Surat up to Mehsana which would include:
  - Identification of traffic of state based vehicles & other state vehicles
  - Identification of traffic of local vehicles (City traffic)
  - Large industries
  - Government sector

- Location and alternative suggestions for feasible CNG outlets based on proposed Gas Grid plan
- Indicative distance from Transmission pipeline to proposed CNG outlets including tap-off size
- Information about prevailing land cost
- Estimation of potential CNG demand
- Suggest on types of CNG filling station i.e. mother, daughter station.
- Indicative sizing of CNG filling station based on present and future demand scenario and optimization of CNG filling station chain
- Indicative costing of CNG stations

1.2.2 Limitations

The study does not include survey amongst the user groups about their willingness for CNG vehicle conversion or purchase. Regarding the location of the CNG stations, the study focus is on the identifying areas where the CNG station could be setup. Exact plot identification is not part of the study.

The land prices for identified location would be on the basis of the prevailing rates. The actual land prices at the time of the land acquisition could however differ.

1.3 APPROACH AND METHODOLOGY

A detailed literature survey was conducted by TCS for getting insights into the current CNG market. The current market scenario for the CNG as fuel for transportation has been covered in this report. Various factors including environmental have been considered for analyzing the factors governing the future prospects of CNG as transport fuel.

The CNG conversion and its implications, have also been analyzed to arrive at a detailed understanding. Information about the technology options and the types of the CNG stations that could be setup has also been collected from various sources and analyzed under this study.

TCS collected primary as well as secondary data to analyze the traffic pattern on the *Surat-Mehsana* National Highway 8 stretch. Towns with population of more than one lakh were targeted for detailed analysis of the vehicle count. Data regarding the local vehicles has also been collected from various Regional Transport Offices (RTO). Data collected is based on passenger cars as well as heavy vehicles to study the traffic pattern.

Locations on the highway were identified where traffic volume survey would be conducted. Registration-plate identification has been used for identifying state & non-state vehicles. Volume counts for the state based vehicles and other state vehicles are based on this survey.

Primary study on the highway intersection and city entry point has been conducted for the following:

- State traffic vehicle count
- Non-state traffic vehicle count
- Segregation volume
- Local traffic volume

At each city bypass and highway intersection point on highway, the traffic count has been captured. The survey locations and other details have been shown in the respective sections. The internal roads where the traffic flow seems to be lower have not been considered for the survey.

The indicative costing for the CNG stations has been worked on the basis of the vendor interactions and other information available with TCS databank.

2 CNG IN TRANSPORT SECTOR

2.1 INTRODUCTION

CNG stands for Compressed Natural Gas. CNG is a mixture of hydrocarbons consisting of approximately 80 to 90 percent methane in gaseous form. Due to its low energy density, it is compressed to a pressure of 200 to 250 Kg/cm^2 (to enhance the vehicle on-board storage in a cylinder) and hence the name Compressed Natural Gas. Natural Gas is colorless, odorless, non-toxic but inflammable and lighter than air. CNG is not a liquid fuel and is not the same as LPG (Liquefied Petroleum Gas) that consists of propane and butane in liquid form. Natural gas is normally transported from the source to the users by pipelines. Besides widespread industrial use as a clean fuel for applications ranging from electric power generation, feedstock for fertilizer plants to furnaces etc., it is becoming a fuel of choice in domestic and commercial sectors.

It is one of the most viable alternatives to traditional fuel energy resources for the automotive industry. CNG is low in pollutants, high in calorific value and heat yield, economical and available in abundance globally. The typical composition of CNG is given in the following table.

Table 2-1 CNG Composition

Item	Percentage
Methane	91.9
Ethane	3.7
Carbon dioxide	2.0
Propane	1.2
i-Butane	0.4
i-Pentane	0.2
n-Pentane	0.2
Nitrogen	0.2
n-Butane	0.1
Others	0.1

2.2 MARKET SCENARIO OF CNG

The market scenario of the CNG has been discussed in brief in this section.

2.2.1 Current Demand and Supply

The consumption of the natural gas has been steadily increasing, both in the domestic and global energy market.

Year	Global (MMTOE)	Indian MMTOE
1973	1064.3	1.3
1993	1794.9	14.1
2010 *(projected)*	2677.2	52.5

Source: IEA Estimates

India accounts for only 1% of the world's natural gas consumption. Nearly half of total natural gas is consumed as feedstock, in India, as compared to 5 % globally. This

is not surprising since the only major gas transmission system in India (HBJ) was set up to provide feedstock to fertilizer plants.

Gujarat accounts for 9% of national energy consumption but has only 5% of the population of India. This is an indication of the relatively high level of development of the state. The state has limited coal deposits and oil / gas is the major local sources of energy.

2.2.2 Future Prospects

Natural gas is generally preferred fuel for various industries. Due to the availability of the gas through the pipelines, the usage in the industrial sector has been on the rise.

Demand for natural gas, in Gujarat and adjoining areas of neighbouring states, is expected to increase from the current level of 38 MMSCMD to 73 MMSCMD by 2006-07.

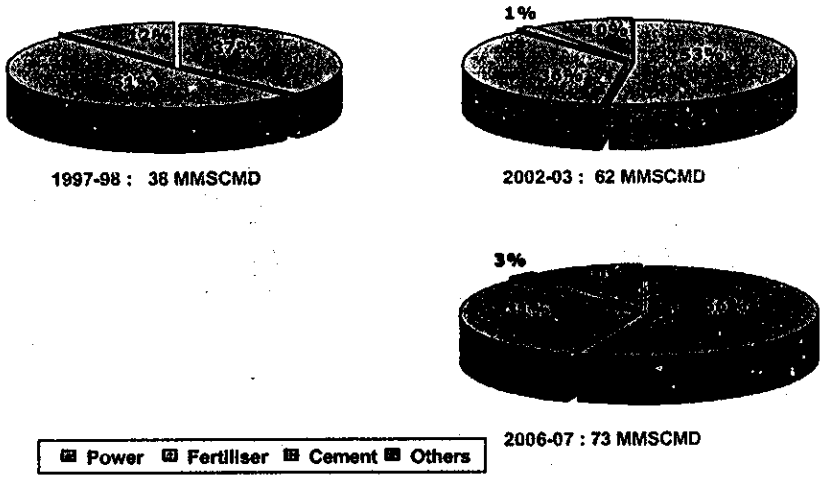


Figure 2-0 Natural Gas Demand in Gujarat and Neighbouring States

Source: TCS report on feasibility of Gas Grid

2.3 TRANSPORT SECTOR IN GUJARAT

The traffic on the highways in Gujarat has been on an increase due to various factors like industrial growth, industrial employment, agricultural output, mineral & mines production, ports etc. These factors have been analyzed in great detail in the Integrated Master Transport Development Plan for Gujarat. This study was conducted by TCS for Gujarat Infrastructure Development Board (GIDB). The projections for the year 2017 in this study are as follows:

Table 2-2 Trip-End Projections for the year 2017

Place	Cargo Trips (Vehicles/day)	Passenger Trips (Vehicles/day)
Valsad	22509	7987
Surat	23616	8420
Bharuch	19140	5963
Vadodara	20198	7597
Panchmahal	7514	5507
Kheda	7644	5878

Place	Cargo Trips (Vehicles/day)	Passenger Trips (Vehicles/day)
Sabarkantha	7630	3123
Ahmedabad	54011	20157
Mehsana	12732	4890
Banaskantha	9992	3989
Surendranagar	5151	2737
Bhavnagar	12238	4715
Amreli	4627	2410
Junagadh	9586	4174
Rajkot	11646	4715
Jamnagar	6166	3617
Kachchh	19866	3271
Dangs	1083	1027
Gandhinagar	7025	2867
Total	262374	103044

The locations that are located on the highway between Surat and Mehsana have been highlighted in the above table.

The number of registered vehicles in the Gujarat is also on rise. The figures for some Regional Transport Office (RTO) are as follows:

Table 2-3 Cumulative Vehicle Registration

RTO	1995-1996	1997-1998	1998-1999	1999-2000
AHMEDABAD	815602	975248	1058833	1150119
BHARUCH	83633	110463	126173	144891
GANDHINAGAR	23865	43175	54175	67678
MEHSANA	150225	189288	211392	234145
NADIAD	245517	299964	328242	359704
SURAT	486743	582442	642293	708323
VADODARA	393068	471996	515526	564926
TOTAL ABOVE	2198652	2672575	2936653	3229785
TOTAL GUJARAT	3577798	4203473	4549798	5190732

Source: Annual administrative publication by the Transport Department

2.4 THE INTERNATIONAL SCENARIO

The concept of natural gas as an automotive fuel started around 1930. Research has proved that it can be used safely.

Many countries are known to be using CNG as an automotive fuel. These include USA, Canada, UK, Italy, Thailand, Iran, Australia and New Zealand. While in most countries, its usage is restricted to private vehicles, in countries like Australia and America, it is the fleet operators who find it useful. More than 50 companies in the US operate their fleet vehicles on CNG. In Italy, about a quarter of a million vehicles are running on CNG, primarily due to the high cost of petrol. France, too, had a taste of CNG as an automotive fuel during World War I. However, not much emphasis was given to CNG, due to the use of LPG and a taxation structure on CNG. Canadian Western Natural Gas company started a CNG conversion programme in 1970 by converting about 100 vehicles in Edmonton city. As early as 1937, the Victorian State Electricity Commission of Australia considered the use of CNG for vehicle fuel. Similarly, the South Australian Gas Company converted 17 vehicles of their fleet to

operate on CNG, but due to the high costs of kits and cylinders, the conversion to CNG could not make much headway.

In New Zealand, a CNG conversion programme started in the 1970s and continued till the late nineties. The New Zealand Energy Research and Development Corporation, the Auckland Gas Company and the Wellington Gas Company were the pioneers in introducing the CNG programme in New Zealand. A variety of vehicles were converted and their performances were monitored. The program severely deteriorated, because of tax adjustments.

In the eighties, other Asian and South American countries embarked upon CNG programmes, namely, India, Bangladesh, Indonesia, Pakistan and Argentina.

The case studies of Argentina and New Zealand have been discussed in detail in the following subsection. Other relevant case studies have also been included.

2.4.1 Argentina Experience

» *The objectives*

Argentina is endowed with both oil and natural gas. The Liquid Fuels Substitution Program was launched in 1984 to free up more oil for exports and to increase fuel taxes on liquid fuels without provoking widespread public protests by offering low price CNG as an automotive fuel. By then, an extensive network of natural gas pipelines reached most cities. To start the program, two refueling stations were established and a few government vehicles and taxis were converted from gasoline to natural gas. Because of the domestic economic situation, no subsidies could be offered to "get the program off the ground." The incentive for switching to CNG was the very large price difference between gasoline and CNG, ensuring 65 percent savings in fuel cost by switching from premium gasoline to CNG.

Safety, quality and other standards were developed and enforced by the regulatory authorities for gas cylinders, conversion kits, conversion workshops, compressors, dispensers, installation procedures and so on. Internationally well known certification agencies carried out the certification. In the late 1980s, the government began to increase the retail price of diesel, aiming in the long run to substitute diesel with natural gas. The primary objective of the Liquid Fuels Substitution Program was in fact the substitution of diesel by natural gas in public transport vehicles. The fiscal policy changes needed to achieve this substitution, however, were not implemented.

Diesel has historically been and continues to be comparable to CNG in price. After taking engine efficiency into account, the price of diesel was lower than that of CNG in May 1994, comparable to that of CNG in December 1998, and rose above that of CNG only in December 1999, so that diesel has actively competed with CNG in the light-duty vehicle market to replace gasoline. Half of new taxis in Argentina are diesel-powered. The market share of gasoline steadily declined, that of CNG increased until 1997, and that of diesel fluctuated until 1997 after which it saw a marked increase at the expense primarily of gasoline, but also of CNG. Between 1985 and 1999, direct investment in the NGV market totaled US$1.5 billion. The converted vehicles operate as bi-fuel vehicles.

» *The project*

In the early years of the NGV program, it took less than two years to pay back the vehicle conversion. Today, the NGV industry generates US$0.65 billion worth of

business per year. About 1.5 billion m^3 of natural gas is sold annually as a transport fuel, approximately equal to the amount of gas consumed in three 500-megawatt power plants. The number of vehicles converted has stabilized at about 5,000 a month. In contrast to gasoline vehicles, the economics for converting diesel vehicles to NG are much less favorable even for intensively driven vehicles. Take, for example, a bus driving 120,000 km a year. Assuming a vehicle purchase price difference of US$22,000 and fuel prices as of December 1999, it takes 59 months to recover the incremental vehicle cost based on fuel cost savings, or close to five years. The fuel prices as of December 1998 would have increased the payback period to 29 years, considerably beyond the useful life of the vehicle.

In Argentina, the NGV market has been developed exclusively by the private sector, with many players entering the NGV market—refueling; manufacture of compressors, dispensers and gas cylinders; and manufacture and installation of conversion kits. In setting up the refueling infrastructure, those who had not been previously involved in the fuel retail business opened CNG refueling stations, as did oil companies. The payback period for an independent operator of a refueling station was approximately three years in the 1990s.

» *Lessons from Argentina*

The NGV program in Argentina is the most successful in the world, measured in terms of NGV population. This program has focused almost exclusively on converting existing gasoline vehicles to CNG, taking advantage of the large price difference between the two fuels. The large price difference in turn is provided by the fuel tax structure. Aside from this indirect support, the government has given no subsidies in the form of financial incentives to the CNG industry, making the CNG program viable in the long run. The CNG industry in Argentina today is exporting ISO 9000 certified compression and dispensing equipment, gas cylinders and conversion kits to other countries in Latin America and Asia. At the same time, the program has made no dent in the automotive diesel market, which is beginning to threaten the CNG market. Heavy-duty public transport vehicles remain entirely diesel fueled. A review of inter-fuel taxation policy as well as vehicle tax policy would be needed if the growth of the automotive diesel market is to be halted in the coming years.

2.4.2 New Zealand

» *The objectives*

New Zealand was a world leader in CNG vehicles in the middle of the 1980s. The sale of natural gas as CNG peaked in 1985 at close to 150 million m^3 a year. Between 1979 and 1985, the number of NGVs doubled every year. By 1986, CNG represented one-tenth of the fuel used by spark ignition engine vehicles (that is, gasoline engine vehicles) in the North Island—the only island where natural gas is available. The oil crisis of the 1970s affected New Zealand, which was importing nearly all of its transport fuels, prompting the government to seek alternative forms of energy. A major offshore gas field had been discovered in 1969. While the field was developed for power generation, it became apparent by the late 1970s that demand for power was well below the forecasted levels, requiring much less gas than originally envisaged even though the Government had already signed a take-or-pay agreement.

» *The Project*

The government therefore evaluated CNG as an alternative use of natural gas, and concluded that substitution of gasoline by CNG would help address two economic problems: balance of payments and unemployment. Urban air pollution was not a consideration in the government's decision to launch a NGV program at the time. The government sponsored extensive investigations into the impact of adopting CNG as a transport fuel starting in 1974. Based on the findings and recommendations, the government in 1979 set a target of 150,000 CNG vehicles by 1985, subsequently revised to 200,000 by 1990. Additional recommendations for the use of natural gas included the construction of a synthetic gasoline plant and a chemical methanol plant, both using natural gas as the feedstock. At the time, there were about 100 gas utility vehicles using CNG and only two refueling stations in New Zealand. Few people had technical expertise. The Ministry of Energy was formed in 1978, and it was not in a strong administrative position to coordinate the implementation of the CNG program in 1979. In response, the government established the CNG Coordination Committee (CCC) to coordinate efforts within the government and the private sector. The Ministry of Energy became the lead agency in 1981, by which time both the CNG program and the ministry were well established.

The government also began to offer financial incentives for vehicle conversion and refueling stations in the form of NZ$200 grants for conversion kits, 25 percent grants for mechanical equipment in refueling stations and loans for refueling stations. The government mounted programs for the implementation of the NGV program: providing training, establishing standards for vehicle conversion and refueling stations, and mounting public awareness campaigns. A major boost to the CNG industry was the decision of the government to require its own fleet to convert to CNG. Within a year, refueling stations became grossly overloaded, and half-hour queues were common.

By the middle of 1980, it became clear that a price differential of 50 percent between gasoline and CNG was not sufficient to achieve the conversion target set by the government. At the same time, various technical problems arose, in some cases giving rise to extremely adverse publicity. The rate of conversion fluctuated erratically. A rapid market survey conducted at the end of 1980 convinced the government that further incentives were needed. The package of incentives, announced at the end of 1980, included accelerated depreciation for vehicle conversions (then costing about NZ$1,000 per vehicle) and changed rules for the 25 percent refueling station grant. There was an immediate response, with the rate of conversion nearly doubling between the latter half of 1980 and the first half of 1981. Additional surveys were conducted in 1981 and 1984 to determine the appropriate level of financial incentives needed.

The above incentive schemes were followed in 1982 by the introduction of industry-funded CNG vouchers entitling voucher holders to NZ$300 of free CNG, and in 1983 a 100 percent government loan for vehicle conversions took the place of the accelerated depreciation program described above. By 1985, over 100,000 CNG conversion kits had been sold, nearly all converting gasoline to CNG. Few diesel vehicles were converted. The gross income of the CNG industry in 1984 was approximately NZ$84 million (US$49 million) and net foreign exchange savings amounted to NZ$30 million (US$17 million). Between 1979 and 1985, the net cost to the government of the various incentive schemes and loans was in

excess of NZ$20 million (or about NZ$200 per vehicle), in addition to administrative costs such as research and development, promotion and servicing of committees.

A number of implementation issues arose and were handled with varying degree of success.

» *Technical issues*

A wide range of technical issues related to vehicle conversion and refueling stations were investigated and handled. Some were known from the beginning and required investigation followed by a decision, such as setting the maximum cylinder filling pressure. Others arose as experience with CNG vehicles progressed, progressed, and some were unforeseen (for example, the maximum cylinder filling pressure set in 1979 proved to be too low and was later raised).

» *Institutional issues*

The CNG program was at first greeted with skepticism, if not outright opposition. Against this setting, the chair and executive officer of the CCC effectively became the product champions. The CCC had an influence on almost all the major government decisions related to CNG except the financial incentives. The CCC had no formal legal or administrative status. It relied on persuasion at the beginning. In time, the Ministry of Energy and the industry gave weight to the suggestions made by the CCC.

Setting standards for vehicle conversion and refueling stations became a key activity within the Standards Association of New Zealand. Acceptance of gas cylinders manufactured in Italy by the Dangerous Goods Inspector of the Department of Labor required extensive translation and interpretation of the Italian cylinder design rules. Establishing training courses for mechanics needed action by the Motor Industry Training Board and the department of Education. The New Zealand Energy Research and Development Committee, a government agency, provided key inputs from the outset. It funded the original technology assessment in 1978 and prepared the implementation plan in 1979. It funded several research projects, especially those directed at how CNG vehicle engines in New Zealand performed.

A small number of government personnel involved with CNG in the beginning stayed with implementation and provided continuity, greatly assisting with progress of the program. Their principal interest was to ensure that New Zealand had a viable alternative to gasoline as a transport fuel. In addition, a small number of people from private sector firms had a similar determination to make CNG a success because of the potential profits the CNG business could bring to their firms. The success of the CNG program can be said to be due in large part to the efforts of these key government and private sector people.

» *Economic*

It goes without saying that, given enough incentives, vehicle owners will switch to CNG. The government of New Zealand introduced a number of financial incentives that persuaded vehicle owners and businesses to convert vehicles and construct refueling stations. The price difference between gasoline and CNG was adequate to give a payback period of 18 months on the investment for vehicle owners spending in excess of NZ$35 per week on gasoline at the time. The industry-funded CNG voucher scheme provided an additional incentive. The

capital cost of conversion was covered by a 100 percent government loan. Government grants and loans helped establish refueling stations.

The market survey conducted jointly by the government and the private sector found that the quality of vehicle conversions had not been good, pointing to a need for quality assurance and warranty for vehicle owners. In fact, CNG was seen as a second-rate fuel used only because it cost less than gasoline. Vehicle owners considering conversion weighed the problems and disadvantages of CNG vehicles against the much lower fuel price. Refueling was not seen as a major problem because 450 refueling stations had been established by 1984.

The new Labor Government elected in 1984 adopted an economic policy of deregulation andliberalization, withdrawing the incentives offered for conversion and refueling stations. From 1985, conversions rapidly declined to almost zero and the consumption of CNG fell gradually as existing CNG vehicles ended their normal useful life, as did the number of refueling stations. A little over 10,000 CNG vehicles remained in the national fleet in the year 2000, a significant decline from the peak of 110,000.

» *Lessons from New Zealand*

The CNG program in New Zealand developed against the backdrop of very high international oil prices following the Iranian revolution and an indigenous supply of natural gas with demand not matching the amount that the government had agreed to "take or pay." In response, the government of New Zealand took the lead in promoting the CNG vehicle program aggressively. It sponsored research, prepared the implementation plan, and coordinated the entire program.

Most important, it provided generous financial incentives, so that the number of CNG vehicles doubled every year, seriously stretching the ability of the industry to cope. The industry was so preoccupied with meeting the demand for conversion that quality at times became a secondary priority, resulting in a poor perception of CNG vehicles in some quarters. When the new Labor Government began to deregulate the economy, withdrawing support for the CNG industry in the form of financial incentives, the market essentially died.

A CNG program that relies heavily on government subsidies, as in New Zealand, is not likely to be sustainable in the long run. Inter-fuel pricing in New Zealand today suggests that the world oil price must rise above US$30 per barrel before CNG becomes commercially viable without government support. The New Zealand experience suggests that the price of CNG should be no more than half of the retail price of gasoline it is substituting. Further, if the CNG price is 30 percent of the gasoline price, no direct support is necessary, but at 50 percent some government support in the form of financial incentives is believed to be needed.

2.4.3 CNG Pilot Project Launch, Singapore

On 22 April 2002, The Ministry of Environment (ENV), SBS Transit Ltd (SBS Transit), and SembCorp Gas Pte Ltd (SembGas), jointly undertook a pilot project to introduce compressed natural gas (CNG) buses in Singapore. Together, they launched the CNG Pilot Project at SembGas's CNG station on Jurong Island. CityCab Pte Ltd (CityCab) and Comfort Transportation Pte Ltd (Comfort) also plan to operate CNG taxis on a trial basis.

» *The Objectives*

The objective of the pilot project, the first to be funded under the Innovation for Environmental Sustainability (IES) Fund set up by ENV in Oct 2001, is to establish the technical and commercial viability of operating a fleet of CNG buses in Singapore. This would enable ENV to develop a plan to extend the use of CNG to other diesel vehicles.

» *The Partners*

SembGas' CNG station on Jurong Island was the first CNG station in Singapore and it would fuel the public transport fleet involved in the pilot project operating in the Jurong/ Tuas area. Built at a cost of $2.6 million, the CNG station received a 50 per cent grant under the IES fund while SembGas invested the remaining $1.3 million in the project. SembGas is Singapore's first commercial importer, transporter and retailer of natural gas through a 22-year agreement for the supply of Natural Gas from Indonesia. The Natural Gas is delivered from West Natuna Sea through a 640 km sub-sea pipeline directly to SembGas' receiving terminal on Jurong Island. SembGas currently supplies Natural Gas to power generation companies as well as industrial customers on Jurong Island and in the Jurong and Tuas industrial area through its reticulation network. SembGas is a joint venture between SembCorp Utilities (50 per cent), Temasek Holdings (30 per cent) and Tractebel (20 per cent).

» *The Project*

The first CNG bus rolled on to the road, with 11 more planned before the end of the year. The buses would be deployed on Service 712 plying between Jurong East Bus Interchange and Sakra Avenue on Jurong Island.

CityCab would test run its CNG vehicles - Nissan AdVan and Opel Zafira - over a trial period of six months. It has also confirmed the order of a Volvo V70 scheduled to arrive in June this year. These are part of the company's plans to explore the use of CNG vehicles in support of the Government's call for taxi operators to bring in green vehicles. During the trial, CityCab would work closely with its suppliers and would conduct a series of tests to study and evaluate the operational and maintenance aspects of CNG vehicles.

2.4.4 Nigerian Government

» *The Objectives*

The desire of the Nigerian government and its joint venture partners to halt the flaring of associated gas, has brought to the fore the importance of the natural gas sector.

» *The Partners*

As a major initiative, Shell Petroleum Development Company (SPDC), formed a new company, Shell Nigeria Gas (SNG). The aim of the new company was to help to push forward the development of domestic gas utilization.

» *The Project*

SNG would develop a series of transmission pipelines in association with the Nigerian Gas Company, and would commence marketing of gas supplies to industrial users throughout the country. SNG are also hoping to pull along prospective investors who may wish to consider a number of potential markets:

Compressed Natural Gas (CNG) Facilities

- Mobile LPG Filling Stations
- LPG Accessories
- CNG Powered Vehicles

The problems of fuel supply have been headline news in Nigeria for the past 3-4 years, and there is growing interest in the use of gas as a fuel source for cars and trucks. The technology has developed significantly worldwide, and is gaining momentum due to the environmental advantages of CNG and LNG over traditional gasoline. The Nigerian Gas Company has already conducted pilot trials on the viability of a CNG fueled car in Nigeria. Opportunities exist for setting up of CNG filling stations, marketing and installation of CNG vehicle conversion kits, and hosts of other equipment required to service and support the use of CNG as an automotive fuel.

Industrial users, the main targets of the initial series of distribution projects being developed by Shell Nigeria Gas Limited, will require the conversion of boilers, kilns, forklifts, and power generators, to use natural gas. Support services will also be required.

A number of other major oil producers have mapped out gas development strategies. Chevron completed the first phase of the Escravos gas-gathering project in 1997, and have commenced engineering work on a 2nd phase development. The company recently briefed the press at a World Bank forum in December, about the current progress on the West African Gas Pipeline project, which they are developing with SPDC.

2.4.5 Pakistan's Initiatives in CNG

» *The Objectives*

The CNG is economical and environment friendly transport fuel, which was introduced in Pakistan under an indigenous programme in 1982, with the establishment of the CNG Station in Karachi. At that time in South Asia as a whole, there was no concept of natural gas use in transport sector. Although it was realised that priority should have been given to substitution of diesel oil, which was a larger burden on import and a major source of pollution, there was the problem of technology and pricing. Pakistan is importing about 5.5 million tonnes of diesel oil annually at a cost of more than $700 million, therefore, a strategy has now also been proposed to gradually replace diesel bus fleets with dedicated CNG-driven buses. 200,000 CNG vehicles required only 30 million cubic feet of gas per day, which is just 1.25 per cent of country's present total gas production. It is assumed that if all the gasoline driven vehicles (about 500, 000) are converted to the CNG, the total consumption of gas will be 3 percent of the present gas production.

» *The Project*

Pakistan ranks number three among the CNG using countries after Argentina and Italy while many Asian countries are studying and utilizing its successful experience. More than 200,000 petrol driven vehicles are using the CNG as motor fuel in the country and industry has so far attracted more than $120 million investment and about $600 million is expected over the next five years. 200 CNG stations have already become operational with 137 in Punjab, 32 in NWFP, 30 in

Sindh and one in Baluchistan. Another 300 stations were under construction in more than 22 cities by June 2001. The 200,000 vehicles converted to CNG are consuming approximately 30 million cubic feet gas daily, replacing 292,000 tonnes of petrol per annum and accruing foreign exchange savings of $60 million.

The price of diesel oil had conventionally been kept very low in Pakistan, so there was little incentive for users to change from diesel to natural gas. It was decided once the CNG fuel got market acceptability and refuelling infrastructure became available, it would be easier to pursue diesel replacement programme. In the beginning both the car owners and manufacturers were reluctant to accept the CNG technology in the country but now Pak-Suzuki have started producing factory converted CNG cars and two other car manufacturers, Kia and Toyota, are also following suit. Pakistan's CNG experience has also been studied and utilised by several Asian countries -- including Bangladesh, China, Indonesia, Iran, Malaysia, Myanmar, Mongolia, Philippines, and Thailand.

2.4.6 Columbian Experience

Colombia, like Argentina, has large gas reserves in its northern region offering a possibility of substantial balance of payments savings. Pipelines built under BOT arrangements supply major cities in the region.

With the CNG price fixed at 60 percent of the gasoline price, and a very inefficient fleet of gasoline buses, the CNG fleet grew to 4,500 vehicles, mainly buses. However, pipeline utilization is low and transmission costs remain high so that expansion into private vehicle fleets has been relatively modest.

2.4.7 Egypt Experience

In Egypt, the Government policy has been driven by the desire to "clean up" Cairo, which is one of the most polluted cities in the world. It has achieved 20,000 conversions through the instrumentality of the licensing of joint enterprises of Egyptian and foreign suppliers to be involved both in the construction of filling stations and the conversion of vehicles. This linking avoids the "chicken and egg" problem of the relationship between vehicle fleet and fueling capacity. Fuel is maintained at less than half that of gasoline and the equipment suppliers link conversion to long-term fuel supply contracts so that those converters do not incur substantial initial capital costs. Very favorable terms are also available from the Social Development Fund to finance customer conversions.

The statistics regarding the number of CNG vehicles and fuelling stations is as shown in the table below:

Table 2-4 CNG Status in Various Countries

Country	Vehicles Converted	Refuelling Stations	VRA*	Last Updated
Argentina	721,830	969		Nov 01
Italy	380,000	369		Nov 01
Pakistan	265,000	310		Jun 01
Brazil	232,973	284		May 02
USA	102,430	1,250		Jan 01
India	84,150	116		Mar 02
Venezuela	40,962	170		Jan 02
Egypt	37,642	60		May 02
China	36,000	70		Jan 01
Ukraine	35,000	87		Dec 01
Russia	31,000	208	2	Dec 01
Canada	20,505	222	2,845	Aug 01
New Zealand	12,000	100	1	Aug 00
Japan	12,539	181	606	Jun 02
Germany	10,000	146	450	Jan 01
Colombia	9,126	32		Nov 01
Bolivia	6,000	17	46	Nov 01
Belarus	5,500	24		Dec 01
Bangladesh	5,000	9		Jul 02
France	4,550	105	100	Oct 00
Trinidad & Tobago	4,000	12		Nov 01
Malaysia	3,700	18		Oct 00
Indonesia	3,000	12		Aug 00
Chile	3,000	11		Nov 01
Australia	2,104	127	55	Aug 01
Sweden	1,550	25		Mar 00
Iran	1,000	3		Mar 02
Great Britain	835	18	46	Aug 00
Moldova	800	3		Dec 01
South Korea	746	28		Dec 01
Holland	574	27	384	Aug 00
Switzerland	520	26	29	Apr 02
Thailand	468	5		Jun 02
Netherlands	300	15		May 02
Spain	300	6	12	Aug 00
Belgium	300	5	60	Aug 00
Mexico	300	2	13	Nov 01
Portugal	238			May 02
Turkey	189	3		Aug 00
Austria	182	6	25	Nov 01
Ireland	81	2	6	Sep 00

Country	Vehicles Converted	Refuelling Stations	VRA*	Last Updated
Cuba	45	1		Feb 01
Finland	34	5	4	Aug 00
Czech	30	11		Aug 00
Nigeria	28	2		Aug 00
Luxembourg	25	5		Aug 00
Iceland	21	1		May 02
Poland	20	4	13	Aug 00
Norway	18	3		Aug 00
Taiwan	6	1		Nov 00
Denmark	5	1	3	Aug 00
Korea	4	1		Aug 00
Algeria		1		Aug 00
Hungary			14	Aug 00
South Africa			4	Aug 00
TOTALS	**2,074,310**	**5,119**	**4,718**	

Source: International Association of Natural Gas Vehicles, www.iangv.com

** VRA: Vehicle Refuelling Appliance*

2.4.8 Delhi Experience

» *The objectives*

The National Capital Region (NCR) of Delhi, India has come a long way to implement CNG as a vehicular fuel. The objective of this program was driven by the Hon'ble Supreme Court orders. These orders have an objective of reducing the overall pollution nuisance in the NCR.

The key aspects of CNG implementation are as follows:

- Key driver for all activities: Supreme Court rulings
- Joint venture between GAIL, BPCL, Delhi Govt., ILFS, IDFC, UTI to create an agency to implement CNG; the agency is Indraprastha Gas Ltd. (IGL)
- IGL hired consultants namely MECON and EIL (under consideration) for Consultancy and Project Management
- Compression capacity as of September 2002 is around 1 MMSCMD
- Compression capacity to be achieved shortly is around 2 MMSCMD
- Pollution levels are visibly lower

Table 2-5 Comparing average levels of particulate matter during the two months after April 1, 2001 (CNG ruling) with that during the same period last year

Station	Agency	Total Suspended Particulate matter (µg/m3) [Permissible limit = 200 mg/m3]		Respirable Suspended Particulate matter (µg/m3) [Permissible limit = 100 mg/m3]	
		Apr-May 2000	Apr-May 2001	Apr-May 2000	Apr-May 2001
Ashok Vihar	(CPCB)	474	275	NM	NM
Janak Puri	(CPCB)	481	NM	NM	NM
Nizamuddin	(CPCB)	619	336	NM	NM
Shadara	(CPCB)	617	373	NM	NM
Shahzada Bag	(CPCB)	625	496	NM	NM
Siri Fort	(CPCB)	424	458	NM	NM

Station	Agency	Total Suspended Particulate matter (µg/m3) [Permissible limit = 200 mg/m3]		Respirable Suspended Particulate matter (µg/m3) [Permissible limit = 100 mg/m3]	
		Apr-May 2000	Apr-May 2001	Apr-May 2000	Apr-May 2001
ITO Crossing	(CPCB)	580	565	208	172
Lodi Road	(TERI)	NM	NM	229	221

» *The Project*

Around 80,000 vehicles are running on CNG in NCR. The total number of registered vehicles in NCR in the year 2000 was around 27 lacs.

Table 2.6 Population of Different Types of Vehicles in Delhi

Vehicles	Population	Percentage
Bus	13455	1
Light commercial vehicle	57081	2
Truck	51771	2
Diesel multi-utility vehicle	47078	2
Gasoline multi-utility vehicle	11769	<1
Taxis	8353	<1
Diesel car	10686	1
Gasoline car	800780	30
Three wheelers	30828	<1
Four stroke two wheeler	192143	7
Two stroke two wheeler	1477330	56
Total	2701274	100

Around 100 CNG Stations have already been setup. Two mega stations with three and four compressor have also been setup. The compressors have 1200 SCM per hour capacity.

The CNG station sizes have been standardized to 30m by 36m. other salient features of the CNG station are:

- Nine line priority panel system
- Compressors of 1200 SCM per hour capacity
- Gas engine based compressors
- Smoke detectors / fire alarms / Auto fire extinguishers
- CNG leakage detectors / Supply cut off systems
- Fully Computer controlled compressor and supply units with real time monitoring and manual overrides
- Box-packed compressor units with only 4-5 days setup time required
- Noise levels within 65 db

The key issues faced during CNG implementation in NCR are:

- Leading vehicle manufacturers unable to meet the demand for CNG conversion
- High waiting time for buses - 3-4 hours though down from 20 hours
- Waiting time for Auto - 2 hours down from 15 hours earlier
- Some 8000 buses are still off the road, implying larger demand and longer waiting time
- IGL has not given permission to setup CNG station for a private concern

2.5 LEARNING FROM CASE STUDIES

- The primary lesson from Argentina is the importance of relative fuel taxation policies.
- The lesson from Colombia is the need for a minimum threshold of demand to keep distribution costs and prices low.
- One lesson from Egyptian experience is that there is scope for increasing the private attractiveness of gas by the development of financing mechanisms which "variabilize" the capital costs of vehicle conversions.
- The New Zealand case shows the likely unsustainability of action to "kick start" the use of CNG unless the economics are fundamentally sound
- Economic viability of CNG depends on the equivalent pump price being no more than half that of the fuels with which it competes. CNG vehicles have found substantial markets in Italy, Argentina and Northern Colombia on that basis.
- Because of the higher initial cost, and myopic view of vehicle purchasers, this can be assisted by financing arrangements (as in Egypt).
- The economic advantage is greatest for high mileage vehicles such as taxis and buses.
- In most countries, CNG is likely to remain a niche fuel serving environmentally critical markets.

2.6 CNG AS A TRANSPORTATION FUEL IN GUJARAT

CNG vehicles in Gujarat are not quite high in number owing to the fact that there aren't many CNG outlets. Currently there are only three cities in Gujarat where CNG outlets are present. Surat and Vadodara each have three CNG outlets and Ankleshwar has one CNG station.

According to The Business Line, in the year 2000, the users of CNG vehicles in Gujarat was around 650 in Surat and 100 in Ankleshwar - both serviced by GGCL, while about 150 vehicles are CNG-powered in Vadodara (GAIL). In other states, Mahanagar Gas Ltd, is the leader in CNG consumption with about 11,500 cars, while Indraprasth Gas Ltd (GAIL) comes second with some 4,000 CNG-driven cars.

Table 2-7 Present Status of CNG in India[1]

City	Company	No. of stations	Cars	Buses	Monthly sale in kg
Delhi	IGL	56	8000	133	82371
Mumbai	MGL	9	10000	10	1102060
Vadodara	GAIL	3	118	0	6074
Surat	GGC	3	667	0	21704
Ankleshwar	GGC	1	89	0	233

[1] Source: World Bank, *http://sdnp.delhi.nic.in, May 11 1999*

3 CNG TECHNOLOGY

3.1 CNG VEHICLES

The Common CNG vehicle fuels at pressures of either 3,000 or 3,600 pounds per square inch (psi) and stores its fuel in one or more cylinders located under the body or in the trunk of the vehicle. The filling valve is located in the same general area as that of the gasoline-refueling receptacle. When the CNG leaves the storage tank, it travels through high- pressure fuel lines into one or more pressure regulators, where it is reduced to atmospheric pressure.

Vehicles can also be operated in the dual mode like Petrol-CNG and Diesel-CNG. Experiments of these kinds have been conducted on vehicles by TELCO, Kirloskar Cummins Ltd., Ashok Leyland, IBP, OIL, Delhi transport Corporation and Gujarat Road Transport Corporation. The results have been reported to be quite satisfactory[2].

Under the CNG Dual Fuel System, a compressed natural gas Conversion Kit is added to a vehicle with no major modifications to the vehicle's system. In fact the capability of the vehicle is enhanced to include operating on an alternative fuel i.e. CNG

The Gas Authority of India Limited (GAIL) has requested vehicle manufacturers to nominate workshops and undertake conversions on their vehicles. The actual performance could be monitored by the Indian Institute for Petroleum (IIP), Kit suppliers from Italy and New Zealand have joined hands with oil marketing companies and vehicle manufacturers to train and initiate conversion from petroleum products to CNG.

Many countries around the world, including India, have abundant reserves of natural gas. Hopefully, it is only a matter of time when things begin to take a turn for the better and CNG would be as prevalent as petroleum products.

» *Economical approach to encourage the use of natural gas in vehicles:*

According to reports, 1000 cc car having an average engine on petrol runs 12 kilometers per litre costing about Rs 30, which comes to about Rs 2.50 per Kilometer. A 1000 cc car on CNG runs 16 Km per Kg costing about Rs 20 which comes to about Rs 1.25 per Km. Thus, by using CNG as fuel, money can be saved up to 55-60 %. Vehicles with engines of less than 1000 cc can save even more. Conversion cost of petrol car to CNG or dual-fuel system is around Rs. 25,000, Rs 27,000 per vehicles, which includes CNG Kits, cylinder and installation charges. CNG Kits and cylinder are imported.

3.2 CNG CONVERSION KIT

Unlike gasoline, which must be vaporized before ignition, CNG is already gaseous when it enters the combustion chamber. When the intake valve opens, the gas enters the combustion chamber, where it is ignited to power the vehicle.

Following describes in brief the main components of the CNG conversion kit that is retrofitted in the vehicle.

[2] *http://in.indiacar.lycosasia.com/infobank/using_cng.htm*

» *Cylinder*

The cylinder is used to store CNG at a working pressure of 200 bar. It is fitted with a shut-off valve and a safety burst disc. The cylinders are type approved by the Chief Controller of Explosives, Government of India

» *Vapour Bag*

Fitted onto the cylinder, the Vapour Bag is used to enclose the cylinder valve and the pipes connecting it and is vented out of the car

» *High Pressure Pipe*

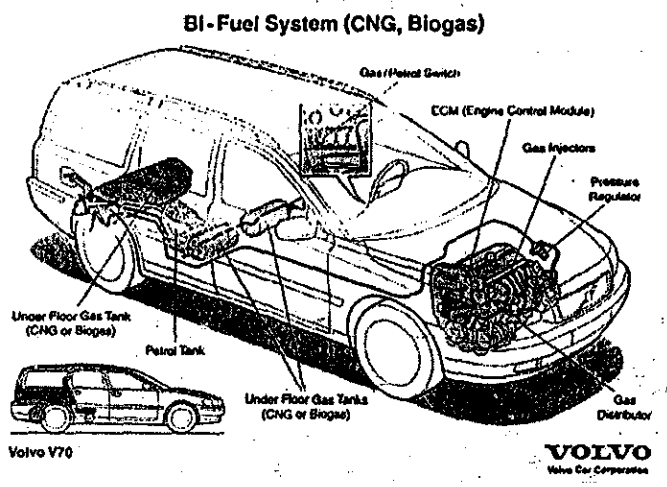
This High Pressure Pipe connects the refuelling valve to the CNG Cylinder and Pressure Regulator

» *Refuelling Valve*

The Refuelling Valve is used to refuel the CNG cylinder

» *Pressure Regulator*

The Pressure Regulator has a Solenoid Valve to shut-off gas supply to the engine. The CNG stored at a high pressure in the cylinder is reduced to just below atmospheric pressure by this unit. This negative pressure is also a safety feature that will not allow gas to pass through when the engine is not running



» *Gas-Air Mixer*

The Gas-Air Mixer is a unique component, specially designed to suit each engine model. It precisely meters gas fed into the engine

» *Petrol-Solenoid Valve*

The Petrol-Solenoid Valve is used to cut off petrol supply to the engine when it is run on CNG

» *Selector Switch*

The Selector Switch is fitted at the dashboard, enabling the driver to choose either the CNG mode or the petrol mode of operation. The electronics built into this unit also ensures safety by switching off the gas solenoid whenever the engine is

switched off. It also serves as a fuel indicator for the quantity of CNG available in the cylinder.

The comparative prices for the CNG conversion KIT are as follows:

Cyl size	Car Model	Cum Duty Price	Octroi 4%	MST 10%	SC on MST 10%	Market Price
65L	Premier Padmini	32000	1280	3328	332.80	37200
65L	AMB, Contessa, Esteem, Omni Gypsy	33500	1340	3484	348.40	39000
60L	AMB, Contessa, Esteem,MUL Car, Omni (Van), Gypsy, Zen	31000	1240	3224	322.40	36100
50L	PP, AMB, Contessa, Esteem, MUL Car, Omni, Gypsy, Zen	30000	1200	3120	312.00	34900
65L	Premier Padmini	32000	1280	3328	332.80	37200
2x60L	MUL Gypsy, Omni 45200	45200	1808	4700	470.08	52600

3.2.2 Comparison with Other Fuels

» *CNG vs. Low Sulfur Diesel Fuel/Vehicles*[3]

Low sulfur diesel fuel, coupled with after-treatment, provides comparable particulate emissions to compressed natural gas (CNG) vehicles. However, low sulfur diesel and after-treatment can achieve this beneficial emission performance much more cost-effectively than CNG. Comparison on other factors is as follows:

- Capital costs are higher for CNG vehicles and the supporting infrastructure
- Reliability is being considered as better in case of diesel

Table 3-1 Characteristics of the Different Fuels

	CNG	Petrol	Diesel
Toxic to skin	No	Moderate	Moderate
Toxic to lungs	No	Moderate	Moderate
Specific Gravity lighter or heavier than air (air =1.00)	0.55 (lighter)	3.4	4.0
Source/feedstock	CNG	Petroleum	Petroleum

» *CNG vs. LPG*

Liquefied Petroleum Gas (LPG) is a clean, high octane, abundant and eco-friendly fuel. LPG is obtained from natural gas through fractionation and from crude oil through refining. It is a mixture of petroleum gases like ethane and butane. The higher energy content in this fuel results in a 10% reduction of CO2 emission as compared to CNG.

The use of LPG as an automotive fuel has become legal in India with effect from April 24, 2000, albeit within the prescribed safety terms and conditions. Hitherto, the thousands of LPG vehicles running in some Indian cities have been doing so illegally by using domestic LPG cylinders, a very unsafe practice. Using domestic LPG cylinders in automobiles is still illegal.

[3] *http://ecdiesel.com/*

Power: Unlike CNG where engine power reduces upto 20 % due to gas carburetors, LPG can be used similarly to diesel with liquid sequential multi point fuel injection. Also, since it is pressurized at a mere 5-7 bars, LPG does not require drag inducing heavy tanks that is the bane of CNG. In CNG, as quantity reduces in the tank with usage, engine power also reduces simultaneously and pressure creating systems have to be installed in order to maintain engine power at optimum levels (thereby increasing the cost of conversion to CNG). On the other hand, LPG doesn't face this problem of power reduction right until the last drop is consumed.

Safety: The conversion of vehicles to LPG has, of course, to be undertaken by a competent person working in accordance with the prescribed standards. Other aspect for safety is in case of leakages, where CNG being lighter than air, releases into the atmosphere and LPG forms a pool which is also dangerous.

Conversion Costs: LPG conversion kits cost Rs. 8000-12000 for conventional carburetor systems and Rs. 15000-18000 for MPFI systems. This is as compared to Rs. 36000- 45000 for CNG conversions. The viability is best exemplified by measures such as fuel economy and savings on account of less engine wear and tear, less consumption of engine oil, lower fuel cost per kilometer etc. (See appended table)

Other difference between LPG and CNG

- For the same volume, LPG requires a tank that is 1/3 times that of CNG
- LPG is more costly as compared to CNG
- The additional cost of LPG powered buses versus diesel vehicles is less at USD 21,000 for LPG. For CNG it is USD 33,000
- The filling time for LPG is same as petrol and diesel, in comparison to the major problem posed by CNG, where pressure reduces when levels decrease
- LPG has got a better calorific power in terms of Mega Joules per Kilogram (CNG-47.7, LPG-66.1)

Table 3-2 Summary: CNG vs. LPG (vis-à-vis Diesel, Petrol)

Parameters	CNG	LPG
Emissions	Average 70% lesser than petrol / diesel	Average 90% lesser than petrol / diesel
Power	Reduces by about 20% as gas carburetors are often used	Same as petrol / diesel vehicles
Volume of Fuel tank	Large tanks avg. 6 times that of petrol / diesel for same mileage: additional weight and eats up boot space	One third that of CNG
Filling time	Relatively high compared to petrol / diesel depending on quality of compressor	Same as petrol / diesel
Market Price	Rs. 13 to 18 per Kg	Rs. 25 to 28 per Kg
Conversion cost	Taxi / car: Rs 33000	Taxi / Car: Rs 20000
Safety	High pressure can be a safety concern, but being lighter it dissipates quickly	5-7 bar, comparable to conventional fuel. Forms pool of fuel on ground in case of leakage
Handling	Requires special equipment	Ease in handling as close to liquid fuels
Dispensing	Requires special equipment. Only a compressor costs Rs 2 crores and a complete station could cost upto 3 crores	Average LPG stations cost Rs 35 lakhs only.
Transportation	Dependent on pipeline networks	Easily transported by road tankers like liquid fuels

Parameters	CNG	LPG
		like liquid fuels.
Distribution	Dependent on pipeline networks	Supplies delivered by road tankers liquid fuels.
Network Establishment	Longer lead time due to pipeline laying	Easy to develop, lead time of hardly three months for each facility
Initial investments in infrastructure	Average US $700,000 for just a dispensing station with compressor of suitable capacity	Average US$ 65000
Global experience	1072822 vehicles	5679000 – 5 times more vehicles on road in cities across the world.

3.2.3 Advantages

Economic benefit: The cost of CNG is almost a half of the cost of Petrol in terms of calorific value resulting in substantial saving in fuel cost, and investment on the CNG kit is paid back in a short period. CNG is the most economical fuel available - from 30 to 60 percent cheaper than gasoline on an equivalent gallon basis. CNG reduces engine wear, more than doubling engine life because CNG burns clean and leaves no carbon deposits. Conversion costs can be recovered from the savings in fuel and repairs over a 2 to 3 year period.

Environment friendly: No cancer causing particulates, less carbon monoxide and hydrocarbon emissions - less acid rain, smog, ground level ozone contamination and greenhouse effects. This is especially important in large metropolitan areas where approximately 60% of urban pollution comes from gasoline - and diesel - powered vehicles. The use of CNG as a fuel reduces vehicular exhaust emissions significantly. Carbon Monoxide emissions are reduced by 70 to 90% and Hydrocarbon emissions by 40 to 60% as compared to vehicles that use petrol. Carbon Dioxide emissions, a cause for global warming, are also reduced significantly by 10%.

Flexibility and ease of use: The basic engine characteristics of a vehicle are retained while converting it to run on CNG. The vehicle therefore is capable of running either on Petrol or CNG at the flick of a switch on its dashboard.

Efficient: CNG is highly efficient and better than gasoline when it comes to cold starts, vapour lock, cold or warm engine driveability, compression ratio and octane rating.

Safer: CNG is much safer than gasoline, diesel fuels, or propane. If released, CNG does not liquefy or accumulate. It dissipates quickly because it is lighter than air and thus less prone to ignite or explode.

» *Other benefits of CNG are as follows:*

- Lesser running cost
- Very easy on the engine, giving longer service life and lower maintenance costs.
- Reduces the demand for finite petroleum supply
- Drastic reduction in the relative hydrocarbon emission by over 80% to 93%
- Improves fuel consumption and engine efficiency. When CNG and air in the right proportions are brought together, they mix thoroughly and rapidly, thereby improving the combustion efficiency, while the engine stays clean internally

- Dry gaseous fuel does not dilute the lubricating oil, thus saving on oil filters and oil changers
- Reduction in engine noise levels significantly owing to its high octane number.
- Corporate Organizations, firms, etc. can claim 100% depreciation on a CNG Conversion Kit as this is a pollution controlling equipment.

3.2.4 Issues with CNG vehicles

Prime among the disadvantages of switching to CNG is the loss of luggage space. CNG cylinders take up a lot of storage space and generally have to be placed in the boot of the car. The body of the cylinders too has to be made of good grade steel capable of handling the roughs and toughs of travelling.

The cost of conversion is another major determining factor. The conversion kit can cost from Rs. 25,000 to Rs. 35,000. However, as mentioned earlier, the payback analysis shows the recovery in a short time frame.

- There is loss of power with CNG use. Dynamometer tests indicate the same.[4]
- CNG-fuelled vehicles have 10-15% lower power output than petrol engines.
- Increased exhaust-valve wear in CNG-operated vehicles are anticipated due to the drying effect of the gaseous fuel
- Limited service availability
- High cost of conversion
- The additional weight of CNG cylinders does pose a problem
- Inability to make an impression on the common man
- Due to its gaseous state, it is difficult to identify any leakage in the system.

Why CNG has not taken off well at most of the places in world?

The answer to this question lies in some of the issues as discussed. Apart from this there are other issues as mentioned below:

- The main factor is the availability of gas and the required distribution network for refilling stations. Huge investment is required to be made for the providing the infrastructure for gas distribution. Moreover, the volume of CNG demand from automotive sector is not so high to justify the investments.
- Prime among the non-conversion factor for CNG is the relative price of Diesel. Most of the developing countries have maintained lower price for Diesel and thus generally the conversion to CNG is not much cost effective
- Greater difficulty in distribution and storage
- Shorter driving range
- Greater weight of fuel tank (gas cylinder)
- Longer refueling time, especially if using slow fill refueling system
- Backfire in the inlet manifold (which occurs when hot gas from the cylinder escapes into the inlet manifold and ignites the mixture)

3.3 CNG REFUELING STATIONS

The purpose of the refueling station is to introduce compressed natural gas at high pressure into a motor vehicle that has been converted to run on CNG.

3.3.1 Technology and Features

There are three main types of CNG Station:

[4] *Source: http://sdnp.delhi.nic.in*

1. "Online" or conventional stations
2. "Mother" stations
3. "Daughter" stations

Over and above these, there are basically two fundamental concepts of refueling station as mentioned below:

1. "Fast fill" - Station which refills vehicles in exactly the same manner as normal petrol stations These are generally suitable for refueling cars, vans & light trucks and are public or fleet operating stations
2. "Trickle fill" - Stations which refill vehicles more slowly, for example over night. This concept is suitable for the fleet refueling of heavy vehicles such as buses and trucks. These stations are generally privately operated

» *Online Stations*

The "Online" station takes gas from an existing supply line, compresses it and dispenses it to the motor vehicle.

» *Daughter Stations*

"Daughter" stations are located in areas that are not connected to gas supply lines. The Daughter station receives Gas from the Transport system and dispenses it to the customer. The gas may be used direct from the Gas transport system or it may be recompressed with a small compressor to increase the utilization of the stored gas.

» *Mother Stations*

The "Mother " station takes gas from the supply line, compresses it and delivers it to a gas Transport System. The gas Transport System then delivers the gas to a daughter station, which is located at some distance from the mother station.

In some cases, "on - line" and "mother" functions may be combined in the same station. In other cases, a station originally designed as a "daughter" station may be converted later to an "on - line" station, or even a "mother" station.

Any of these stations can act as "Fast Fill" or "Trickle Fill" stations.

3.3.2 Basic Operation of a CNG Station and its Main Components

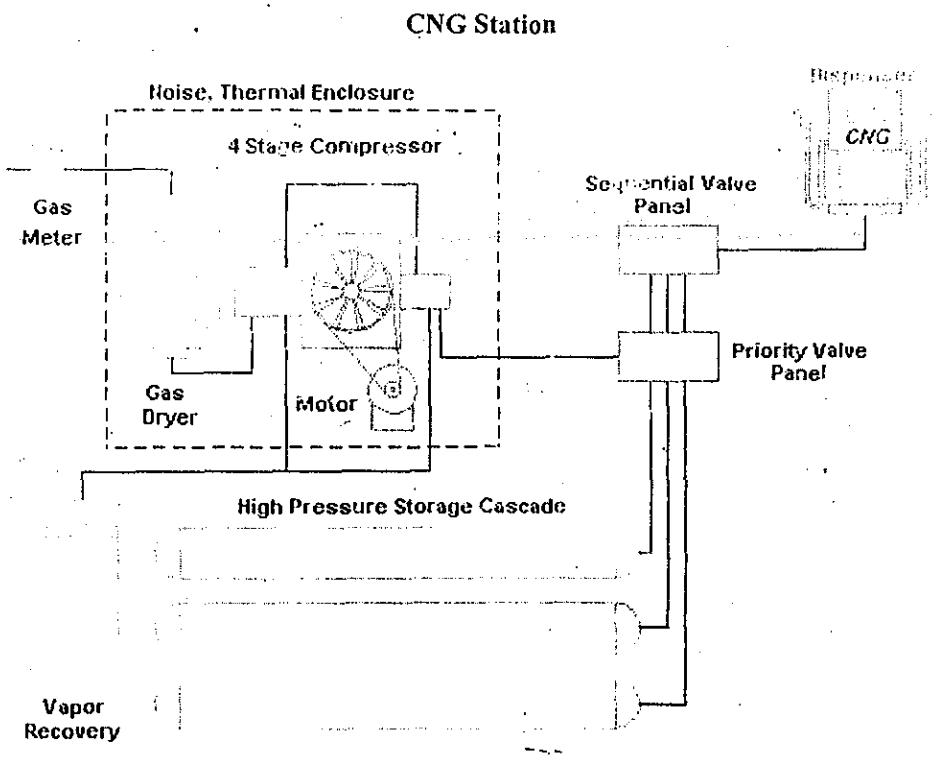


Figure 3-1 Schematic Diagram for a Typical CNG Station

There are typically five main components in a CNG station. Considering a conventional type of station:

» *The pressure regulating Station or PRS*

This receives gas from the pipeline and regulates and filters it to suit the compressor inlet requirements. A gas meter may also be fitted to record the consumption of the incoming gas

» *The compressor*

This receives gas from the PRS typically at pipeline pressures of 0.35 to 15.0 bar (5 to 220 psi). The gas is then compressed to a very high pressure, generally 25 MPa (3600 psi). The compressor may be electrically or gas engine driven and is usually a multi-cylinder reciprocating type machine (although in some cases hydraulic compressors have been used).

» *The gas storage system (or storage cascades)*

The gas storage system receives high-pressure gas from the compressor for storage until it is required at the dispenser. Storage provided enables vehicles to be filled without the compressor having to start up each time the dispenser is used. The storage cascades can be arranged in a series of 1, 2, or 3 banks to minimize

compression costs; this topic will be explained in a following section. The vehicle is filled to maximum pressure of 20 MPa for fast filling stations.

» *The priority-Fill or Sequential System .*

The sequential system allocates gas from the compressor to the storage and from the storage to the vehicle in the optimum sequence. It may also have compressor " top off " facility so that gas may be pumped direct from the compressor to the dispenser.

» *The CNG dispenser*

It dispenses the high-pressure gas to the customer's vehicle. Dispensers can have 1 or 2 outlets (single or dual hose) and generally include electronic metering to record individual and total sales. However, manually operated and non-metering dispensers are also available.

The same equipment will also be used in the Mother and Daughter stations although arranged in a different configuration.

For example, the service station will include a PRS and compressor, but need not include gas storage or priority system. Daughter stations will incorporate means of decanting the gas from gas-to-gas transport system and should include a gas storage system and a dispenser (they may or may not include a compressor).

3.3.3 Issues with CNG Refueling Stations

Consumers concern regarding insufficient level of gas in tanks: There can be number of reasons for this accusation- One of the main reason is that there may be less percentage of Methane quantity in gas, so if we use such a natural gas which contains less amount of Methane level than in that circumstance we will consume more gas. But for the other reasons about customers concern we need to examine methods of refueling gas cylinder at CNG stations.

» *Pressure basis refueling method:*

In this method the residual pressure of gas is found out before refueling e.g. if 50 bar residual pressure is already available in cylinder so 150 bar more pressure is supplied regardless of volume or weight of gas and is charged as per bar chart provided by HDIP. In fact, 200 bar pressure is achieved in order to give a complete fill of a vehicle cylinder. Sometimes, even at 180-190 bar pressure customers are charged for full fill. Some operators have provided a cut off switch at dispensers and supply of gas is terminated as soon as 200 bar pressure is achieved even if room is still there for further filling. So customer is absolutely unaware of quantity of gas dispensed in his/her vehicle and he/she has no idea as to what would be the mileage of his/her vehicle.

» *Volume basis of refueling method:*

CNG is dispensed in cubic meters in volume-based dispensers. At 200 bar pressure and 20 C ambient temperature, 10 M3 gas is filled in 50 lt. water cylinder and around Rs 190.00 are charged from the customer. During winter season, it is ok, when ambient is 18-20 C. But as soon as ambient goes up to 40 C plus due to heat gas expands and less gas is filled by weight although by volume still 10 M3 gas will be filled in 50 lt. cylinder and customer is charged around Rs 190.00 for

complete fill. So in summer less mileage of vehicle is observed and customers start paying more for per kilometer running of their vehicle.

» *Weight or mass basis of refueling method:*

This is most accurate and acceptable method of CNG refueling. In weight basis, customer is charged for exact quantity of gas his/her vehicle cylinder has been dispensed with and charged for the same quantity.

Therefore, customer must be educated about a clear difference between volume, mass and pressure based filling techniques in order to get right quantity of gas at right price at right place.

4 CNG DEMAND ESTIMATION

4.1 SWOT ANALYSIS FOR SETTING UP CHAIN OF CNG STATIONS

» *Strengths*

- GAS Availability: The prime strength of GSPC lies in its gas fields.
- Infrastructure: Gujarat State Petronet limited is laying the gas grid pipeline; the existence of this grid is also a strength for GSPC

» *Weaknesses*

- Previous experience of GSPC in retail market: GSPC has been involved in making bulk gas supply to industries and has no previous experience in the retail market
- Marketing expertise with GSPC: The current marketing expertise of GSPC may not be sufficient to promote CNG as a vehicular fuel.
- High investment: The setting up of CNG stations demands huge investments and the profitability of the CNG stations could affect the balance sheet of GSPC.

» *Opportunities*

- Government Regulations / Courts order: The location identification would give GSPC an edge, whereby it can meet any eventuality of sudden demand of CNG. This could arise in cases like court orders or Government imposed regulations etc. The time frame available then, would be sufficient for GSPC to setup CNG stations (unlike the case of New Delhi where the CNG stations setting up took lot of time).
- Business strength: The retail market has generally been attractive for brand creation, and the CNG stations could fulfill the requirement of the same.
- Increasing environment concerns: As the environment concerns are on rise, there would be industries / individuals and bodies, which would use low emission vehicles. The CNG would become the best fit for such cases and GSPC would be able to cater to this market.
- Government support: Being a corporation under the state government of Gujarat, it is imperative that the Government support would be available to GSPC for such initiative that helps in reducing pollution and in turn lower health expenditures for Government (this could also be a threat if Government privatizes the corporation).
- CNG based vehicles: The economic benefit of CNG would drive many a vehicle owners to convert their petrol-based cars to dual fuel cars by using conversion kits. GSPC could have major market share in this segment.

» *Threats*

- Competition: There are few companies like Gas Authority of India Limited (GAIL) and Gujarat Gas Company Limited (GGCL) that are operating in

the same market and have much greater financial capabilities. They also have existing CNG stations in Gujarat and an established customer base.

- Aggressive marketing by other companies: The companies in conventional fuel sector could start aggressive marketing and as the Administered Price Mechanism (APM) has been lifted, the competition could be stiffer and the customer may not have economical benefit to switch over to CNG. The market could change significantly when international companies enter the Indian markets.
- Price of CNG and other fuels: The price of CNG would have to be governed by the international prices and the prices of the fuel that CNG substitutes. Higher or comparative prices of CNG compared to conventional fuels like Diesel and petrol would make it unattractive for a person to switch over to CNG.
- Mass scale introduction of LPG as automotive fuel: The chances of CNG becoming automotive fuel is as good as that of LPG. In case of promotion of LPG by other companies, which requires relatively very low investments, the market for CNG could be affected.
- Standardization of emission norms for all categories of fuels: In such a case the Government regulation or courts order would focus upon enforcing the regulation instead of dictating other guidelines. This would create situation in which the emission norms would be the sole criteria and not the fuel that is to be used. This could also pose a threat to CNG stations.

4.2 DEMAND ESTIMATION METHODOLOGY

The demand estimation for CNG is on the basis of the primary as well as the secondary data. The primary and secondary data have been used for the demand estimation for the highway traffic and city traffic respectively.

The following scenarios have been considered for demand estimation analysis

4.2.1 Very optimistic scenario: Central Government / Court order for CNG vehicles on national level

This scenario could arise if the public transport and few other categories of vehicles are ordered by the Central Government / Supreme Court to be run on CNG at national level.

4.2.2 Optimistic scenario: State Government / Court order for CNG vehicles on state / city level

This scenario could arise if the public transport and few other categories of vehicles are ordered by the State Government / Supreme Court to be run on CNG at State level or in City limits.

4.2.3 Moderate scenario: Supply driven CNG transportation grows at high rate

This scenario could arise if there are incentives to the vehicle owner to own a CNG vehicle or convert existing vehicle to CNG

4.2.4 Pessimistic scenario: Low CNG based vehicles

This scenario could arise if there are no incentives to the vehicle owner to own a CNG vehicle or convert an existing vehicle to CNG

4.3 ASSUMPTIONS

The demand estimation is based on various assumptions as described below:

- The following percentages for the techno-commercial feasibility for converting the vehicles to CNG have been considered:

Table 4-1 Technical feasibility assumptions

Category	Techno Commercial Feasibility
HEAVY TRAILOR	0%
TRUCKS	25%
LIGHT TRUCKS	35%
BUSES PRIVATE	30%
BUSES ST	50%
CAR/JEEP	50%
TRACTOR ETC.	0%
THREE WHEELERS	100%

- The following percentages for the feasibility for converting the vehicles under various scenarios have been considered:

Table 4-2 Assumptions for CNG conversion under varjous scenarios

			rucks		Light trucks		
Very Optimistic	100%	100%	100%	100%	100%	100%	100%
Optimistic	100%	0%	100%	10%	100%	0%	100%
Moderate	0%	0%	10%	5%	15%	0%	20%
Pessimistic	0%	0%	0%	0%	2%	0%	0%
	Buses ST						Auto
Very Optimistic	100%	100%	100%	100%	0%	0%	100% 100%
Optimistic	100%	0%	100%	100%	0%	0%	100% 100%
Moderate	40%	0%	50%	25%	0%	0%	50% 0%
Pessimistic	5%	0%	15%	5%	0%	0%	20% 0%

- Calculation of the fuel consumption of various types of the vehicles is based on the following assumptions:

Table 4-3 Fuel consumption assumptions

Vehicle	Region	Average Distance Km / Day	Mileage Km / Lt.	Fuel Consumption Lt.
HEAVY TRAILOR	State	150	2	75
	Non-State	200	2	100
TRUCKS	State	200	4	50
	Non-State	300	4	75
LIGHT TRUCKS	State	150	6	25
	Non-State	150	6	25
BUSES PRIVATE	State	200	5	40
	Non-State	300	5	60
BUSES ST	State	300	5	60
	Non-State	300	5	60

Vehicle	Region	Average Distance Km / Day	Mileage Km / Lt.	Fuel Consumption Lt.
CAR/JEEP	State	100	12	6
	Non-State	200	12	17
TRACTOR ETC.	State	50	6	8
	Non-State	50	6	8
THREE WHEELERS	State	150	25	6
	Non-State	150	25	6

4.4 TRAFFIC SURVEY

4.4.1 Survey approach and methodology

TCS collected primary as well as secondary data to analyze the traffic pattern on the *Surat-Mehsana* National Highway 8 stretch. Towns with population of more than one lakh were targeted for a detailed analysis of the vehicle count. Data regarding the local vehicles has also been collected from various Regional Transport Offices (RTO). Data collected is based on passenger cars as well as heavy vehicles to study the traffic pattern.

Locations on the highway were identified where traffic volume survey would be conducted. Registration-plate identification have been used for identifying state & non-state vehicles. Volume counts for the state based vehicles and other state vehicles are based on this survey.

Primary study on the highway intersection and city entry point has been conducted for the following:

- State traffic vehicle count
- Non-state traffic vehicle count
- Segregation volume
- Local traffic volume

At each city bypass and highway intersection point on highway, the traffic count has been captured. The survey locations and other details have been shown in the respective sections. The internal roads where the flow seems to be lower have not been considered for the survey.

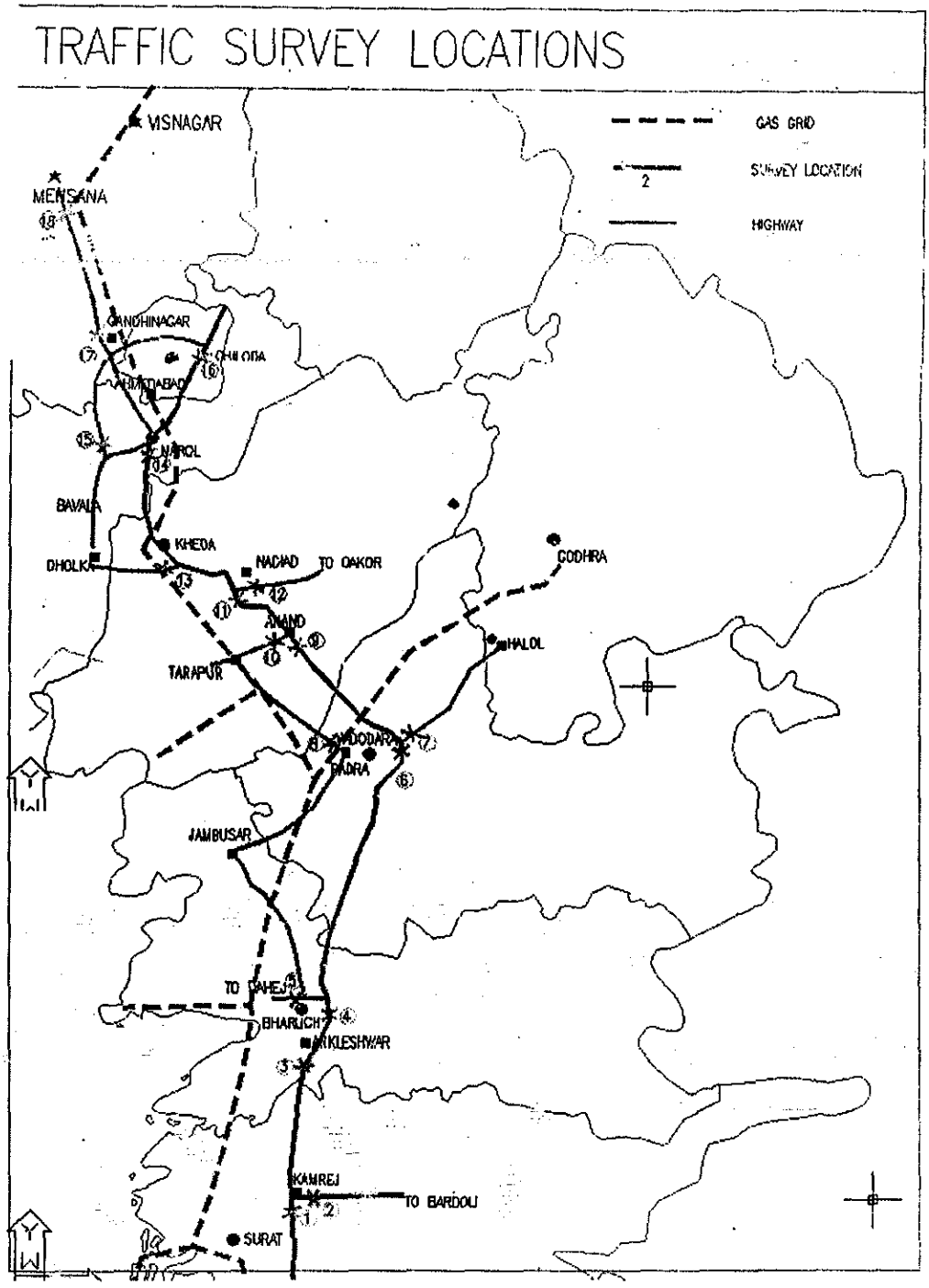


Figure 4-1 Traffic Survey Locations

» *Site Locations*

The to and fro data for each of the following locations has been collected

1. From Mumbai to Surat
2. Surat to Bardoli
3. Surat to Ankleshwar

4. Ankleshwar to Bharuch
5. Bharuch to Dahej
6. Bharuch to Baroda
7. Baroda to Halol
8. Baroda to Jambusar
9. Baroda to Vasad
10. Vasad to Tarapur
11. Anand to Nadiad
12. Nadiad to Dakor
13. Nadiad to Dholka
14. Nadiad to Ahmedabad at Narol Crossroad
15. Ahmedabad to Udaipur at Chiloda Circle
16. Narol to Aslali
17. Narol to Adalaj
18. Between Adalaj and Mehsana

The locations are as demarcated in the map of Gujarat. The basis of selection of these sites is the total traffic that is plying on the route between Mehsana and Surat, as those vehicles will be our potential targets for CNG usage.

Example: For traffic plying from Surat to Mehsana

- All traffic entering Surat from Mumbai is calculated at pt 1. While traffic entering from Bardoli is calculated at pt 2.
- The traffic count at pt 3 gives us all traffic coming from Surat and pt 1 & pt 2. Any addition in traffic from Ankleshwar is obtained from the count at pt 4. At the same time, some traffic is terminated in Ankleshwar.
- Vehicles, which going to Dahej, are calculated from pt 5; this includes all vehicles coming from Baroda as well.
- Traffic coming for Dahej and Bharuch is collected at pt 6. Any traffic going out from pt 6 gets segregated and the count at pt 9 (Vasad) is the traffic coming from Halol and Baroda traffic at pt 11 (Nadiad) is the data at pt 9 minus data at pt 10 i.e. the traffic going to Tarapur from Vasad.
- The traffic from Nadiad goes either to Borsad or Dakor and the remaining continues on NH8. The traffic lost at Borsad and Dakor is calculated at pt12 & pt 13 respectively. Similarly traffic coming to Ahmedabad (pt 1) from Anand, Dakor and Borsad is available form pt 11, pt 12 & pt 13 respectively.
- The traffic from Aslali goes to Udaipur, Saurashtra, Mehsana or Ahmedabad. Traffic going to Udaipur is counted at pt 16, which includes traffic form Saurashtra as well. Traffic to Saurashtra is counted at pt 15. Rest of the Traffic is going to Ahmedabad. Vehicles leaving Ahmedabad and new vehicles joining from Ahmedabad are counted at pt 18 at Adalaj. The final traffic coming for Ahmedabad and Saurashtra is calculated at pt 17 before entering into Mehsana.

In this way, the entire traffic plying on the stretch form Surat to Mehsana is calculated with the traffic congestion at all the intermediaries thereby giving us an insight of probable CNG locations as well. Similarly, traffic from Mehsana to Surat has been calculated from the same survey locations.

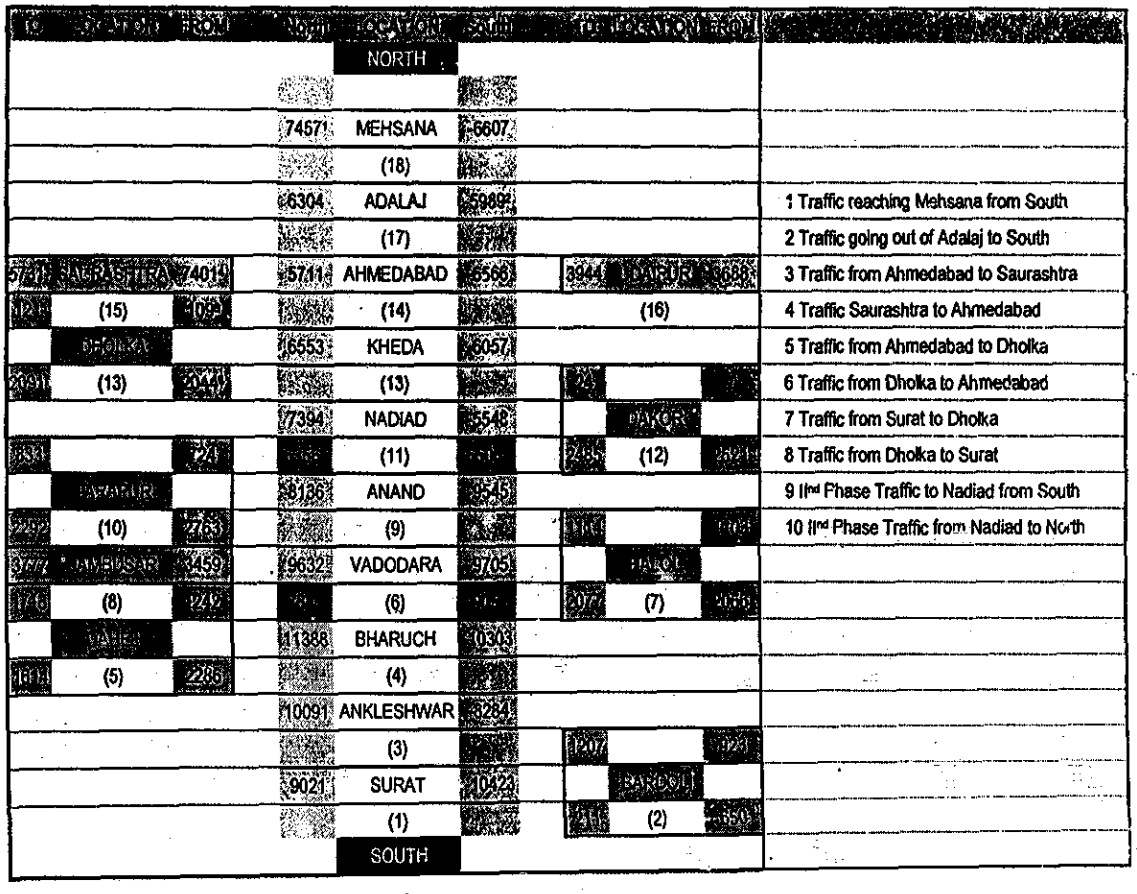
The survey was conducted in three sections in three days with overlapping. The details of the sections are given below:

- Section 1: Point 11 to Point 18
- Section 2: Point 6 to Point 11
- Section 3: Point 1 to Point 6

Overlap between the sections has been considered; e.g. traffic count at the point 11 has been considered during the sections 1 survey and during section 2 survey as well. This helps in cross-checking the daily traffic movement

4.4.2 Survey data analysis

Table 4-4 Survey Results on Surat-Mehsana Highway (10/07/2002 to 17/07/2002)



The above graphic summarizes the results of the survey. The important locations on the highway and the important junctions have been identified here, and the total volume count for the same is being shown in the graphic.

The total traffic plying on the highway is represented as follows:

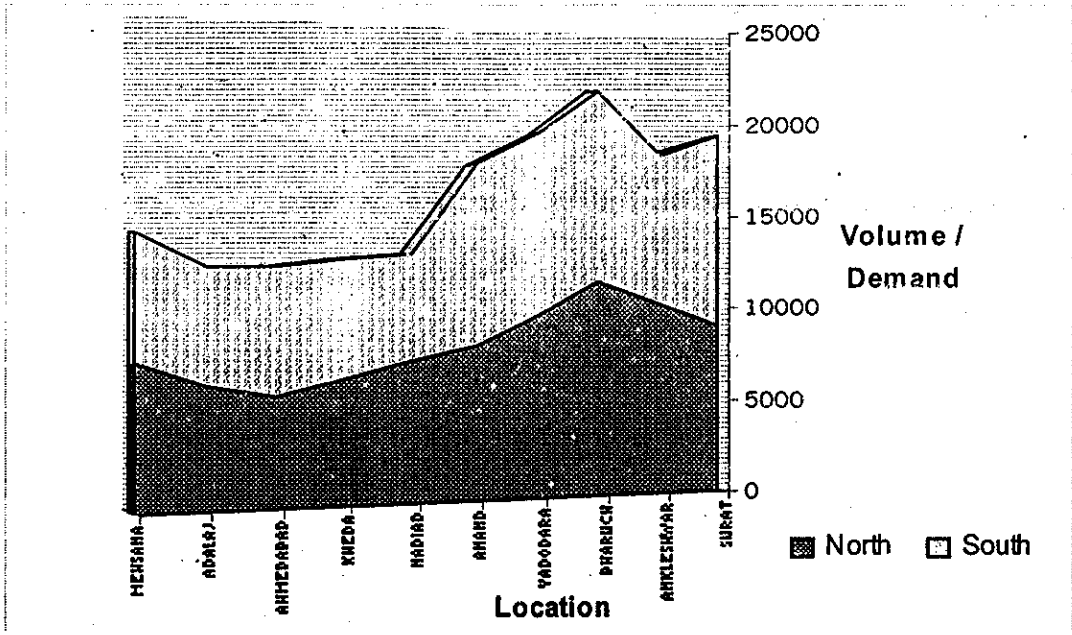


Figure 4-2 Total Traffic Count on Surat-Mehsana Highway

4.5 CNG DEMAND

The demand for CNG is a function of the number of vehicles plying on the highway. Generally in traffic studies, the Passenger Car Units (PCU, the PCU factor for a vehicle is based on the vehicle characteristics like speed, capacity, size etc.) are considered for calculation purposes. However, for demand estimation purposes, the PCU cannot be directly used. To make the demand estimation easier, the PCU has been modified and instead of passenger as basis, we have used the fuel consumption as basis. This has been referred to as FCU (Fuel Car Units)

The FCU is based on the average daily run and the mileage of the vehicle. A four-wheeler car traveling 100 km per day and giving the mileage of fuel at around 12 lt. per km has been assigned a FCU of 1. A vehicle whose daily run is same but mileage is half as compared to the car has been assigned the FCU twice as that of the car. Care has been taken in the calculations for the 350 km Surat-Mehsana distance and the number of survey locations on this stretch.

One FCU = Consumption of approx 8 lt. of fuel

The consumption of CNG under similar conditions would be approximately 8 kg.

In volume terms, the consumption comes out to be 10 Standard Cubic Meter (SCM) per car per day, Therefore, 1 FCU = 10 SCM

The standard measurement for bulk demand for natural gas is Million Metric Standard Cubic Meter per Day (MMSCMD).

4.5.1 Projected demand under various scenarios

» *Very Optimistic Scenario*

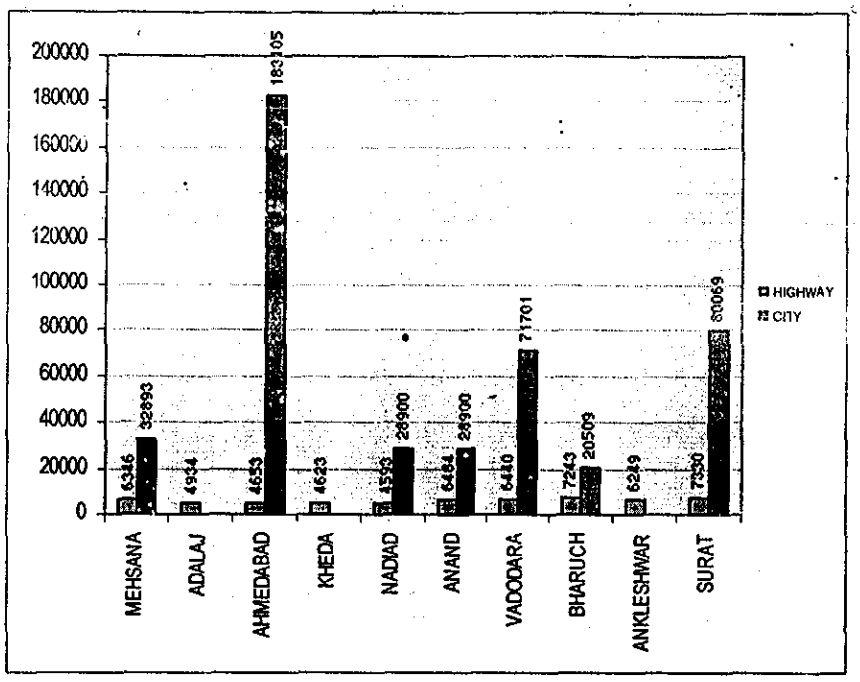


Figure 4-3 CNG Vehicles in Most Optimistic Scenario

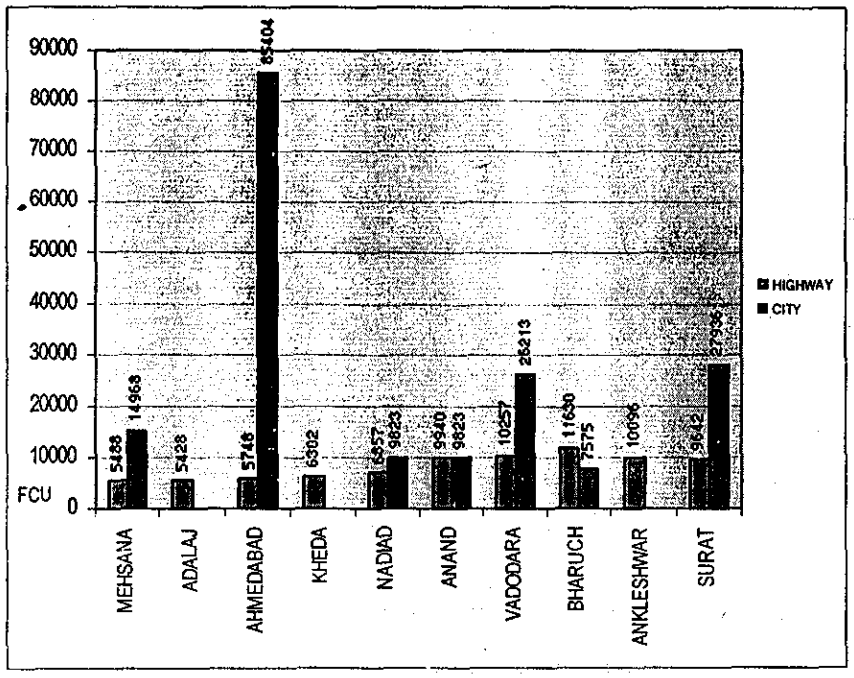


Figure 4-4 CNG Demand under Most Optimistic Scenario

The total number of vehicle units that would be the potential CNG users under this scenario has been shown in the figure above. The same number of vehicle has been converted to the Fuel Car Unit. The methodology for the same has been discussed in the previous section.

Though this scenario is most unexpected, it gives the outer limit to the extent of number of CNG vehicles.

As seen in the figure, the count of vehicle on highways is relatively high on the Anand-Surat stretch and also on Mehsana. It is interesting to note that the demand pattern at Mehsana is not same as the vehicle count curve, this due to high number of cars and jeeps on the Mehsana-Ahmedabad stretch.

The peak demand in this scenario is around 11600 PCU, which is about 116000 SCM per day. Therefore in standard units, the peak demand in this scenario is about 0.11 MMSCMD. Taking all ten locations into consideration, the average demand on the highway is 81390 SCM per day, which is equivalent to 0.08 MMSCMD

For city traffic, Ahmedabad has the highest demand at 854040 SCM which is equivalent to 0.8 MMSCMD. The total demand taking the cities and highway into consideration is at 2.6 MMSCMD.

» *Optimistic Scenario*

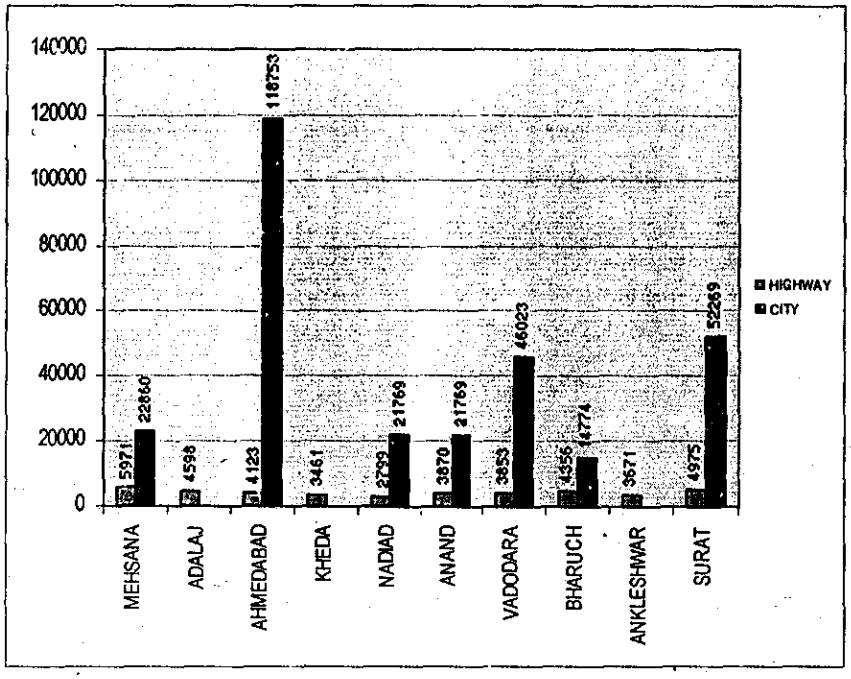


Figure 4-5 CNG Vehicles in Optimistic Scenario

The number of potential CNG vehicles in the optimistic scenario is around 3.4 lacs. Ahmedabad has the highest share with about 1.2 lacs potential vehicles. Other major cities are Vadodara and Surat.

On highway, the Nadiad-Bharuch and Mehsana stretch has relatively higher number of potential CNG vehicles.

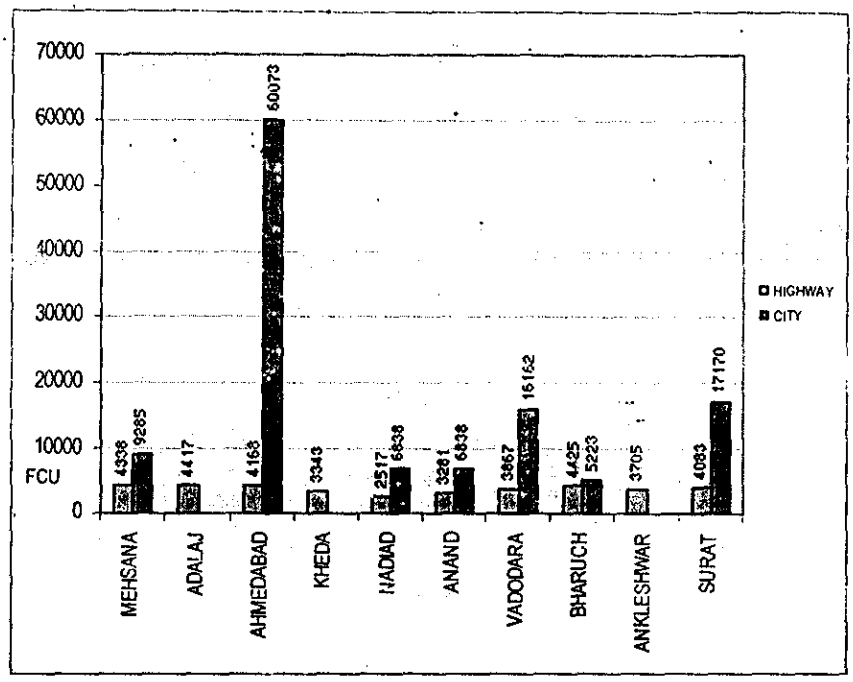


Figure 4-6 CNG Demand under Optimistic Scenario

In the optimistic scenario, the demand for CNG on highway is at an average of 38000 SCM per day per location. The peak demand is at Mehsana-Ahmedabad stretch that is estimated to be about 44000 SCM per day. In cities, Ahmedabad has the highest demand of about 600000 SCM per day that is equivalent to 0.6 MMSCMD. The total demand under this scenario is 1.59 MMSCMD.

» *Moderate Scenario*

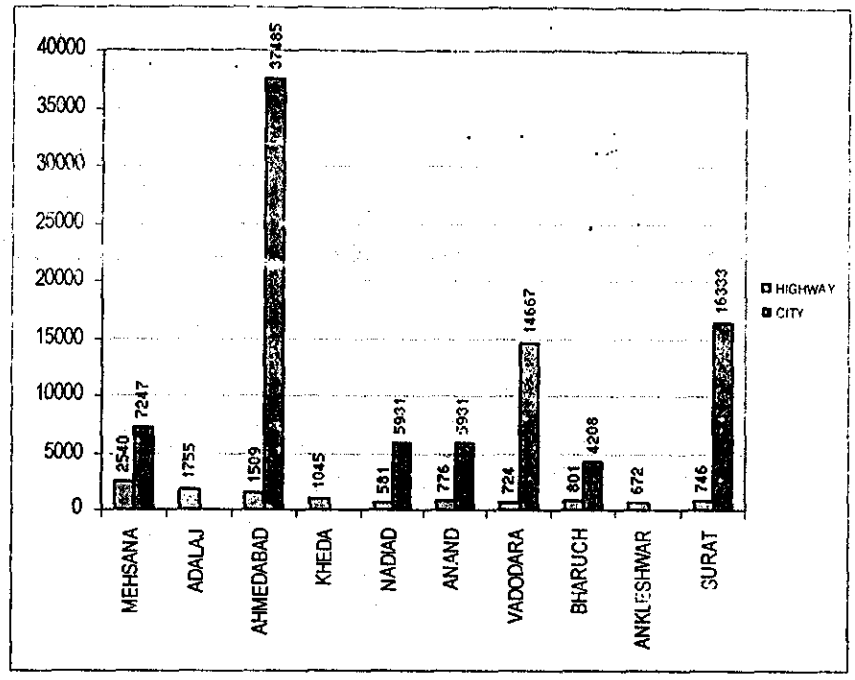


Figure 4-7 CNG Vehicles under Moderate Scenario

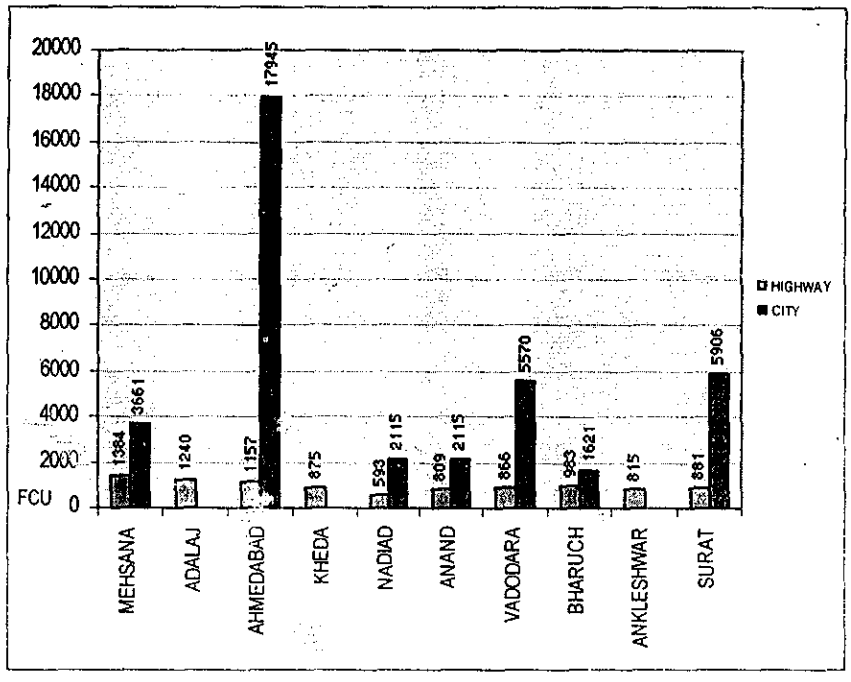


Figure 4-8 CNG Demand under Moderate Scenario

The moderate scenario is the most probabilistic scenario. The demand under the moderate scenario is highest at Highway on Mehsana-Ahmedabad stretch. The average demand on Ahmedabad-Mehsana Stretch is around 12000 SCM per day. The average demand on the Ahmedabad -Surat stretch is just above 8000 SCM

per day. The average demand on highway is around 9600 SCM per day per location.

The total demand in cities is at 389330 SCM per day (0.39 MMSCMD), with Ahmedabad contributing for half of the total demand at around 0.18 MMSCMD.

» *Pessimistic Scenario*

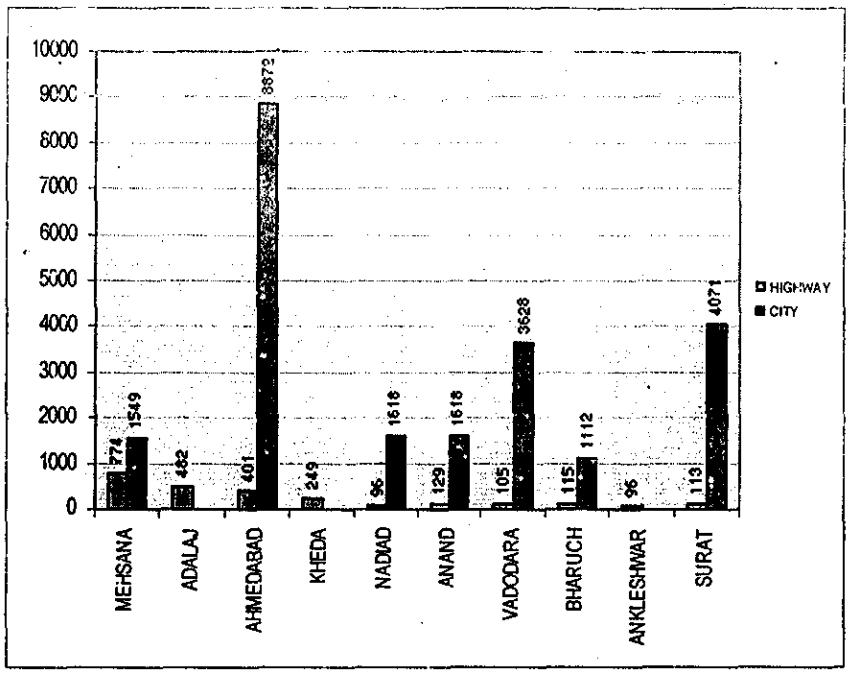


Figure 4-9 CNG Vehicles under Pessimistic Scenario

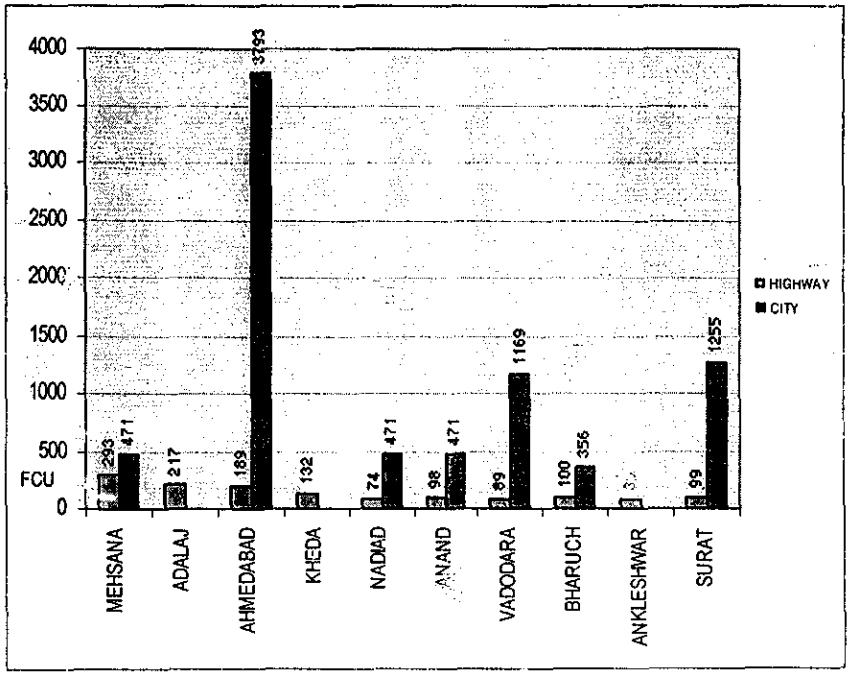


Figure 4-10 CNG Demand under Pessimistic Scenario

In the most pessimistic scenario, the probability of the CNG vehicles is very less, and thus there would be very few number plying on the road. The figures of under the pessimistic scenario suggest the same.

The average demand on the highway is a meager 1370 SCM per day per location. The total demand from highway traffic is thus at 13700 SCM per day. The total demand from City traffic is at 57000 SCM per day.

4.5.2 Concentrated traffic volume of large industries

To compliment the primary survey data of traffic count, TCS also carried out extensive study on identifying other factors directly related to traffic. Till the compilation of this report, the following information has been collected.

» *Industrial Estates on Mehsana-Surat Stretch*

Mehsana	
	• Chatraal • Kalol • Kadi
Ahmedabad	
	• Naroda • Vatva • Sanand • Changodhar • Santej • Aslali • Narol • Rakhial
Vadodara	
	• Vasad • Vagodia • Chaani • Savli
Bharuch	
	• Dahej
Ankleshwar	
	• Ankleshwar • Palej • Panoli
Surat	
	• Kosamba • Kim • Pandesara • Hazira

» *Private vehicles at various locations*

#.	Location	Type	No.
1	Mehsana-Ahmedabad	Private Company Travel Buses, Jeeps / mini buses	558
3	Ahmedabad-Patan	Private Vehicles (jeep, mini-bus etc.)	102
4	Ahmedabad-Surat	Private Company Travel Buses, Jeeps / mini buses	1514

The above information has been collected from various transport operators and from large organizations having operations in these cities and or highway. The detailed information is shown in the annex: company vehicle data.

» *Private Tourist Buses*

Location	No. of Buses
Ahmedabad-Surat	134

TCS contacted various Tourist operators that operate number of buses on the Mehsana-Surat highway. Each transport operator wise vehicle data was collected and compiled.

4.5.3 Government Sector

» *State Transport Buses*

Location	No. of Buses
Mehsana-Ahmedabad-Surat Route	28
Within 100 km Mehsana-Surat Route	148
TOTAL	176

The following information has been compiled on the basis of the timetable available from GSRTC.

4.6 EXISTING FUEL SALES

To augment the current analysis, TCS has also collected the data on fuel sales in the region. The data has been collected for all the petrol pumps on the Surat-Mehsana highway.

» *Fuel sales for State Transport Buses*

The state-run buses under Gujarat State Road Transport Corporation (GSRTC) manage their fuel supplies at specific depots. The figures for the same are as follows:

Depot	Monthly Consumption In Litres*	Daily Consumption In Litres*
Ahmedabad	283045	9435
Chandola	123125	4104
Kalol	95231	3175
Vadodara	171203	5707
Bharuch	146428	4881
Ankleshwar	147530	4918
Surat	254224	8474

*During Jun-Aug'02

4.7 FACTORS AFFECTING THE DEMAND PROJECTIONS

There are various factors that could affect the CNG demand from the transport sector. The effect of the some of these factors cannot be quantified and thus these have to be considered when the implementation ofJun-Aug'02 the project is about to begin. **During the setup of the infrastructure, the mid-term corrective actions could also be taken based on the actual development and the conditions.**

The following sub-section describes some important factors that could affect the demand projections and in turn the recommended location too.

4.7.1 Government and Judiciary Intervention

The Supreme Court of India has passed an order to convert all buses, autos and cars operating in Delhi to use CNG only. Delhi government is implementing this order in full effect and making sure that all transport vehicles in the national capital use CNG only for reducing pollution level of Delhi.

Now, if the Gujarat High Court passes a similar order, by *Suo Motto* or based on PIL by some citizen/ citizen groups/ NGO, CNG demand in Gujarat will increase tremendously. Gujarat has very high number of NGOs working for social cause, religious bodies involved in welfare of citizens, noted citizens associated with philanthropic activities and persons associated with eminent educational institutions, in such scenario, raising environment issues could be expected. Considering the reported increased pollution in chemical zones of the country, from Mehsana to Vapi, such PIL may be anticipated. Even judiciary has become active in the matters related public concern in last decade and thus decisions favoring CNG could be given.

Same way, if Government by its own will or under pressure from judiciary or citizens, enacts a law asking commercial vehicles operating in the golden corridor from Mehsana to Vapi to use CNG only for reducing pollution, it will also result in high CNG demand.

4.7.2 Development of Expressways / Other Highways

Ahmedabad-Baroda expressway is under construction and may come up in near future. It may reduce the traffic on National Highway 8 between Ahmedabad-Baroda in great extent. Vehicles passing on new expressway may not be able to refill from the proposed CNG stations on NH 8. So new CNG stations may be required on this expressway.

Similarly, if highway connecting Jambusar to Tarapore is laid, it will affect in great way the Saurashtra bound traffic from south of Surat, which currently uses NH 8.

The new Ring road coming up around Ahmedabad will also affect traffic towards Saurashtra and north Gujarat as well as GIDCs surrounding Ahmedabad.

All such new and proposed roads may force change in locations of CNG station or opening of new CNG station. The reason being that if CNG station would not be available on new roads, vehicle owners may not shift to CNG.

4.7.3 Pricing of CNG and other Fuels

With the dismantling of APM, fuel prices in India are now directly dependent on the global market prices. So fluctuations in international prices of petrol /diesel due to various reasons will affect the fuel prices in India. CNG's price may not be affected so much due to international events as that of petrol /diesel and this factor may work in favour of people opting for CNG based vehicles.

However, the relative pricing of CNG with other fuels like diesel and petrol would have a bearing on its usage. The economic benefit with the use of CNG should justify the initial expenses for conversion.

4.7.4 Presence of CNG Stations

Only a few cities namely Surat, Ankleshwar and Baroda are having CNG stations in Gujarat currently. While developing new CNG stations in these cities, care would have to be taken to ensure that both new and old CNG stations get enough business.

Otherwise competition among themselves in small segment would prove disaster for both.

Same way, when new expressway/highway/roads come up, location of new CNG stations have to take into effect, the location of existing CNG stations at that time.

4.7.5 Technical Issues with CNG Conversion

Conversion of existing diesel/petrol vehicles on CNG vehicles involve very high cost and also not much technical capability currently exists in India to convert large number of vehicles at a time. This was the reason for the chaos during initial days of CNG implementation in Delhi as very few buses and transport vehicles were able to convert into CNG.

Serious thought would have to be given for conversion of vehicles to CNG. Government will have to support the conversion cost in one way or another to encourage small private auto and taxi owners to convert their vehicles into CNG. Government can spend this amount in same way as it spends for various social causes like health, sanitation, education etc., as it will result in decrease of pollution, which will have direct effect on public health and environment.

Government may also encourage private entrepreneurs to increase capability of CNG conversion by giving them various incentives on tax, excise and providing them with subsidies.

4.7.6 Emission Norms

The Government of India is now very stringent on emission norms after Supreme Court order on the same. In the case of Delhi, the courts ordered the methodology of achieving the low pollution by making compulsory switching to CNG. The same objective could also be met by having the emissions modified or implemented strictly without enforcing the technology. In such a scenario, the vehicle manufacturers could use technology that provides for less polluting vehicles instead of going for CNG vehicles.

CNG vehicles' manufactures would have to make sure that they adhere to latest international emission norms like Euro- II etc.

5 DEMAND PROJECTIONS

5.1 DEMAND PROJECTION METHODOLOGY

Since the CNG stations would be setup over a period, the demand projection plays an important role in determining the future requirements. As discussed in the previous section, many factors could affect the demand estimation and projections.

5.1.1 Factors for Demand Projections

Some of the factors that affect the transportation activities are as follows:

» *Population growth*

With the growth in population, the passenger-trips would definitely grow. The population growth rate for Gujarat is expected to be 1.4% p.a. from 2002 to 2010 as against growth of 1% p.a. from 1981-1991.

» *Urban Population*

The urban population for the various traffic zones has been projected to grow exponentially. The urban population for Gujarat is expected to grow at a rate of 2.8% p.a. from 2002 to 2010, and to go up to 46% of the total population by year 2010 as against 40% in 2001.

Past studies conducted by TCS reveal that the districts of Gandhinagar, Surat, Vadodara and Valsad are expected to have a higher growth in the urban population than the state average. It is expected that Ahmedabad followed by Surat would be the most urbanized district in the state with close to 90% population being urbanized.

» *Agricultural Production*

The agricultural production for Gujarat has been projected to grow in line with the Production targets under Tenth Five Year Plan. Growth rate for total agricultural production after the year 2002 has been estimated to be around 4.75% p.a.

» *Industrial production*

Number of factories in the state are expected to grow at a rate of 12% p.a. Double-digit growth rate in industrial production has been projected for few districts like Kheda Bhavnagar, Jamnagar and Kutch. The expected growth rate of industrialisation in Gujarat is around 8.4% p.a.

» *Net State Domestic Product (NSDP)*

NSDP is the value of goods and services produced in the state economy in the given year. It is an indicator of the health of the state economy. The growth in NSDP depends on the growth in various sectors of the economy. NSDP consists of production from three sectors, namely Primary consisting of agriculture, Secondary consisting of manufacturing sector and Tertiary consisting of service sector which includes trade, hotels and restaurant, transport, storage and communication, banking and insurance, real estate, ownership of dwellings and business services, public administration and other services.

Based on the forecasts of future growth in NSDP and the share between various sectors, projections can be made for production in agriculture and industrial sectors.

The growth rate in NSDP during 1991-96 was observed to be 4.5 percent per annum. During 1996-2001, this rate climbed up to 5.5 percent per annum.

This rate is expected to be around 6% p.a. during the next decade. Ministry of Finance has projected a growth of 7% p.a. for the same period. However, going by the experience of lower growth, a realistic growth rate of 6% has been assumed.

All of the above mentioned factors directly or indirectly affect the State domestic product. Therefore, the factor that has been considered for demand projection is State Domestic Product. Another factor that is also very important is the trend in Vehicle Registration.

» *RTO Registration details*

Another important figure that has direct correlation with the traffic count is the registration of vehicles. The highest growth rate is observed in the motor vehicle segment of cars. The growth for total registrations in Gujarat is around 9 percent per annum. For the cities that are located on Surat-Mehsana stretch, the growth rate is 8% p.a. The following table shows the registration details for the same district RTO viz. Mehsana, Ahmedabad, Nadiad, Vadodara, Bharuch, Surat.

Table 5-1 Demand Projection Factor: RTO Registrations

	1996	1997	1998	1999	2000	GROWTH RATES
AUTO	111541	124447	137352	152337	164111	8%
JEEP	36294	41118	45941	49982	53900	8%
CAR	182154	207608	233062	255381	290471	10%
TAXI	15016	15791	16566	17305	17465	3%
BUS	25217	27022	28827	30719	34231	6%
ALL	2198653	2435615	2672576	2936634	3229786	8%
GUJARAT	3377798	3790636	4203473	4679793	5190732	9%
YoY %		12.2%	10.9%	11.3%	10.9%	

5.1.2 Demand Projections

Based on the above analysis, the projected NSDP growth rate is around 6% and the vehicle-registration growth rate is around 8%. The trends in the developed countries shows that the high growth rates are generally not be sustained. therefore, the growth rate has been divided into two phases. During the period 2002-2005, the growth that has been assumed to be is 8% p.a. During the period 2005-2010, a lower growth rate has been assumed at 6% p.a.

The demand projections are based on data under "Moderate" scenario.

Table 5-2 Base Data of Year 2002 for Projection

	Base Year 2002			
	Count in nos.		Demand in SCM per Day	
Location	Highway	City	Highway	City
MEHSANA	2540	7247	13837	36615
ADALAJ	1755		12396	
AHMEDABAD	1509	37485	11571	179445

	Base Year		2002	
	Count in nos.		Demand in SCM per Day	
Location	Highway	City	Highway	City
KHEDA	1045		8751	
NADIAD	581	5931	5932	21152
ANAND	776	5931	8086	21152
VADODARA	724	14667	8656	55696
BHARUCH	801	4208	9832	16208
ANKLESHWAR	672		8148	
SURAT	746	16333	8812	59061
TOTAL	**11149**	**91802**	**96021**	**389329**

The above table shows the basic data on which the demand has been projected.

The following table shows the volume count and demand projections for year 2005.

Table 5-3 Projections for Year 2005

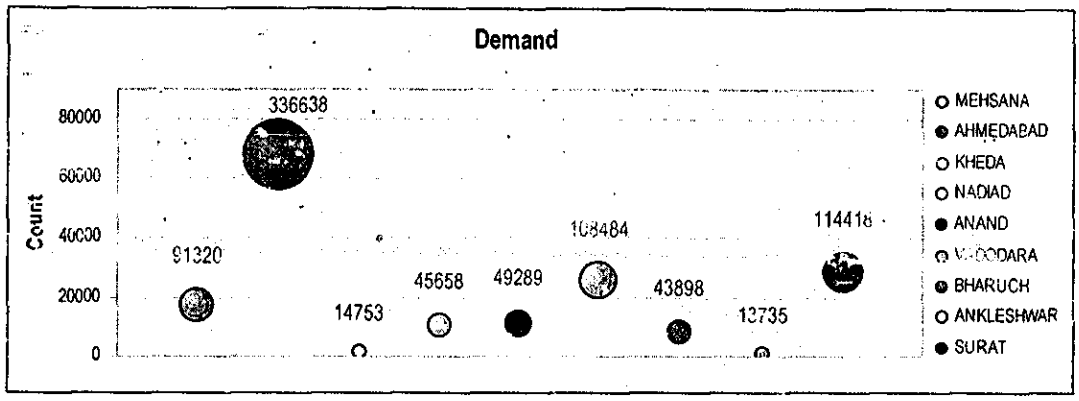
CAGR: 8%	Projections		2005	
	Count in nos.		Demand in SCM per Day	
Location	Highway	City	Highway	City
MEHSANA	3200	9129	17431	46124
ADALAJ	2211		15615	
AHMEDABAD	1901	47220	14576	226049
KHEDA	1316		11024	
NADIAD	732	7471	7473	26645
ANAND	977	7471	10186	26645
VADODARA	912	18477	10905	70161
BHARUCH	1008	5300	12386	20417
ANKLESHWAR	846		10264	
SURAT	940	20574	11100	74400
TOTAL	**14043**	**115642**	**120960**	**490441**

The following table shows the volume count and demand projections for year 2010.

Table 5-4 Projections for Year 2010

CAGR: 6%	Projections		2010	
	Count in nos.		Demand in SCM per Day	
Location	Highway	City	Highway	City
MEHSANA	4282	12216	23327	61725
ADALAJ	2959		20897	
AHMEDABAD	2544	63191	19505	302505
KHEDA	1762		14753	
NADIAD	979	9998	10000	35657
ANAND	1308	9998	13631	35657
VADODARA	1221	24726	14593	93891
BHARUCH	1350	7093	16575	27323
ANKLESHWAR	1132		13735	
SURAT	1258	27533	14854	99563
TOTAL	**18795**	**154755**	**161870**	**656321**

5.2 POTENTIAL SERVICE ZONES



The figure shows the projected number of vehicles in the year 2010 for each location. This includes the city and highway vehicles. The circular area represents the demand (number on top of circle) in SCM per day at each location.

Based on the above, the locations can be divided into three categories as follows:

Demand	Area	Classification of Market
Greater than 300k SCM / Day	Ahmedabad	Large
Between 100k-300k SCM / Day	Mehsana Vadodara Surat	Medium
Between 10k to 100k SCM / Day	Kheda Nadiad Anand Bharuch Ankleshwar	Small

6 CNG STATION CONFIGURATION AND COSTING

The configuration and costing for the CNG stations in Gujarat for GSPC is based on discussions with few leading vendors of compressors and CNG stations. Configuration for similar type of station could be standardized i.e. all mother stations would have the same configuration and all daughter station would have a similar configuration.

The major factors that affect the configuration are:

- Number of vehicles for refueling
- Time period in which the refueling is to be done
- Price of gas vis-à-vis electricity price for operating the compressor
- Inlet and Outlet pressure for compressor design
- Number of daughter stations under a mother station

The configurations are on the basis of discussions with vendors, and the experience of CNG stations at other places in the country.

6.1 CONFIGURATION OF DAUGHTER STATIONS

A daughter station can refill around 60 cars from its own storage reservoir and the process is relatively slow (unless provided with a compressor for dispensing at high flow rates).

The following is the configuration of the daughter station

1. Storage Cascade: 80 cylinders Three Bank cascade
2. Flow rate around 200 SCM per Hour

The daughter station would be refilled twice a day and thus would cater to the demand of 120 vehicles per day.

6.2 CONFIGURATION OF MOTHER STATIONS

The mother station would be required to meet the demand from the vehicles as well as the daughter stations.

As the volume of vehicles is quite high, plenty of CNG stations with normal capacity would be expensive compared to lesser number of high capacity stations. It has been assumed that one station would refill around 800 vehicles per day.

Table 6-1 Mother Station Configuration Parameters

Capacity		800	Vehicles per day
		10	Daughter fills per day
Demand		14	SCM per vehicle
		800	SCM per daughter station
	Total	**17600**	**SCM per Day**
Compressor Configuration			
	Working	20	Hours per day
	Flow Rate	880	SCM per hour

Since the daughter station would have to travel to the mother station for refilling, the geographical distribution of mother station is also an important aspect. Therefore, all the online stations could be configured as mother station thus creating a well managed supply chain.

The capacity of mother station thus takes into account five daughter stations refilling twice a day.

Therefore the indicative configuration for the Online / Mother Station is as follows:

1. Natural Gas Compressor, Maximum Flow Rate 1000 SCM / Hour, with Remote Mounted Electrical Control and Gas Recover System
2. Three Bank Two Line Priority Panels
3. Storage Cascade, 80 cylinders Three Bank cascade
4. High Flow, Dual Hose, Two Line Sequencing Dispensers

These configurations could easily be changed without changing the overall output. For example, if two stations in a zone are installed with 'X' capacity, an alternative could work with four stations of '0.5X' capacity.

The costing for the stations is given in the following sections

6.3 COSTING FOR A DAUGHTER STATION

Components	Unit	Unit Cost Rs. '000	Required	Sub Total Rs. '000	Amount Rs. '000
DAUGHTER STATION					**3650**
Truck	Km	900	1	900	
Cylinders	No.	20	80	1600	
Dispensing mechanism	No.	300	2	600	
Land and other Infrastructure	Mt.	3	150	450	
Civil works and Safety equipment	-			100	
				TOTAL	**3650**
				TOTAL INVESTMENT IN RS. LACS	**37**

Note: Indicative Price as of August 2002, subject to negotiation

The daughter station does not require much infrastructure. The existing petrol pumps and other facilities could be used for setting up the required infrastructure. Thus, the land price has been taken at lesser value in comparision to the market price.

6.4 COSTING OF A MOTHER STATION

Components	Unit	Unit Cost Rs. '000	Required	Sub Total Rs. '000	Amount Rs. '000
LAND					**5250**
Land with at least 20 mt. front opening	Sq. mt.	7	750	4500	
BUILDING – CIVIL WORKS					**4025**
Office, control room, compressor and cylinder storage room, shed and toilet/washroom	Sq. mt.	7	500	3500	

Components	Unit	Unit Cost Rs. '000	Required	Sub Total Rs. '000	Amount Rs. '000
Underground Gas Piping	-			250	
Flooring	Sq. mt.	0.5	550	275	
CNG EQUIPMENT					**27900**
Natural Gas Compressor	No.	22000	1	22000	
Remote Mounted Electrical Control	-		Included		
Gas Recover System	-		Included		
Three bank Two Line Priority Panel for buffer direct vehicle fill	No.	150	2	300	
Dispensers (High flow dual hose two line sequencing)	No.	2000	2	4000	
Cylinders	No.	20	80	1600	
Inspection, Testing	-			50	
STORES AND SPARES					**200**
Stock of necessary parts	-			200	
OFFICE EQUIPMENT					**150**
Fax, Computer, Printers, Cabinets, Billing System, Etc.				150	
FURNITURE & FIXTURES					**150**
Table, Chairs, Electrical Accessories,	-			50	
Fire Extinguishers, Safety devices, equipments				100	
PRELIMINARY EXPENSES				0	**700**
Gas Connection and Installation	-			200	
Electricity Connection Charges (11 KV Power Supply)				250	
Licenses, Registration etc.	-			150	
Other approvals				100	
OTHERS					**1695**
Engineering costs (Approx 5% of CNG equipment)	-			1395	
Working capital and Contingency	-			300	
				TOTAL	**40070**
				TOTAL INVESTMENT IN RS. LACS	**401**

Note: Indicative Price as of August 2002, subject to negotiation

The above table shows the various cost elements involved in setting up a CNG station.

» *Land*

A minimum of 750 sq. mt. of land with at least 20 mt. front opening is required for installing CNG filling station. On an average, an amount of Rs. 52.5 lacs would be required for the acquisition of 750 sq. mt. of commercial land. The prices would vary according to the location and this is an average cost taken for calculation purposes. On highways, the land is generally cheaper and a larger plot could be purchased. The subsequent section on location identification represents the comparison of costs of commercial land at selected locations.

» *Building*

There are certain civil works required to be carried out at the proposed location. The civil works would be carried out on an area of 250 sq. mt. The rest of the area will be floored with tiles. Civil work includes the following:

- Office
- Control Room
- Compressor and Cascade/Cylinder Storage Room
- Shed for Dispenser
- Toilet/washroom
- Underground Gas Piping
- Flooring

» *Material Inputs*

There are two main inputs required for the CNG filling station, one is the natural gas and the other is electricity. The filling station would need to obtain both the connections. The cost associated with obtaining the gas connection has been considered as Rs. 2 lacs. An amount of Rs. 2.5 lacs is required for obtaining electricity connection.

» *CNG Equipment*

The following equipment is required for a CNG filling station:

- Gas Compressor
- Electric Control Panel
- Storage Cascade
- Priority Panel for Vehicle Priority
- CNG Dispenser high flow dual hose

Gas is filled into the vehicles with the help of dispenser. This dual hose dispenser is capable of handling two vehicles at a time. There are various foreign manufacturers providing the CNG filling station equipment.

» *Stores & Spares*

The whole equipment required for setting up a CNG filling station is imported. Therefore, it is required to build an inventory of necessary spare parts to meet the unforeseen circumstances such as breakdown or any other fault in any part or equipment. For this purpose, a stock of necessary spare parts worth $8,000 will be imported along with other equipment to maintain a minimum level of spare parts.

» *Furniture and Fixtures*

Furniture and fixtures mainly include tables, chairs, sofas, fans & lights, carpet, curtains and fire extinguishers. It is estimated that the furniture and fixtures of Rs. 1.5 lacs would be purchased.

» *Office Equipment*

Some office equipment is also required for the proposed project. A provision of Rs. 1.5 lacs has been made for acquiring the required office equipment.

» *Manpower Requirement*

Manpower is not a part of the fixed cost. However, manpower requirement for the CNG filling station includes manager, cashier, dispenser, operators, accountant, watchman and sweeper. The total staff strength would be 13 persons for the two shifts. The annual cost for the manpower would be approximately Rs. 8 lacs.

6.5 CNG STATIONS REQUIREMENTS

The requirement for number of CNG station is based on the projected demand (as shown in the previous chapter) and the configuration of the typical mother station and daughter station.

The projections for demand and count have been further refined. The demand for areas of Adalaj have been merged into the demand of Mehsana and Ahmedabad in a ratio of 30% and 70% respectively. Similarly, for Kheda the demand has been distributed to Ahmedabad and Nadiad in a ratio of 30% and 70% respectively.

The refined demand projections are as follows:

Table 6-2 Refined Demand Projections

	Refined Projections					
	Count in nos.		Demand in Sm3 per Day		Total	
Location	Highway	City	Highway	City	Count	Demand
Mehsana	5170	12216	29596	61725	17386	
Ahmedabad	6247	63191	46631	302505	69438	
Nadiad	2817	9998	22699	35657	12815	
Anand	3196	9998	25375	35657	13194	
Vadodara	2140	24726	18091	93891	26866	
Bharuch	2571	7093	22865	27323	9665	
Ankleshwar	2063		20212		2063	
Surat	3319	27533	20392	99563	30853	
				TOTAL	182280	

The working calculation for the arriving at the numbers is given in the annex: CNG station configuration. The number of CNG stations required, based on the above demand is as follows:

Table 6-3 CNG Supply Chain Requirements

DISTRICT	ONLINE STATIONS	DAUGHTER STATIONS
Mehsana	4	22
Ahmedabad	17	80
Kheda	3	16
Anand	3	17
Vadodara	7	28
Bharuch	2	20
Surat	8	32
TOTAL	44	215

The best way to justify the distribution of these stations is to compare with the existing fuel sales data. The fuel sale of petrol and diesel of the fuel stations on the highway has been taken and the weighted distribution of the same is represented in

the following table. Similarly, the percentage distribution for the proposed configuration is also represented in the table

Table 6-4 Existing Supply Chain vis-à-vis Proposed Supply Chain

PERCENTAGE DISTRIBUTION	AHMEDABAD	ANAND	BHARUCH	KHEDA	MEHSANA	SURAT	VADODARA	TOTAL
EXISITNG FUEL SALE	13%	12%	20%	15%	6%	18%	16%	100%
PROPOSED CNG SUPPLY CHAIN	20%	15%	14%	11%	18%	12%	11%	100%

The difference in the distribution is in the range of 3-7 percentage points except for Mehsana. These differences are marginal and justify the proposed distribution network. The difference of 12 percentage points at Mehsana seems relatively high. This could be attributed to the huge number of vehicles (potential CNG vehicles) that ply between Mehsana and Ahmedabad.

6.6 OVERALL COSTING

The overall costing of the infrastructure would include the costing for the daughter stations, mother stations and transmission pipeline costs etc.

The table below summarizes the overall costing:

Table 6-5 Overall Cost for Setting up Chain of CNG Stations

	Costing Element	No.	Cost in Rs. lacs	Total cost in Rs. lacs
1.	Online Mother Stations	44	401	17644
2.	Daughter Stations	215	37	7955
3.	Transmission Pipeline (in Km)	170	50	8500
	Total	259 ~~429~~	488	34099

Note: Indicative Price as of August 2002, subject to negotiation

6.7 CONCLUSION

It may be noted, that there could be 10% variation with the projected figures. The number of CNG stations required are in the range of 40 to 50 and the daughter station would be required within the range of 200 to 230.

The total cost for setting up the chain of CNG stations would be between Rs. 310 crores to Rs. 370 crores approximately.

7 SELECTION OF LOCATION

Selection of an appropriate locations for setting up CNG stations is a critical task. The supply chain management for the whole infrastructure would be in disarray if proper care is not taken while selecting the locations.

7.1 SERVICE ZONES

The service zones were identified based on the

- Traffic Density of Zones
- Magnets and Generators of Traffic
- Location of major industrial estates
- Commercial centers
- Initial reconnaissance survey conducted by TCS on Surat- Mehsana highway etc.

The potential service zones that were identified initially are as follows:

- MEHSANA
  - Mehsana city
  - Chhatraal / Kalol
- AHMEDABAD
  - Ahmedabad city
  - Naroda
  - Sanand
  - Vatva
  - Sarkhej
- GANDHINAGAR
  - Gandhinagar
- KHEDA
  - Nadiad
  - Nadiad highway
- ANAND
  - Anand City
  - Anand highway
- VADODARA
  - Vadodara city
  - Highway
- BHARUCH
  - Bharuch city
  - Ankleshwar / Highway
- SURAT
  - Surat City
  - Kamrej

7.2 LOCATION IDENTIFICATION METHODOLOGY

The major factors considered for identification of location of setting up of CNG stations are:

7.2.1 Traffic Nodes

Nearness to the traffic nodes is an important criterion. Location of station on an arm leading to the node with sufficient distance from the node would make the station more viable and will cater to the demand for the same.

7.2.2 Traffic Volume

The traffic volume helps in deciding the concentration and location of CNG stations.

7.2.3 Existing Trip Pattern

Existing Trip Pattern in terms of the major magnets and generators, major origin and destination of trips gives clue regarding the network arms where the station should be located.

7.2.4 Existing Fuel Sales

The existing fuel sales in the fuel pumps on the highway gives a picture of the existing demand and consumption pattern (though micro locational factors also contribute to the same).

7.2.5 Projected Demand

The projected demand would help in identifying the no of locations in zones, the concentration of the same and the location of stations.

7.2.6 Locational Advantage

The locational advantage was a decisive factor in selecting the finalized locations out of the probable ones.

However, the intensity of usage of the CNG station will also depend on exact plot location of the station in the region identified as micro factors like traffic congestion for entry, lack of space for queuing etc affect the usage. Hence, care needs to be taken on identification of the plot for the same.

7.3 FINALIZED LOCATIONS

7.3.1 Recommended locations

The recommended locations for setting up CNG stations are mentioned in the table below. Alternative location for areas where it could be difficult to procure land, has been mentioned. The alternative location is not required for areas where there is a long stretch at which the CNG station could be setup.

DISTRICT	LOCATION	ALTERNATIVE
MEHSANA	1) ON HIGHWAY, KALOL	-
	2) MEHSANA-GOJARIA CROSSROADS	-
	3) NEAR PATAN CROSS ROADS	-
	4) NANDASAN CROSS ROADS	-
AHMEDABAD	1) ON HIGHWAY, ADALAJ, NEAR NH 8C INTERSECTION	-

DISTRICT	LOCATION	ALTERNATIVE
	2) ON HIGHWAY, GOLA	-
	3) ON HIGHWAY, SATELLITE	-
	4) ON HIGHWAY, SARKHEJ	-
	5) 132' RING ROAD, NARANPURA	RING ROAD, MEMNAGAR
	6) NEAR CTM	GHODASAR
	7) ON HIGHWAY, NAROL	-
	8) JASODA CROSS ROADS, NEAR EXPRESSWAY	-
	9) ON HIGHWAY, NARODA	-
	10) ON HIGHWAY, ODHAV	-
	11) NEAR PALDI BUS STAND	PALDI, ASHRAM ROAD
	12) SABARMATI, NEAR GANDHINAGAR CROSSROADS	SABARMATI
	13) NEAR WADAJ BUS STAND	WADAJ, ASHRAM ROAD
	14) NEAR NEW CLOTH MARKET	JAMALPUR / RAIPUR
	15) RELIEF ROAD (TOWARDS LAL DARWAJA)	LAL DARWAJA
	16) KALUPUR (TO NARODA) AFTER OVERBRIDGE	ON SHYAMPRASADA VASAVADA ROAD
	17) SARDARNAGAR CROSSROADS (FROM INDIRA BRIDGE)	NEAR SARDARNAGAR, ON PROPOSED RING ROAD
KHEDA	1) KHEDA CROSSROADS	ON HIGHWAY, KHEDA
	2) DABHAN CROSSROADS, NADIAD	ON HIGHWAY, KHEDA
	3) NADIAD CITY, NEAR SANTRAM TEMPLE (MANDIR)	-
ANAND	1) ANAND CROSSROADS	ON HIGHWAY, ANAND
	2) ANAND CITY, NEAR RAILWAY STATION / BUS STAND	-
	3) NEAR EXPRESSWAY ENTRY/EXIT FOR ANAND	VASAD
VADODARA	1) NEAR CHAANI, OCTROI POINT	-
	2) OLD PADRA ROAD	-
	3) KARJAN CROSSROADS	ON HIGHWAY, KARJAN
	4) MAKARPURA	NEAR BYPASS
	5) NEAR RAILWAY STATION	-
	6) SURSAGAR	-
	7) MAIN ROAD, GORWA	-
BHARUCH	1) ON HIGHWAY, NEAR NARMADA BRIDGE	-
	2) ON HIGHWAY, ANKLESHWAR	-
SURAT	1) RING ROAD CROSSROAD, KHATODARA	SACHIN
	2) ON HIGHWAY, NEAR OCTROI POINT, KAMREJ	-
	3) MANGATE CHOWK, VARACHA ROAD	NAVAGAM
	4) OPP. APMC, BARDOLI ROAD	NEAR FLYOVER
	5) OPP COLLECTOR OFFICE, GHODDOD ROAD	ATHVA GATE
	6) MAIN ROAD HAZIRA	HAZIRA
	7) ADAJAN PATIA, HOP POOL	-
	8) NEAR VARIVAI GATE CROSSROADS	ON TOWER ROAD (TOWARDS BRIDGE)

At some places in the following table, the locations are mentioned as 'on highway' followed by the area. This means that the station could be setup in the area anywhere on the highway.

7.3.2 Approximate land price for the suggested locations

The following table shows the information about the site in terms of the distance from transmission pipeline, and prevailing land prices (indicative). The distance for places within short distances of the GAS GRID has been taken as 2 Km. Actual plot identification would only give the exact distance.

DISTRICT	LOCATION	LAND PRICE RS. / SQ. MT.	DISTRIBUTION PIPELINE LENGTH in KM*
MEHSANA	1) ON HIGHWAY, KALOL	1200	2
	2) MEHSANA-GOJARIA CROSSROADS	1500	2
	3) NEAR PATAN CROSS ROADS	5000	3
	4) NANDASAN CROSS ROADS	2500	2

DISTRICT	LOCATION	LAND PRICE RS. / SQ. MT.	DISTRIBUTION PIPELINE LENGTH in KM*
AHMEDABAD	1) ON HIGHWAY, ADALAJ, NEAR NH 8C INTERSECTION	2800	5
	2) ON HIGHWAY, SOLA	5000	15
	3) ON HIGHWAY, SATELLITE	7000	
	4) ON HIGHWAY, SARKHEJ	4500	
	5) 132' RING ROAD, NARANPURA	6000	
	6) NEAR WADAJ BUS STAND	10000	
	7) NEAR PALDI BUS STAND	12000	
	8) NEAR CTM	5400	35
	9) ON HIGHWAY, NAROL	4800	
	10) JASODA CROSS ROADS, NEAR EXPRESSWAY	6500	
	11) ON HIGHWAY, NARODA	4800	
	12) ON HIGHWAY, ODHAV	4800	
	13) NEAR NEW CLOTH MARKET	16000	6
	14) RELIEF ROAD (TOWARDS LAL DARWAJA)	18000	
	15) KALUPUR (TO NARODA) AFTER OVERBRIDGE	15000	
	16) SARDARNAGAR CROSSROADS (FROM INDIRA BRIDGE)	3000	2
	17) SABARMATI, NEAR GANDHINAGAR CROSSROADS	6000	3
KHEDA	1) KHEDA CROSSROADS	3000	7
	2) DABHAN CROSSROADS, NADIAD	3200	3
	3) NADIAD CITY, NEAR SANTRAM TEMPLE (MANDIR)	8500	3
ANAND	1) ANAND CROSSROADS	4000	8
	2) ANAND CITY, NEAR RAILWAY STATION / BUS STAND	8500	
	3) NEAR EXPRESSWAY ENTRY/EXIT FOR ANAND CITY	2500	5
VADODARA	1) NEAR CHAANI, OCTROI POINT	2000	24
	2) OLD PADRA ROAD	5000	
	3) KARJAN CROSSROADS	750	
	4) MAKARPURA	1700	
	5) NEAR RAILWAY STATION	12000	
	6) SURSAGAR	13000	
	7) MAIN ROAD, GORWA	4000	
BHARUCH	1) ON HIGHWAY, NEAR NARMADA BRIDGE	2500	10
	2) ON HIGHWAY, ANKLESHWAR	2500	16
SURAT	1) RING-ROAD CROSSROAD, KHATODARA	12000	31
	2) ON HIGHWAY, NEAR OCTROI POINT, KAMREJ	12000	
	3) MANGATE CHOWK, VARACHA ROAD	18000	
	4) OPP. APMC, BARDOLI ROAD	30000	
	5) OPP COLLECTOR OFFICE, GHODDOD ROAD	24000	
	6) MAIN ROAD HAZIRA	2500	
	7) ADAJAN PATIA, HOP POOL	7000	
	8) NEAR VARIVAI GATE CROSSROADS	8500	

Note: Indicative Price as of August 2002, subject to negotiation

In addition to the above, the location could include the ST Bus depots where the transport corporation may provide the land. However, this scenario would arise only if CNG is made compulsory for public transport vehicles or these transport service organizations agree to ply part of their fleet on CNG.

8 THE ROAD AHEAD

The consideration of the "moderate scenario" leads one to conclude that the number of CNG stations required are within the range of 40-50 for the locations on Surat-Mehsana highway. Apart from these, the projection also leads to the requirement of Daughter station in the range of 180 to 220.

This study is based on current environmental factors. It may happen that the real situation differs significantly from the projections in this report. GSPC must keep itself prepared for any eventuality that can lead to projections going haywire. In addition to being prepared for the contingency, GSPC would also have to resolve many issues and follow a road map for business success in implementing CNG Stations in Gujarat. The contingency plan for GSPC has been discussed in the next section and the road ahead in the subsequent section.

8.1 CONTINGENCY PLAN

The contingency plan would have to work around, when the scenario no longer remains moderate. It could turn into an optimistic scenario and may also become a pessimistic scenario.

8.1.1 Towards an Optimistic Scenario

In case, the scenario becomes an optimistic scenario, the number of vehicles on CNG would be around **320%** as that of projected and the demand would rise further to **340%** of the projected demand under a moderate scenario. (For "very optimistic scenario" these percentages are more than 500%)

This essentially means that for every planned station 2.4 additional CNG Stations are required to be setup. Therefore, numbers of online stations in the range of 130-160 and daughter stations in the range of 600-700 would be required.

8.1.2 Towards an Pessimistic Scenario

In case, the scenario becomes a pessimistic scenario, the number of vehicles on CNG would be just around **quarter** of projected and the demand would reduce to 20% of the projected demand under a moderate scenario.

This implies that for every five station planned; only one station would be utilized to its capacity. Therefore, numbers of online stations required would be in the range of 10-15 and daughter stations in the range of 40-50.

8.2 ROAD AHEAD

» *Obtain practical, systematic and long term Government directive / notification on CNG*

Given the current scenario of pollution in various cities of Gujarat, the directive asking for implementation of CNG / LPG or other alternative fuels should come as no surprise. The opportunity in this case with GSPC and its associated companies is to make the most of it and help Government in drafting a systematic, long-term implementation plan. The initial bottlenecks that were faced in Delhi

are lessons to be learnt. International scenario must be kept in mind while devising these policies.

One may also note that all over the world, the emission norms have been made stricter rather than forcing the public with a particular type of fuel. The relative taxation policy of the Government for different and competing fuels must also be kept transparent so as to reduce the uncertainties for infrastructure developers as well as the common public.

» *Crosscheck projections at intermediate stages*

The projections made in this study are based on the projections and past trends for gross domestic product and growth rate in registration of vehicles among others. The future growth rate assumed for the projections may or may not be sustained. It is recommended to conduct intermediate crosschecking exercise and ascertain deviations, if any, from the projections. Suitable corrections shall be made in case of any major deviations from the projections.

» *Take prior legal opinion on various issues that could arise*

In Delhi, there were plenty of cases under judiciary and there were many challenges to court rulings or to government notifications etc. GSPC with government would have to analyze the future situation in Gujarat and take preventive action failing which its business could be affected and huge investment made could be lying idle because of some court case or other.

It would also be required to take other aspects like safety and related liabilities etc. into account prior to implementing its plans.

» *Conduct survey among vehicle owners*

It is recommended to conduct survey amongst the user group to ascertain their needs and perception regarding the CNG fuel and conversion. The survey shall also focus upon the existing customers in Gujarat and in other parts of the country. The bottlenecks and key factors governing the CNG conversion shall also be analyzed.

» *Tie up with existing retail-fuelling stations*

GSPC would have to analyze the possibility of tie up with existing fuel supply stations for setup of its daughter station. It could also go for geography-based tie up with private companies who then cater to the market in the specified region. This way it can also compare performance of its business partners. There could also be other possibilities, which have to be analyzed, and then play in the market with the best strategy.

» *Invite private parties for taking up different geographical areas. Decide on tariff / royalty structure with these parties*

If private parties are invited for distribution and selling, various issues of costing, pricing, annual royalty fees or one time deposit etc. would also have to be finalized.

» *Design and specifications of CNG stations*

Once most of the issues are over, design and specification work of CNG station could be taken up. This would have to take care of the future needs and demands for CNG.

» *Plot identification / Procurement issues*

This study has identified the locations where the CNG stations could be located. The exact plot identification and the intricacies involved in that would have to taken up at an appropriate time. Various issues like who would purchase the land, who would identify the land etc would have to be resolved once the distribution strategy is finalized.

» *Required permissions from various agencies*

There could be various permissions that may be required before setting up a CNG station. This would necessitate dealing with many agencies for certification, permission etc. All permissions may be obtained before starting upon the respective work. The issue here could be who would obtain these clearances. The business partners may seek assistance from GSPC for obtaining these clearances.

» *Phase wise implementation*

The implementation of the project should be done in a phase wise manner. Pilot implementation could be done at early stages. Preference may be given to relatively highly polluted cities with major demand centres.

» ***Consider the health costs associated with pollution and forex savings, if any, for pricing of CNG. Analyze tax benefits that may be required to be given by government***

Pricing of CNG would be another critical aspect leading to market capture. Though, the price may vary according to the international prices, GSPC could request the Government for giving incentives to the agencies and the CNG vehicle owners as well. For this purpose the differential cost of healthcare provided by Government due to the pollution and also savings in foreign exchange could be evaluated. This evaluation would provide an idea of the benefit of implementing CNG.

» *Discuss and Negotiate with CNG kit manufacturers for purchasing kits in bulk, also start dealing with vehicle manufacturers for appropriate standardizations and norms*

GSPC along with its business partners could negotiate with the CNG kit manufacturers for purchase of kits in bulk. Along with this, GSPC may start holding discussions with vehicle manufacturers for standardization of various parts for interoperability.

» *Setup marketing division*

GSPC may analyze its existing marketing structure. Marketing divisions may be required to setup, to cater to the needs of retail, industrial bulk purchasers. Separate cell for corporate fleet owners may also be required.

» *Tie with existing transport fleets*

GSPC should hold talks with organizations like GSRTC and Ahmedabad Municipal Transport Service (AMTS) to convert part of their fleet to CNG vehicles and introduce new vehicles as CNG only. GSPC in this case would be required to setup Dedicated CNG stations for these big fleets. Special equipment would be needed for filling these high number, large capacity vehicles.

CRITICAL POLICY REQUIREMENTS[5]

THE WORLD BANK

From the foregoing combination of experience and reasoning it is possible to distil some conclusions about where it may be sensible to act to encourage the use of natural gas for transport, and by what instruments.
A local reserve of gas is clearly the first requirement, both because the expense of transport internationally is likely to make it uneconomic and because that increases the probability of securing a substantial balance of payments advantage by its exploitation. World reserves of gas are more widely distributed than those of liquid fuels so that developing countries like Argentina, Bangladesh and Pakistan may see a strategic advantage in its development. More important than large gas reserves is the availability of a city gas distribution network. **CNG use alone is not enough to justify the development of gas field and the construction of gas ransport and distribution infrastructure.** Many large cities in Bangladesh, Brazil, Colombia, Indonesia, Pakistan and eastern Europe and the Former Soviet Union already have extensive gas networks.

Second is the cost relative to other fuels. IPPC estimated the wellhead gasoline equivalent production cost of CNG to lie between 70 and 90 percent that of gasoline or diesel so that, given difference in distribution and storage costs the resource costs at the pump would often be very similar. However, international evidence suggests that, except for some very heavy mileage vehicles, the pump price difference would need to be about 50 percent of the production cost of liquid fuels for natural gas to be attractive to users. **Hence natural gas would seem to require strong fiscal encouragement if it is to be more than a niche fuel.**

Arising from this are questions of fiscal policy. In many countries gasoline taxation is sufficiently high for the relative attractiveness of gasoline and natural gas to be manipulated through differential taxation. That is partly the basis of the popularity of NGVs in Italy. But it is rarely so for diesel which is for many purposes the direct competitor of CNG, and which typically carries a low tax rate. Relative tax rates may thus be encouraging the highest mileage urban vehicles (taxis, buses, etc) to switch from gasoline not to CNG but to diesel, the fuel with the most damaging urban environmental impacts.

The usual reason for low tax rates on diesel is its use for heavy inter-urban freight movement and agricultural purposes. Given that the health impact of particulate emissions is likely to be less in low density inter-urban and rural areas than in cities, the emphasis on the economic rather than the environmental impact of diesel fuelling outside urban areas may not be unreasonable. Hence it is necessary to develop tax structures which protect the urban environment but do not discourage use of the most economical fuel by agricultural or intercity freight vehicles. **One possible way of doing that is to identify the most damaging vehicle types (cars and urban buses) and use high duties on those types of diesel vehicle, rather than fuel taxation, as the means of changing the balance of economic advantage.** That is already done in some countries by exempting clean vehicles from import duties or vehicle license duties.

How to set relative tax levels is inevitably a complex issue. In principle, the answer is to identify the emission values of different pollutants, and to structure vehicle and fuel taxes to reflect differences in the summed value of emissions for different vehicle types. In practice, however, emission levels depend not only on the fuel type and composition, but also on where and how it is burned. Moreover, the evidence on the health costs of different pollutants remains sketchy in many countries. So, at best, the use of fiscal incentives would be somewhat rough and ready. But that may be sufficient to counteract some of the most obvious distortions in existing incentive systems.

[5] *Infrastructure Notes, Transport Sector, The World Bank*

ROLE OF GOVERNMENT

THE WORLD BANK[6]

The cases of Argentina and New Zealand highlight a number of issues related to the role of a government in launching and sustaining a NGV program, and that of government support in particular. The government can assist in a number of ways.

Potential Government Assistance

Establishing a proper regulatory framework is one of the principal roles of the government. The government should ensure that there is a level playing field, players are encouraged to increase efficiency and quality of service and products through competition, and monitoring and enforcement of regulations and standards are adequate.

Establishing safety and performance standards is another important government function. Both Argentina and New Zealand moved quickly to address this aspect, although the maintenance of performance standards was less than satisfactory in the latter.

Adopting an inter-fuel taxation policy favorable to automotive natural gas is necessary if the NGV program is to be viable and sustainable on a commercial basis. In Argentina, gasoline is so heavily taxed that CNG is commercially competitive. In neither country has diesel been taxed to the extent necessary to promote conversion from diesel to CNG. In New Zealand, one of the key incentives for conversion came from government subsidies, so that when the subsidies were withdrawn, inter-fuel price differences alone could not sustain the CNG program. A further question is the extent to which the retail prices should differ. For a given payback period, high-usage vehicles need a smaller price difference than lower-mileage vehicles. If all vehicles including private passenger cars are targeted for conversion, the price difference required would be much greater than if only high-usage commercial vehicles such as taxis and delivery vans are targeted.

Providing subsidies was the policy aggressively pursued by the government of New Zealand. In the early days of a NGV program, the infant industry argument may justify subsidies. For example, to break the logjam in which car owners wait for adequate refueling infrastructure before investing in a fuel switch, while business enterprises wait for a sufficient number of converted vehicles before investing in refueling stations, the government may consider subsidizing startup costs. However, as the case of New Zealand demonstrates, large subsidies are unlikely to be sustainable in the long run, threatening the survival of the NGV program. In the words of Robert Cumming who spoke on behalf of the International Association for Natural Gas Vehicles in Mexico City in 1997, "Governments that believe that all they need is a two-to three-year kickstart are wasting their time and money" (Cumming 1997). It would be preferable to provide modest but consistent support over a long period of time than large subsidies that are reduced significantly or withdrawn altogether after a few years. Heavy subsidies may also lead to serious market distortions, such as over-supply of refueling stations.

Providing non-monetary incentives is another option. Examples include reduced frequency of required emissions inspection tests or the right to drive a CNG vehicle in high-occupancy vehicle lanes or on days when other vehicles are not permitted (as in cities that ban vehicle usage on certain days to reduce air pollution). Such incentives alone would not induce vehicle owners to switch to natural gas, but coupled with other incentives (most importantly fuel cost savings), they could play a useful role.

Mandating conversion to natural gas is not a step that should be taken lightly, especially if financial and logistical (fueling and driving range) burdens are anticipated to be great on vehicle owners. The Supreme Court decision imposed in Delhi for buses is one example. The New Zealand government's decision to convert government fleets to CNG in one sense falls under this category. An indirect way of mandating conversion is to set emission standards that can be met only by NGVs. In the United States, the South Coast Air Quality Management District (SCAQMD) in California has recently banned diesel buses in favor of NG and other alternative fuel engines.

Acting as a champion is a consideration for the government, specially in the early days of the NGV program. The government can publicize the benefits of NGVs, perhaps using prominent senior officials to reinforce the message. It is equally important for the private sector to assume this role.

The issue of inter-fuel taxation is a complex one and is beyond the scope of this report. However, a few general principles from tax theory may be outlined here. To devise an optimal tax scheme, which would enable the government to raise sufficient revenues while minimizing the loss of consumers' welfare from the higher prices they would have to pay because of the taxes, the following rule is often taken as the starting point: if a certain set of conditions are met1 , then no intermediate goods should be taxed, and the tax rates on final consumption goods should be inversely proportional to their own price elasticities of demand. Thus, if consumers are likely to cut back consumption markedly in response to a price increase (as in the case of certain luxury goods), that item should not be taxed much, but if consumers are likely to continue to consume only slightly less on account of the price increase (as in the case of such staple food items as rice or maize), then the item should be taxed relatively more. Under these conditions, because diesel used in freight and passenger transport, industry, and agriculture is an intermediate good, diesel for these purposes should not be taxed. However, the above conditions are not satisfied:

Vehicles in cities cause congestion, diesel emissions are harmful to public health, and all vehicles, but heavy-duty vehicles consuming diesel in particular, damage roads, so that there is an external cost associated with the use of diesel (for productivity loss due to congestion, additional healthcare costs and expenditures for road maintenance) _ Diesel and gasoline are substitutes for lightduty vehicles in the long run so that taxing diesel little and gasoline much more would result in an automotive fuel switch out of gasoline to diesel _ In many developing countries not all final goods can be taxed, so that taxes on petroleum products, which are relatively easy to collect, become an important source of government finance, especially in low income countries _ A number of markets in developing countries have distortions that impede perfect or even near-perfect competition. All these trends argue for taxing diesel even when it is an intermediate good.

That gasoline and diesel are substitutes in the light-duty vehicle category is a particularly strong argument for making their tax levels comparable, or else the fuel that is taxed less (almost universally diesel) will be consumed more, eroding the tax base and requiring higher tax rates elsewhere to collect the same amount of money. Yet another consideration in designing tax is equity—items that the poor consume disproportionately more than the rich as a share of their total expenditures (such as food) should be taxed less than the above "inverse elasticity" rule would imply so as to lessen the tax burden on the poor. Conversely, for goods consumed more by the rich than the poor, such as gasoline, the tax rate should be higher. Where the impact of an increase in the price of diesel on household expenditures has been studied, the effects have been found to be regressive—that is to say, the total expenditures of poor households rise more in percentage terms than those of the rich when the price of diesel is raised—although the magnitude of the impact is not large, remaining of the order of a couple of percentage points.

This would argue somewhat for not raising the tax on diesel as much as the above factors might suggest. This is one reason why some governments view diesel as a "social" fuel, limiting tax on diesel compared to gasoline, which is seen as a fuel for the rich, since only better-off families can afford to purchase motorized vehicles. Nevertheless, the equity argument alone would not justify keeping the end-user price of diesel at half that of gasoline as seen in a number of countries. Natural gas used in the transport sector is no different than liquid fuels from the point of view of tax theory with one exception; the environmental externality is lower relative to old technology gasoline vehicles, and considerably lower with respect to conventional diesel. To set the tax level capturing externalities would require a knowledge of contributions of vehicles with different fuels to the overall air and noise pollution, and health and other damages associated with each fuel. This level of information is seldom, if ever, available in most developing country cities.

It is important to note that the incremental tax adjustment to deal with the externality should be applied to that good only—there is no reason to tax complements more heavily or substitutes less heavily independent of their own polluting characteristics. In the case of fuel taxes, this means that government should tax diesel more, and not lower the rate of tax on natural gas. Further, additional considerations include other externalities associated with NGVs— congestion and damage to roads (which would increase because NGVs are heavier) as well as the fact that natural gas and liquid fuels are close substitutes. Subsidized natural gas is made available in a number of countries. A prime example is natural gas sold to the fertilizer industry.

It is important to have market-based natural gas pricing rather than government-determined below market pricing for the long term viability of the NGV program. Subsidizing natural gas (that is to say, selling it below cost) to promote its use in the transport sector, a position promoted by some, ignores these widely accepted principles of

[6] *Breathing Clean, Technical Paper, The World Bank*

optimal tax theory. Another important point is that fuel taxation is a poor proxy for an efficient externality charge, because air pollution or congestion is a highly localized phenomenon, while fuel tax is usually set at a national level. From the point of view of taxing environmental health damages, emissions in densely populated areas need to be taxed, which a tax on diesel does not capture well. The option of heavily taxing urban buses fueled by conventional diesel, which may be more targeted, invites other problems: buses are often the transport mode used by the poor, while a heavy tax on diesel buses would result in higher bus fares; and such a vehicle tax scheme may also eliminate transit buses altogether in favor of numerous mini-buses, which may be more difficult to regulate and control for emissions. These issues point to the complexity of setting fuel and vehicle taxes in such a way to minimize distortions and maximize welfare.

Another reason cited for consideration in setting inter-fuel taxation is balance of payments for countries that have indigenous sources of natural gas and that import crude or refined products. However, if the exchange rate is fully determined by market forces so that it reflects opportunity costs, there is no reason to differentiate taxes to save imports. A related issue is diversification of energy sources so as to minimize the impact of possible future price hikes. This may justify differentiated taxation to a degree, although not so much as to give incentives to switch entirely from liquid fuels to NG.

Given that diesel is taxed little or even subsidized in many developing countries, conversion from diesel to natural gas would become economic only if diesel itself or diesel vehicles are taxed much more. While there may be a number of good reasons why the retail price of diesel relative to gasoline should be raised in the long run, there would nevertheless be a significant impact on other uses of diesel—in rail transport, agriculture, and industry, for example. One way of addressing this is to give rebates on the diesel tax to industrial and agricultural users of diesel. In any event, promotion of NGVs is unlikely to play a dominant role in determining diesel taxation. In practice, a combination of a number of instruments are likely to be needed to achieve multiple objectives, including taxing items that cause negative externalities; more uniform taxes across different fuels that are substitutes; tax rebates to industrial users of fuels; higher taxes on diesel vehicles, particularly those used primarily in intracity transport; and targeted subsidies for the poor to compensate for higher expenditures resulting from increased taxes, to mention a few.

Because gasoline is already taxed much more in most developing countries, if CNG has any chance of success on a commercial basis, it is as a gasoline substitute. A large price difference between gasoline and CNG is currently achieved by taxing CNG much less. Several issues need to be considered in this case: _ If gasoline is effectively the sole source of tax revenue from refined products (because all other fuels are taxed little or subsidized), the government may not welcome a successful CNG program whereby consumers shift from relatively heavily taxed gasoline to essentially untaxed CNG. This would be particularly a concern in low-income countries where tax revenue from hydrocarbons accounts for a significant fraction of the government's total tax take. _ If the CNG program is so successful that a sizable portion of the gasoline market is replaced by CNG while the automotive diesel market is untouched, the resulting product slate (with a very low gasoline-to-diesel ratio) will be difficult to manage for countries with refineries.

If taxing CNG little does not provide sufficient financial incentives for conversion, the government might consider increasing the tax on gasoline further (which in turn could further reduce the gasoline-to-diesel ratio for demand), or reducing the tax on CNG, or both. If the tax difference between CNG and gasoline is to be widened at all, it would probably make sense to target high-usage vehicles only. Leakage—diversion of CNG to users not targeted by the government—is unlikely to be a serious concern for two reasons. First, unlike liquid fuels, natural gas is much more difficult to transport, so that diversion to non-automotive users from refueling stations would not be simple. Second, since the tax scheme would target the price difference between CNG and gasoline to be at the level that would make conversion to CNG financially attractive only or high-usage vehicle owners, lower mileage vehicle owners would not benefit from converting to CNG to take advantage of the price difference.

9 ANNEXES

9.1 ANNEX: SURVEY DATA FOR VOLUME

POINT		15	15
LOCATION		SARKHEJ ROAD	SARKHEJ ROAD
ROUTE		AHMEDABAD TO SAURASHTRA	AHMEDABAD TO SAURASHTRA
START DATE /TIME		10/07/2002 0800 hrs	10/07/2002 0800 hrs
		TOTAL	TOTAL
HEAVY TRAILER	S	100	305
	N	62	60
TRUCKS	S	1377	1815
	N	314	110
LIGHT TRUCKS	S	629	942
	N	21	3
BUSES PRIVATE	S	315	510
	N		
BUSES ST	S	270	70
	N	0	0
CAR/JEEP	S	1931	2063
	N	34	11
TRACTOR JCB ETC.	S	67	
	N	0	
THREE WHEELERS	S	80	107
	N	0	0
TOTAL		5731	7401

POINT		18	18
LOCATION		MEHSANA ROAD	MEHSANA ROAD
ROUTE		AHMEDABAD TO MEHSANA	MEHSANA TO AHMEDABAD
START DATE /TIME		10/07/2002 0800 hrs	10/07/2002 0800 hrs
		TOTAL	TOTAL
HEAVY TRAILER	S	25	41
	N	100	86
TRUCKS	S	1261	991
	N	748	727
LIGHT TRUCKS	S	584	532
	N	0	3
BUSES PRIVATE	S	299	286
	N	23	11
BUSES ST	S	366	372
	N	32	30
CAR/JEEP	S	3076	2667
	N	42	10
TRACTOR JCB ETC.	S	121	107
	N	0	0
THREE WHEELERS	S	810	744
	N	0	0
TOTAL		7457	6607

POINT			
LOCATION			
ROUTE			
START DATE /TIME			
		TOTAL	TOTAL
HEAVY TRAILER	S	69	70
	N	78	80
TRUCKS	S	1584	1406
	N	650	691
LIGHT TRUCKS	S	660	632
	N	21	13
BUSES PRIVATE	S	254	202
	N	24	3
BUSES ST	S	457	430
	N	33	23
CAR/JEEP	S	2099	2144
	N	43	19
TRACTOR JCB ETC.	S	25	20
	N	0	0
THREE WHEELERS	S	307	326
	N	0	0
TOTAL		6304	5989

POINT		13	14
LOCATION		NAROL ROAD	NAROL ROAD
ROUTE		SURAT TO AHMEDABAD	AHMEDABAD TO SURAT
START DATE /TIME		10/07/2002 0800 hrs	10/07/2002 0800 hrs
		TOTAL	TOTAL
HEAVY TRAILER	S	65	72
	N	159	96
TRUCKS	S	1137	1550
	N	991	1119
LIGHT TRUCKS	S	731	902
	N	53	54
BUSES PRIVATE	S	89	132
	N	3	13
BUSES ST	S	432	427
	N	19	7
CAR/JEEP	S	1584	1833
	N	152	39
TRACTOR JCB ETC.	S	45	43
	N	21	0
THREE WHEELERS	S	246	279
	N	0	0
TOTAL		5711	6566

POINT		[illegible]	[illegible]	[illegible]	[illegible]
LOCATION		[illegible]	[illegible]	[illegible]	[illegible]
ROUTE		[illegible]	[illegible]	[illegible]	[illegible]
START DATE /TIME		[illegible]	[illegible]	[illegible]	[illegible]
		TOTAL	TOTAL	TOTAL	TOTAL
HEAVY TRAILER	S	15	57	12	49
	N	1	27	1	23
TRUCKS	S	28	485	28	502
	N	4	62	2	101
LIGHT TRUCKS	S	3	32	3	44
	N	2	8	0	0
BUSES PRIVATE	S	6	25	8	21
	N	2	0	0	2
BUSES ST	S	10	196	4	203
	N	0	0	4	0
CAR/JEEP	S	23	417	28	374
	N	0	5	0	14
TRACTOR JCB ETC.	S	7	340	16	315
	N	3	0	0	2
THREE WHEELERS	S	17	437	0	394
	N	0	0	3	0
TOTAL		121	2091	109	2044

POINT		91	11
LOCATION		NADIAD ROAD	NADIAD ROAD
ROUTE		AHMEDABAD TO SURAT	SURAT TO AHMEDABAD
START DATE /TIME		10/07/2002 0800 hrs	10/07/2002 0800 hrs
		TOTAL	TOTAL
HEAVY TRAILER	S	78	199
	N	131	142
TRUCKS	S	1726	2356
	N	1021	1217
LIGHT TRUCKS	S	623	854
	N	29	102
BUSES PRIVATE	S	72	158
	N	2	5
BUSES ST	S	253	326
	N	3	11
CAR/JEEP	S	1408	1718
	N	76	66
TRACTOR JCB ETC.	S	35	98
	N	0	0
THREE WHEELERS	S	91	142
	N	0	0
TOTAL		5543	7394

POINT		k)	l)	m)	n)
LOCATION		KHEDA ROAD	KHEDA ROAD	KHEDA ROAD	KHEDA ROAD
ROUTE		AHMEDABAD TO DAKOR	SURAT TO DAKOR	DAKOR TO AHMEDABAD	DAKOR TO SURAT
START DATE /TIME		10/07/2002 0800 hrs	10/07/2002 0800 hrs	10/07/2002 0800 hrs	10/07/2002 0800 hrs
		TOTAL	TOTAL	TOTAL	TOTAL
HEAVY TRAILER	S	0	20	0	16
	N	1	2	0	12
TRUCKS	S	1	290	2	350
	N	0	136	0	29
LIGHT TRUCKS	S	1	254	2	254
	N	0	22	0	4
BUSES PRIVATE	S	0	34	0	42
	N	0	13	0	0
BUSES ST	S	0	254	0	234
	N	0	11	0	0
CAR/JEEP	S	1	982	8	953
	N	0	14	0	27
TRACTOR JCB ETC.	S	1	90	4	53
	N	0	1	0	0
THREE WHEELERS	S	2	398	8	511
	N	0	0	0	0
TOTAL		7	2521	24	2485

POINT		11	11
LOCATION		NADIAD ROAD	NADIAD ROAD
ROUTE		AHMEDABAD TO SURAT	SURAT TO AHMEDABAD
START DATE /TIME		16/07/2002 0100 hrs	16/07/2002 0100 hrs
		TOTAL	TOTAL
HEAVY TRAILER	S	71	58
	N	80	119
TRUCKS	S	1709	1649
	N	931	1114
LIGHT TRUCKS	S	731	761
	N	32	54
BUSES PRIVATE	S	96	116
	N	22	20
BUSES ST	S	408	395
	N	16	8
CAR/JEEP	S	1937	1893
	N	64	111
TRACTOR JCB ETC.	S	64	56
	N	0	6
THREE WHEELERS	S	166	146
	N	0	0
TOTAL		6356	6508

POINT		0	0	0	0
LOCATION		TARAPUR ROAD	TARAPUR ROAD	TARAPUR ROAD	TARAPUR ROAD
ROUTE		AHMEDABAD TO TARAPUR	SURAT TO TARAPUR	TARAPUR TO AHMEDABAD	TARAPUR TO SURAT
START DATE /TIME		16/07/2002 0100 hrs	16/07/2002 0100 hrs	16/07/2002 0100 hrs	16/07/2002 0100 hrs
		TOTAL	TOTAL	TOTAL	TOTAL
HEAVY TRAILER	S	27	2	14	3
	N	21	1	14	5
TRUCKS	S	1035	186	1941	171
	N	132	48	271	41
LIGHT TRUCKS	S	922	75	4197	62
	N	1	1	5	1
BUSES PRIVATE	S	144	8	148	9
	N	6	0	2	0
BUSES ST	S	51	52	38	11
	N	0	0	0	0
CAR/JEEP	S	389	273	454	234
	N	1	1	2	3
TRACTOR JCB ETC.	S	52	51	48	59
	N	0	0	0	0
THREE WHEELERS	S	211	135	229	125
	N	0	0	0	0
TOTAL		2292	833	2763	724

POINT		9	9
LOCATION		VADODARA ROAD	VADODARA ROAD
ROUTE		AHMEDABAD TO SURAT	SURAT TO AHMEDABAD
START DATE /TIME		16/07/2002 0100 hrs	16/07/2002 0100 hrs
		TOTAL	TOTAL
HEAVY TRAILER	S	118	110
	N	150	120
TRUCKS	S	3525	2821
	N	1343	978
LIGHT TRUCKS	S	857	752
	N	74	50
BUSES PRIVATE	S	296	289
	N	21	9
BUSES ST	S	449	446
	N	4	7
CAR/JEEP	S	2239	2160
	N	78	36
TRACTOR JCB ETC.	S	93	82
	N	0	0
THREE WHEELERS	S	298	276
	N	0	0
TOTAL		9545	8136

POINT		[illegible]	[illegible]
LOCATION		[illegible]	[illegible]
ROUTE		[illegible]	[illegible]
START DATE /TIME		[illegible]	[illegible]
		TOTAL	TOTAL
HEAVY TRAILER	S	118	110
	N	150	120
TRUCKS	S	3525	2821
	N	1343	978
LIGHT TRUCKS	S	857	752
	N	74	50
BUSES PRIVATE	S	296	289
	N	21	9
BUSES ST	S	449	446
	N	4	7
CAR/JEEP	S	2239	2160
	N	78	36
TRACTOR JCB ETC.	S	93	82
	N	0	0
THREE WHEELERS	S	298	276
	N	0	0
TOTAL		9545	8136

POINT		6	6 Z
LOCATION		VADODARA-BHARUCH ROAD	VADODARA-BHARUCH ROAD
ROUTE		AHMEDABAD TO SURAT	SURAT TO AHMEDABAD
START DATE /TIME		16/07/2002 0100 hrs	16/07/2002 0100 hrs
		TOTAL	TOTAL
HEAVY TRAILER	S	133	130
	N	339	160
TRUCKS	S	3619	3570
	N	2722	2310
LIGHT TRUCKS	S	1033	1201
	N	80	197
BUSES PRIVATE	S	299	289
	N	7	16
BUSES ST	S	12	11
	N	1	0
CAR/JEEP	S	1226	1430
	N	39	81
TRACTOR JCB ETC.	S	29	39
	N	0	0
THREE WHEELERS	S	166	198
	N	0	0
TOTAL		9705	9632

POINT		7			
LOCATION		[illegible] ROAD	[illegible] ROAD	[illegible] ROAD	[illegible] ROAD
ROUTE		[illegible] TO [illegible]	SURAT TO [illegible]	[illegible] TO [illegible]	[illegible] TO SURAT
START DATE /TIME		[illegible] hrs	[illegible] hrs	[illegible] hrs	[illegible] hrs
		TOTAL	TOTAL	TOTAL	TOTAL
HEAVY TRAILER	S	6	11	6	11
	N	8	10	8	10
TRUCKS	S	201	264	201	264
	N	512	151	503	136
LIGHT TRUCKS	S	122	343	121	345
	N	54	16	4	18
BUSES PRIVATE	S	18	68	18	69
	N	2	1	2	5
BUSES ST	S	2	207	2	220
	N	1	11	1	11
CAR/JEEP	S	105	744	105	727
	N	12	26	2	24
TRACTOR JCB ETC.	S	6	36	5	36
	N	0	0	0	0
THREE WHEELERS	S	25	189	24	190
	N	0	0	0	0
TOTAL		1114	2077	1103	2066

POINT		6	6
LOCATION		VADODARA BHARUCH ROAD	VADODARA BHARUCH ROAD
ROUTE		AHMEDABAD TO SURAT	SURAT TO AHMEDABAD
START DATE /TIME		17/07/2002 1000 hrs	17/07/2002 1000 hrs
		TOTAL	TOTAL
HEAVY TRAILER	S	100	114
	N	321	216
TRUCKS	S	3948	3159
	N	2057	2030
LIGHT TRUCKS	S	1037	882
	N	52	56
BUSES PRIVATE	S	229	223
	N	6	1
BUSES ST	S	6	7
	N	0	1
CAR/JEEP	S	1102	970
	N	80	90
TRACTOR JCB ETC.	S	26	34
	N	0	0
THREE WHEELERS	S	167	120
	N	0	0
TOTAL		9051	7849

POINT		[illegible]	[illegible]	[illegible]	[illegible]
LOCATION		DABHEL ROAD	DABHEL ROAD	DABHEL ROAD	DABHEL ROAD
ROUTE		AHMEDABAD TO DABHEL	SURAT TO DABHEL	DABHEL TO AHMEDABAD	DABHEL TO SURAT
START DATE /TIME		17/07/2002 1000 hrs	17/07/2002 1000 hrs	17/07/2002 1000 hrs	17/07/2002 1000 hrs
		TOTAL	TOTAL	TOTAL	TOTAL
HEAVY TRAILER	S	44	75	23	68
	N	11	9	1	19
TRUCKS	S	262	651	200	851
	N	65	131	30	148
LIGHT TRUCKS	S	101	83	76	84
	N	0	0	0	0
BUSES PRIVATE	S	88	45	70	71
	N	0	0	0	0
BUSES ST	S	60	40	72	63
	N	0	0	0	0
CAR/JEEP	S	772	363	538	692
	N	2	0	46	0
TRACTOR JCB ETC.	S	17	6	29	24
	N	0	0	0	0
THREE WHEELERS	S	281	154	199	246
	N	0	0	0	0
TOTAL		1713	1614	1242	2286

POINT		3	4
LOCATION		BHARUCH ROAD	BHARUCH ROAD
ROUTE		AHMEDABAD TO SURAT	SURAT TO AHMEDABAD
START DATE /TIME		17/07/2002 1000 hrs	17/07/2002 1000 hrs
		TOTAL	TOTAL
HEAVY TRAILER	S	198	147
	N	409	498
TRUCKS	S	3762	4003
	N	2511	2667
LIGHT TRUCKS	S	995	1280
	N	156	202
BUSES PRIVATE	S	244	211
	N	45	50
BUSES ST	S	209	205
	N	12	17
CAR/JEEP	S	1266	1577
	N	170	261
TRACTOR JCB ETC.	S	30	34
	N	11	0
THREE WHEELERS	S	295	236
	N	0	0
TOTAL		10303	11388

POINT		3	4
LOCATION		ANKLESWAR ROAD	ANKLESWAR ROAD
ROUTE		AHMEDABAD TO SURAT	SURAT TO AHMEDABAD
START DATE /TIME		17/07/2002 1000 hrs	17/07/2002 1000 hrs
		TOTAL	TOTAL
HEAVY TRAILER	S	114	82
	N	196	70
TRUCKS	S	3148	3412
	N	2227	2855
LIGHT TRUCKS	S	817	1196
	N	51	97
BUSES PRIVATE	S	274	321
	N	24	38
BUSES ST	S	211	227
	N	9	12
CAR/JEEP	S	976	1269
	N	7	24
TRACTOR JCB ETC.	S	27	35
	N	0	0
THREE WHEELERS	S	203	183
	N	0	0
TOTAL		8284	10091

POINT		2	2	2	2
LOCATION		BARDOLI ROAD	BARDOLI ROAD	BARDOLI ROAD	BARDOLI ROAD
ROUTE		AHMEDABAD TO BARDOLI	MUMBAI TO BARDOLI	BARDOLI TO AHMEDABAD	BARDOLI TO MUMBAI
START DATE /TIME		17/07/2002 1000 hrs	17/07/2002 1000 hrs	17/07/2002 1000 hrs	17/07/2002 1000 hrs
		TOTAL	TOTAL	TOTAL	TOTAL
HEAVY TRAILER	S	1	0	0	0
	N	0	0	1	0
TRUCKS	S	105	35	102	58
	N	4	0	5	0
LIGHT TRUCKS	S	186	36	123	92
	N	0	0	0	0
BUSES PRIVATE	S	2	0	2	0
	N	0	0	0	0
BUSES ST	S	45	3	28	31
	N	0	0	1	0
CAR/JEEP	S	639	120	428	322
	N	1	0	4	2
TRACTOR JCB ETC.	S	50	6	59	35
	N	0	0	0	1
THREE WHEELERS	S	174	11	70	106
	N	0	0	0	0
TOTAL		1207	211	823	650

POINT		1	1
LOCATION		SURAT ROAD	SURAT ROAD
ROUTE		AHMEDABAD TO SURAT	SURAT TO MUMBAI
START DATE /TIME		17/07/2002 1000 hrs	17/07/2002 1000 hrs
		TOTAL	TOTAL
HEAVY TRAILER	S	79	89
	N	246	188
TRUCKS	S	2756	3777
	N	1817	2146
LIGHT TRUCKS	S	1187	1208
	N	264	227
BUSES PRIVATE	S	141	196
	N	45	55
BUSES ST	S	53	64
	N	4	7
CAR/JEEP	S	1301	1514
	N	222	274
TRACTOR JCB ETC.	S	52	74
	N	0	1
THREE WHEELERS	S	654	903
	N	0	0
TOTAL		9021	10423

9.2 ANNEX: SURVEY DATA FOR FUEL SALES

Name	Co	No.of Petrol Filling station	No.of Diesel Filling station	Petrol Daily sale lit.	Petrol Monthly sale lit.	Diesel Daily sale lit.	Diesel Monthly sale lit.	Route	Location	DISTRICT
Transport corp of india ltd	IBP	2	2	250	7500	8000	240000	MSN-SRT	Ashlali	AHMEDABAD
Auto services	IBP	2	4	300	9000	5000	150000	MSN-SRT	Ashlali	AHMEDABAD
R M Petroleum	BPCL	2	3	650	19500	8000	240000	MSN-SRT	Ashlali	AHMEDABAD
Gujarat petroleum	IOC	2	3	500	15000	9000	270000	MSN-SRT	Bareja	AHMEDABAD
Gurukrupa petroleum	IOC	1	2	450	13500	3800	110000	SRT-MSN	Bareja	AHMEDABAD
Gheewala automobiles	HPCL	2	2	700	21000	5500	165000	MSN-SRT	Bareja	AHMEDABAD
Jalaram petroleum service	HPCL	1	2	400	12000	4500	135000	SRT-MSN	Bareja	AHMEDABAD
Jay ambe petroleum	IOC	1	2	500	15000	3200	96000	SRT-MSN	Chhatral	AHMEDABAD
Gokulesh petroleum	IOC	3	10	6700	200000	65000	1900000	MSN-SRT	Narol	AHMEDABAD
Gujarat auto service	IOC	1	2	600	18000	5500	165000	SRT-MSN	Narol	AHMEDABAD
Gujarat auto centre	IOC	0	4	-	-	13500	400000	SRT-MSN	Narol	AHMEDABAD
Maharaj Petroleum	IOC	1	1	350	10500	2200	66000	MSN-SRT	Adas	ANAND
Dayal Petroleum	IBP	1	4	400	12000	9000	270000	SRT-MSN	Anand	ANAND
Krishna Automobiles	IBP	1	4	350	10500	9500	285000	SRT-MSN	Anand	ANAND
M B Patel &Co	IOC	2	2	600	18000	4000	120000	MSN-SRT	Anand	ANAND
Ghanshyam Petrolaum	IOC	1	4	400	12000	14000	420000	SRT-MSN	Anand	ANAND
Ramesh bhai & Brothers	IOC	1	1	300	9000	4000	120000	SRT-MSN	Anand	ANAND
J R Patel &Co	HPCL	2	3	650	19500	9000	270000	SRT-MSN	Anand	ANAND
Adinath Petroleum	HPCL	1	4	350	10500	14000	420000	MSN-SRT	Anand	ANAND
Ravi petroleum	BPCL	2	3	550	16500	9500	285000	MSN-SRT	Opp Umiya	ANAND
Vishwanath Petroleum	IBP	1	4	450	13500	10500	315000	MSN-SRT	Vasad	ANAND
Yogeshwar Petroleum	IOC	1	4	450	13500	16000	480000	MSN-SRT	Vasad	ANAND
B P Patel & Co	IOC	1	2	450	13500	7000	210000	SRT-MSN	Vasad	ANAND
Godavari Petroleum	HPCL	1	3	400	12000	8000	240000	SRT-MSN	Vasad	ANAND
Javer bhai & Co	BPCL	2	4	600	18000	9000	270000	SRT-MSN	Vasad	ANAND
Sarang Petroleum	IOC	1	2	450	13500	6000	180000	MSN-SRT	Ankleshwar	BHARUCH
O M Desai	BPCL	2	3	700	21000	6500	195000	MSN-SRT	Ankleshwar	BHARUCH
Paras Servicestation	BPCL	1	3	400	12000	8500	255000	MSN-SRT	Ankleshwar Road	BHARUCH
National Petroleum	IOC	2	4	800	24000	17000	510000	SRT-MSN	Ankleswar	BHARUCH
Taluka Sahkari Mandli	IOC	1	2	350	10500	8000	240000	SRT-MSN	Ankleswar	BHARUCH
Jai Mahakali Petroleum	IOC	1	2	250	7500	4000	120000	MSN-SRT	Asuria, Nabipur	BHARUCH
K D &Co	HPCL	-	2	-	-	6000	180000	SRT-MSN	Asuria, Nabipur	BHARUCH
M Patel & Co	IOC	-	4	-	-	13000	390000	SRT-MSN	Bharuch	BHARUCH
Sri Auto Petroleum	BPCL	2	2	800	24000	7000	210000	MSN-SRT	Bharuch	BHARUCH
Sagar Petroleum	HPCL	1	2	400	12000	6500	195000	MSN-SRT	Near Nyay Mandir	BHARUCH
Yogi Petroleum	HPCL	2	4	750	22500	14000	420000	MSN-SRT	Bharuch Zadeshwar	BHARUCH
Sri Auto Petroleum	IOC	2	3	750	22500	11000	330000	MSN-SRT	Near Nyay Mandir	BHARUCH
Vijay Petroleum	IBP	2	3	750	22500	15500	465000	MSN-SRT	Kamedra (Ankleshwar)	BHARUCH
Patel Auto Services	HPCL	2	2	650	19500	7000	210000	MSN-SRT	Karjan Char Rasta	BHARUCH
Akta Petroleum	IOC	2	3	550	16500	11000	330000	SRT-MSN	Karjan Manglej Chowkdi	BHARUCH
Gujarat Petroleum	HPCL	2	7	700	21000	17000	510000	SRT-MSN	Kim	BHARUCH
Y D Patel & Co	BPCL	2	4	550	16500	12000	360000	MSN-SRT	Kim	BHARUCH
Ram Kabir Petroleum	IOC	1	3	450	13500	9000	270000	MSN-SRT	Manglej Chowkdi	BHARUCH
H R Patel &Co	IOC	1	3	300	9000	6000	180000	MSN-SRT	Palej	BHARUCH

Name	Co	No.of Petrol Filling station	No.of Diesel Filling station	Petrol Daily sale lit.	Petrol Monthly sale lit.	Diesel Daily sale lit.	Diesel Monthly sale lit.	Route	Location	DISTRICT
New Petroleum	HPCL	-	3	-	-	8500	255000	MSN-SRT	Panoli	BHARUCH
Highway Service Centre	BPCL	1	2	450	13500	6500	195000	SRT-MSN	Panoli G I D C	BHARUCH
Jalaram Petroleum	IBP	1	2	300	9000	4500	135000	SRT-MSN	Por	BHARUCH
M S Shah & Co	BPCL	2	4	550	16500	8000	240000	SRT-MSN	Por	BHARUCH
B P Patel & Co	BPCL	1	2	350	10500	6000	180000	SRT-MSN	Chaklasi Chowkdi Nadiad	KHEDA
Rishi petroleum	IBP	2	4	800	24000	8000	240000	SRT-MSN	Dabhan	KHEDA
Hotson petroleum	IOC	2	2	500	4500	15000	135000	MSN-SRT	Dabhan	KHEDA
Santram petroleum	IOC	1	2	600	18000	3000	90000	SRT-MSN	Dabhan	KHEDA
Hanom petroleum	HPCL	2	2	550	16000	4500	120000	MSN-SRT	Dabhan	KHEDA
G.M patel &sons	HPCL	1	1	300	9000	2700	80000	MSN-SRT	Dabhan	KHEDA
Swaminarayan petroleum	HPCL	2	6	2800	84000	24000	720000	SRT-MSN	Dabhan	KHEDA
Prakash automobie	IBP	0	7	-	-	22000	666000	MSN-SRT	Kheda	KHEDA
Shree ghanshyam	IBP	1	4	350	9000	8500	255000	MSN-SRT	Kheda	KHEDA
Chetak motors	IBP	2	2	400	12000	4000	120000	SRT-MSN	Kheda	KHEDA
Associated services	IBP	1	2	450	13500	5500	110000	SRT-MSN	Kheda	KHEDA
Kiraj petroleum	IOC	2	3	1100	33000	7500	225000	SRT-MSN	Kheda	KHEDA
Tamilnadu co	HPCL	2	3	1200	36000	6500	195000	SRT-MSN	Kheda	KHEDA
Maruti petroleum	IBP	1	2	500	15000	3000	90000	SRT-MSN	Nadiad	KHEDA
Prakash centre	HPCL	1	2	350	10000	2500	75000	MSN-SRT	Nadiad	KHEDA
M S Patel &Co	HPCL	1	4	450	13500	12000	360000	MSN-SRT	Nadiad	KHEDA
Jalaram Petroleum	IOC	1	1	250	7500	3000	90000	MSN-SRT	Nadiad Bye pass	KHEDA
Jalaram petroleum services	HPCL	1	2	1200	35000	6000	180000	MSN-SRT	sherta (Nadiad)	KHEDA
Jolly petroleum	HPCL	1	1	250	7500	2000	60000	MSN-SRT	Vaso	KHEDA
Jolly Petroleum	BPCL	1	2	200	6000	3000	90000	MSN-SRT	Vaso	KHEDA
Sagar highway services	IOC	1	3	700	20000	4000	120000	MSN-SRT	Adalaj	MEHSANA
N.C Desai &Company	HPCL	1	3	600	18000	5000	150000	SRT-MSN	Chhatral	MEHSANA
Somnath Service station	HPCL	1	2	400	12000	3500	105000	SRT-MSN	Chhatral	MEHSANA
Ambica Auto Service	IOC	1	4	1200	3500	8500	255000	MSN-SRT	Ganeshpura	MEHSANA
Ganpathi petroleum	IBP	3	3	2000	60000	8000	240000	MSN-SRT	Kalol	MEHSANA
Bhagwati petroleum	IOC	1	2	450	13500	4500	135000	MSN-SRT	Kalol	MEHSANA
N.C Desai &Company	HPCL	2	3	1500	45000	2500	75000	SRT-MSN	Kalol	MEHSANA
Kishanji Nathuji and &brothers	IBP	1	2	350	11000	3700	111000	MSN-SRT	Nadasan	MEHSANA
Rajeev petroleum co	IOC	2	3	1000	30000	8000	240000	SRT-MSN	Nandasan	MEHSANA
S Meghee	IBP	1	2	700	20000	3000	90000	MSN-SRT	Opp IFCO	MEHSANA
Surat Petroleum	BPCL	1	4	650	19500	14000	420000	MSN-SRT	Kamrej Surat	SURAT
Jubilee Petrol Centre	IOC	2	6	750	22500	18000	540000	SRT-MSN	Kosamba	SURAT
Shreeji Petrol Centre	IBP	2	4	650	19500	18000	540000	MSN-SRT	Mangrol X, Kosamba	SURAT
Gopi Ganesh Auto	IBP	1	4	550	16500	13000	390000	SRT-MSN	Pipodra	SURAT
Ganesh Petroleum	IOC	2	4	900	27000	21000	630000	MSN-SRT	Pipodra (Surat)	SURAT
Shreeji Petroleum	IOC	1	4	700	21000	24000	720000	SRT-MSN	Surat	SURAT
Shri Ganesh Co	IOC	2	4	900	27000	25500	750000	SRT-MSN	Surat	SURAT
Ganesh Petroleum	IOC	1	7	800	24000	42000	1260000	MSN-SRT	Surat	SURAT
Shri Ganesh [illegible]	HPCL	1	3	600	18000	9000	270000	SRT-MSN	Surat	SURAT
Shri Ganesh	BPCL	2	4	800	24000	14000	420000	SRT-MSN	Surat	SURAT
Shri Ganesh	BPCL	2	2	500	15000	6000	180000	MSN-SRT	Ajwa	VADODARA
Shri Ganesh	IOC	1	6	600	36000	18000	1080000	MSN-SRT	Ajwa Chowkdi	VADODARA
Shri Ganesh	IBP	1	3	400	12000	8000	240000	SRT-MSN	Alamgir	VADODARA

Name	Cc	No.of Petrol Filling station	No.of Diesel Filling station	Petrol Daily sale lit.	Petrol Monthly sale lit.	Diesel Daily sale lit.	Diesel Monthly sale lit.	Route	Location	DISTRICT
Gujarat Auto Service	IBP	1	3	300	9000	7000	210000	MSN-SRT	Jambucha Bye pass	VADODARA
D J Patel	HPCL	1	2	450	13500	7000	210000	SRT-MSN	Baroda	VADODARA
Express Auto Service	HPCL	1	2	400	12000	7500	225000	SRT-MSN	Baroda Highway	VADODARA
Mahalaxmi Automobiles	IBP	1	4	350	10500	15000	450000	SRT-MSN	Chhani	VADODARA
Minal Service Station	IOC	1	4	400	12000	9000	270000	SRT-MSN	Chhani	VADODARA
Shakti Auto Centre	HPCL	1	2	300	9000	4500	135000	SRT-MSN	Chhani	VADODARA
Company Petroleum	BPCL	2	3	1200	36000	32000	960000	MSN-SRT	Chhani	VADODARA
R K Auto Services	HPCL	1	2	300	9000	4000	120000	MSN-SRT	Kashipur	VADODARA
Shraddha Petroleum	IOC	1	3	500	15000	10500	315000	MSN-SRT	Near Raj Pipla	VADODARA
E M & Co	HPCL	1	1	450	13500	2500	75000	MSN-SRT	OFF GSPC	VADODARA
Unity Gonemment Ltd	IBP	1	4	500	15000	13500	405000	SRT-MSN	Raj pipla	VADODARA
Krishna Petroleum	BPCL	-	2	-	-	5500	165000	MSN-SRT	Raj pipla	VADODARA
Gayatri Petroleum	IBP	-	4	-	-	9500	285000	SRT-MSN	Vadodara	VADODARA
Shiv Petroleum	IOC	-	2	-	-	7000	210000	MSN-SRT	Varedia	VADODARA
Mahal Filling Petroleum	HPCL	1	2	300	9000	5500	165000	MSN-SRT	Vasad Road	VADODARA

9.3 ANNEX: FUEL SALES PIVOT TABLE

	AHMEDABAD	ANAND	BHARUCH	KHEDA	MEHSANA	SURAT	VADODARA	Grand Total
Numbers of Pumps on Highway	11	14	23	20	10	10	18	106
Average of Petrol Daily sale lit.	1105	450	545	663	890	730	463	653
Sum of Petrol Daily sale lit.	11050	6300	10900	12600	8900	7300	6950	64000
Average of Petrol Monthly sale lit.	33050	13500	16350	19158	23300	21900	15100	19276
Sum of Petrol Monthly sale lit.	330500	189000	327000	364000	233000	219000	220500	1889000
Average of Diesel Daily sale lit.	11909	8979	9239	7435	5070	19850	9556	9803
Sum of Diesel Daily sale lit.	131000	125700	212500	148700	50700	198500	172000	1039100
Average of Diesel Monthly sale lit.	351909	269357	277174	204050	152100	594000	316667	294896
Sum of Diesel Monthly sale lit.	3871000	3771000	6375000	4081000	1521000	5940000	5700000	31259000

9.4 ANNEX: COMPARISION TABLE OF EXISTING AND PROPOSED DISTRIBUTION

EXISTING	AHMEDABAD	ANAND	BHARUCH	KHEDA	MEHSANA	SURAT	VADODARA	Grand Total
PETROL DISTRIBUTION	17%	10%	17%	19%	12%	12%	12%	100%
DIESEL DISTRIBUTION	12%	12%	20%	18%	5%	19%	18%	100%
PETROL KM RUN	154700	88200	152600	[illegible]	124600	102200	97300	[illegible]
DIESEL KM RUN	786000	754200	1275000	892200	304200	1191000	1032000	6234600
DAILY TOTAL KMS	940700	842400	1427600	1068600	428800	1293200	1129300	7130600
PERCENTAGE DISTRIBUTION	13%	12%	20%	15%	6%	[illegible]	16%	100%
PROPOSED	AHMEDABAD	ANAND	BHARUCH	KHEDA	MEHSANA	SURAT	VADODARA	Grand Total
HIGHWAY VEHICLES	2738	1896	1525	2639	3067	1969	1270	15104
PERCENTAGE DISTRIBUTION	18%	13%	10%	17%	20%	13%	8%	100%
CITY VEHICLES	37485	5931	24208	5931	7247	16333	14667	91800
TOTAL VEHICLES	40223	7827	25733	8570	10314	18302	15937	106905
CNG DEMAND	20248	15053	13563	10885	17556	12096	10732	100132
CNG KM RUN	161981	120420	108506	87080	140449	96770	85852	801058
PERCENTAGE DISTRIBUTION	20%	15%	14%	11%	18%	12%	11%	100%

9.5 ANNEX: DEMAND PROJECTIONS UNDER VARIOUS SCENARIOS

» *Very Optimistic Scenario*

	VOLUME COUNT		CNG DEMAND	
CITY	HIGHWAY	CITY	HIGHWAY	CITY
MEHSANA	6346	32893	5488	14968
ADALAJ	4934		5426	
AHMEDABAD	4653	183105	5748	85404
KHEDA	4515		5884	
NADIAD	4377	28900	6020	9823
ANAND	6241	28900	8210	9823
VADODARA	5881	71701	9602	26213
BHARUCH	6712	20509	10763	7575
ANKLESHWAR	5617		9666	
SURAT	7087	80069	8923	27936
Average	**5636**	**63725**	**7573**	**25963**
Total	**56363**	**446078**	**75733**	**181741**
Overall Total	**502442**		**257474**	

» *Optimistic Scenario*

	VOLUME COUNT		CNG DEMAND	
CITY	HIGHWAY	CITY	HIGHWAY	CITY
MEHSANA	5971	22860	4338	9285
ADALAJ	4598		4417	
AHMEDABAD	4123	118753	4168	60073
KHEDA	3971		4266	
NADIAD	3819	21769	4363	6838
ANAND	5661	21769	6483	6838
VADODARA	4645	46023	5915	16162
BHARUCH	5378	14774	6854	5223
ANKLESHWAR	4393		5937	
SURAT	5918	52269	5770	17170
Average	**4848**	**42603**	**5251**	**17370**
Total	**48477**	**298218**	**52510**	**121590**
Overall Total	**346695**		**174100**	

» *Moderate Scenario*

	VOLUME COUNT		CNG DEMAND	
CITY	HIGHWAY	CITY	HIGHWAY	CITY
MEHSANA	2540	7247	1384	3661

	VOLUME COUNT		CNG DEMAND	
CITY	HIGHWAY	CITY	HIGHWAY	CITY
ADALAJ	1755		1240	
AHMEDABAD	1509	37485	1157	17945
KHEDA	1383		1089	
NADIAD	1256	5931	1020	2115
ANAND	1896	5931	1505	2115
VADODARA	1270	14667	1073	5570
BHARUCH	1525	4208	1356	1021
ANKLESHWAR	1224		1199	
SURAT	1969	16333	1210	5906
Average	1633	13114	1223	5562
Total	16328	91800	12232	38933
Overall Total	108128		51165	

» *Pessimistic Scenario*

	VOLUME COUNT		CNG DEMAND	
CITY	HIGHWAY	CITY	HIGHWAY	CITY
MEHSANA	774	1549	293	471
ADALAJ	482		217	
AHMEDABAD	401	8872	189	3793
KHEDA	356		168	
NADIAD	311	1618	147	471
ANAND	486	1618	223	471
VADODARA	297	3628	117	1169
BHARUCH	361	1112	159	356
ANKLESHWAR	277		130	
SURAT	573	4071	196	1255
Average	432	3210	184	1141
Total	4317	22468	1840	7986
Overall Total	26786		9826	

9.6 ANNEX: RTO REGISTRATION FIGURES

RTO	DISTRICT	AUTO	JEEP	CAR	TAXI	BUS	ALL VEHICLES
1995-1996	SURAT	19349	4424	36661	1023	739	486743
	BHARUCH	6303	1341	5125	785	218	83633
	VADODARA	17982	5213	31346	2837	1032	393068
	NADIAD	18212	3326	18004	2433	478	245517
	AHMEDABAD	40953	12678	82385	4946	21630	815602
	GANDHINAGAR	630	563	1628	186	784	23865
	MEHSANA	8112	8749	7005	2805	836	150225
	TOTAL VEHICLES REGISTERED IN GUJARAT						3377798
1997-1998	SURAT	25731	5620	46106	1054	883	582442
	BHARUCH	7989	1789	7807	1073	539	110463
	VADODARA	21411	5838	40658	3378	1264	471996
	NADIAD	24865	4740	22031	2551	558	299964
	AHMEDABAD	45225	15471	103807	5471	22141	975248
	GANDHINAGAR	[illegible]	1362	[illegible]	251	[illegible]	43175
	MEHSANA	10974	11121	9242	2788	[illegible]	189288
	TOTAL VEHICLES REGISTERED IN GUJARAT						4203473
1998-1999	SURAT	29180	6047	[illegible]	1070	[illegible]	642293
	BHARUCH	[illegible]	1958	[illegible]	1206	[illegible]	126173
	VADODARA	[illegible]	6194	[illegible]	3601	[illegible]	515526
	NADIAD	[illegible]	5340	[illegible]	2578	[illegible]	328242
	AHMEDABAD	[illegible]	16369	[illegible]	5680	[illegible]	1058833
	GANDHINAGAR	[illegible]	1840	[illegible]	[illegible]	[illegible]	54175
	MEHSANA	[illegible]	12234	[illegible]	2869	[illegible]	211392
	TOTAL VEHICLES REGISTERED IN GUJARAT						[illegible]
1999-2000	SURAT	[illegible]	6378	[illegible]	1059	[illegible]	708323
	BHARUCH	[illegible]	2117	[illegible]	1273	[illegible]	144891
	VADODARA	[illegible]	6542	[illegible]	3614	[illegible]	564926
	NADIAD	[illegible]	6023	[illegible]	2570	[illegible]	359704
	AHMEDABAD	[illegible]	17275	[illegible]	5695	[illegible]	1150119
	GANDHINAGAR	[illegible]	2206	[illegible]	[illegible]	[illegible]	67676
	MEHSANA	[illegible]	13359	[illegible]	2916	[illegible]	234145
	TOTAL VEHICLES REGISTERED IN GUJARAT						[illegible]

9.7 ANNEX: COMPANY VEHICLES DATA

This data has been collected by primary survey. The results have not been authenticated. These numbers for providing insights to the current status of vehicles with various industries and some of these could be targeted.

#	INDUSTRY	NO. OF VEHICLES
	AHMEDABAD-SURAT HIGHWAY	
1	CMC INDUSTRY	3
2	INDIAN AGRO INDUSTRY	4
3	COCA COLA	175
4	DEWA CHEMICALS LTD	8
5	DUTRON CHEMICALS LTD	7
6	L P GAS ASSOCIATE	90
7	THERMO PUMPS LTD	5
8	WENTRON PUMPS LTD	9
9	SHIVANI CEMENT PRODUTS LTD	3
10	V B PATEL AUTO GUJARAT LTD	40
11	ASIAN FOOD INDUSTRY	6
12	C E MA	12
13	G T I (INDIA) LTD	7
14	CHAROTAR CRASIN TRADERS	15
15	D R TOBACCO Co	8
16	WATER PARK INDUSTRY	4
17	VITRUN	13
18	SRIRAM PIPE INDUSTRY	4
19	CHAROTAR PLY INDUSTRY	2
20	PATEL &Co PVT LTD	8
21	GODREJ AGROVET LTD	11
22	KHEDA DISTRICT MILK PRODUCT LTD	70
23	RWTON	14
24	KISAN AGRO LTD	3
25	VIJAY TANKS LTD	12
26	KOTAK SALES CORPORATION	10
27	DIAMOND CHEMICALS LTD	8
28	BLUE STAR LTD	15
29	MESANA STEEL LTD	5
30	NILA BAURG ENGG LTD	3
31	VIMAL DYES &GAS COMPANY LTD	7
32	INDUS VALLEY SCHOOL	12
33	CRONOS LTD	8
34	UASC LTD	10
35	BAY LINES LTD	4
36	BAYER DIAGOSTICS LTD	7
37	ASHISH MOVERS PVT LTD	12
38	TRITON LTD	18

#	INDUSTRY	NO. OF VEHICLES
39	MEENA PRINT PVT LTD	17
40	SURAKSHA INDUSTRY LTD	6
41	MODERN PETROFILES LTD	14
42	SOLAR EQUIPMENT PVT LTD	20
43	PRASANT HYDROGASES PVT LTD	8
44	KUSTAR KALICO MASHINARY LTD	17
45	ORBIC FABRIC LTD	2
46	R B POLYMERS LTD	4
47	ADIAL OIL & CHEMICALS LTD	14
48	JCT ELECTRONICS LTD	4
49	JAY PRAKASH INDUSTRY LTD	9
50	HIMGIRI FOOD LTD	4
51	MEGHDOOT GINING & PROCESSING IND LTD	20
52	NESTLER LTD	12
53	ZAVERI POLYMERS LTD	3
54	RAM KOTAN INDUSTRY	2
55	HARIOM INDUSTRY	6
56	CHINA SHIPPING LTD	4
57	J B CHEMICALS LTD	6
58	UNITED PHOSPHORUS INDUSTRY LTD	26
59	LAXMI SILK MILLS	3
60	GUJARAT RUBBERS LTD	4
61	NEWCON POLYMERS LTD	6
62	ARTEX INDUSTRY LTD	3
63	NAUDOLIA ORGANIC CHEMICALS LTD	1
64	P L PLASTICS INDUSTRY	2
65	JAYANT INDUSTRY	4
66	TEXTILES INDUSTRY LTD	3
67	YOGESHWAR INDUSTRY LTD	5
68	SHREE SYNTHETICS LTD	4
69	UMA TEXTILES LTD	3
70	BHANOLIY TEXTILES LTD	2
71	RAVI TEXTILES LTD	5
72	VRAJ RAVI TEXTILES LTD	2
73	GOPANI TEXTILES LTD	3
74	SIDDHARTH CHEMICALS LTD	8
75	LAXMI SILK MILLS	4
76	SUMETH SYNTHETICS LTD	7
77	MAJDA TEXTILES LTD	9
78	ZINDAL AGRO INDUSTRY LTD	3
79	VIMAL DYING & SILK MILLS LTD	6
80	SUZLON FIBERS LTD	8
81	ANMOL SAFETY PRODUTS LTD	12
82	SUNNY GLOVES INDUSTRIES	14
83	DYE-O- PRINT (GUJ)PVT LTD	5
84	DHRUV DYES TUFF PVT LTD	5

#	INDUSTRY	NO. OF VEHICLES
85	GAYATRI INTERMEDIATES PVT LTD	13
86	SHANMUKH PETROCHEM PVT LTD	10
87	MINOL ACID &CHE PVT LTD	8
88	SABRI AROMATICS	4
89	BARODA CHEMICALS MFG Co	6
90	IMPACK INDUSTIES	8
91	REFCON INDUSTIES	9
92	KEYTEX ENGG WORKS	3
93	CEEPEEM ENGG Co PVT LTD	18
94	OSWAL MACHINERY LTD	10
95	PLASTICO PUMPS LTD	7
96	ALFA TOOLS PVT LTD	6
97	GAUTEM POLYSTER PVT LTD	8
98	AJAY CORRUGATED & PLASTIC PVT LTD	4
99	GRACE PAPER MILLS PVT LTD	9
100	TIRUPATI CARD BOARD MILLS	6
101	URVASHI PULP PAPER MILLS PVT LTD	3
102	POLYCAPS (BARODA) PVT LTD	2
103	SHRI RAM RUB TECH PVT LTD	5
104	SHREERANG INDUSTRIAL ENTER PRISES	6
105	GUJARAT INDRA CHEM PVT LTD	4
106	INDUSTRIAL APPLICATYIONS	12
107	CADIOX GAS COMPANY	18
108	ABBOTT LABORATORIES (INDIA)LTD	23
109	DEDHIA PHARMA CHEM PVT LTD	16
110	SIMALIN CHEMICAL INDUSTRIES LTD	7
111	LYKA LABS LTD	8
112	I C P A HEALTH PRODUTS LTD	9
113	BARODA POLYMERS PVT LTD	4
114	ADHUNIK POLYTEX LTD	3
115	ASTIK DYES TUFF PVT LTD	5
116	OMGLASS FIBRE EQUIPMENTS	8
117	LIBRA REEDS MFG LTD	18
118	HINDUSTAN STAINLESS STEEL LTD	12
119	KOSAK BEARINGS PVT LTD	7
120	MODERN EQUIPMENTS MFRS	4
121	MAHAVIR MARBLE & KOTA STONE	5
122	LUPIN CHEMICALS LTD	28
123	GUJARAT INSETCTICIDES LTD	17
124	L K CONTINENTAL LTD	10
125	MARUTI SERVICE STATION	90
126	TATA ENGG SERVICE STATION	80
	AHMEDABAD-MEHSANA HIGHWAY	
1	NIRMA	21
2	TORRENT	15
3	RATNAMANI TELCO LTD.	12

#	INDUSTRY	NO. OF VEHICLES
4	DEVINCE SCHOOL	20
5	ONGC	279
6	AMIL MILK BUS	7
7	IFFCO	9
8	OTHER BUS JEEPS	85

9.8 ANNEX: MINISTRY OF SURFACE TRANSPORT- NOTIFICATION

MINISTRY OF SURFACE TRANSPORT
(Transport Wing)
NOTIFICATION
New Delhi, The 31st January 2000.

G.S.R. 77(E) - whereas the Supreme Court of India vide its order dated 29th April 1999 and 13thMay 1999 in the matter of Writ Petition No. 13029/85 M.C.Mehta vs. Union of India has directed that in the National Capital Region from 01st April 2000 no vehicle shall be registered unless it conforms to EURO II norms ;

And Whereas the Central Government has to take steps to implement the aforesaid orders of the Hon'ble Supreme Court;

And Whereas the draft of certain rules further to amend the Central Motor Vehicle Rules, 1989 was published as required by sub=section (1) of section 212 of the Motor Vehicles Act, 1988 (59 of 1988) in the Gazette of India, Extraordinary, Part II Section 3, Sub-section (i) dated the 01st October, 1999 with the notification of Government of India in the Ministry of Surface Transport (Transport Wing), No. G.S.R. 681 (E) dated 01stOctober, 1999 inviting objections and suggestions from all persons likely to be affected thereby within a period of
Forty-five days from the date on which copies of the Gazette of India containing the notification are made available to the public;
And whereas copies of the said Gazette were made available to the public on 04thOctober , 1999.

And whereas , the objections and suggestions recieved from the public have been considered by the Central Government.

Now, therefore, in exercise of the powers conferred by Sections 12, 27, 64, sub-section (14) of section 88, sections110, 137,164 and 206 read with section 211 of the Motor Vehicle Act, 1988 (59 of 1988), the Central Government hereby makes the following rules further to amend the Central Motor Vehicles Rules, 1989, namely:-

1. (1) These rules may be called the Central Motor Vehicles (3rd Amendment) Rules, 2000.
(2) They shall come into force :-
(a) in the National Capital Region, on and from 1st April 2000, and
(b) in other areas of the country, from such date as may be notified by the Central Government.

2. In the Central Motor Vehicles Rules, 1989, in rule 115 after sub-rule (10), the following sub-rule shall be inserted, namely :-

" (11) Mass Emission Standards (Bharat Stage-II)" :-

(A) Motor Cars with seating capacity of and upto 6 persons (including driver) and Gross Vehicle Mass (GVM) not exceeding 2500 kg.

Vehicles with	Standrads (Type Approval = COP) (g/km)		
	CO	(HC + Nox)	PM
Gasoline engine	2.2	0.5	--
Diesel engine	1	0.7	0.08

(B) Four-Wheeler Pasenger Vehicles with GVW equal to or less than 3500 kg and designed to carry more than 6 persons (including driver) or maximum mass of which exceeds 2500 kg.

		Limit Values for Type Approval (TA) as well as COP				
Class	Ref. Mass (rw) Kg	Mass of CO (g/km)		Mass of HC + NOx (g/km)		Mass of PM(g/km)
		Gasoline	Diesel	Gasoline	Diesel	Diesel
I	rw<1250	2.2	1	0.5	0.7	0.08
II	1250< rw <1700	4	1.25	0.6	1	0.12
III	1700 <rw	5	1.5	0.7	1.2	0.17

NOTES :-

1. The test including driving cycle shall be as per sub-rule (10) with the modifications that
   (i) there shall be no relaxation of norms for COP purposes,
   (ii) the tests shall be on Chassis dynamometer,
   (iii) The driving cycle shall be at a maximum speed of 90 Kmph and
   (iv) The reference fuel shall be of a maximum of 0.05 % sulphur content.
2. Commercial fuel for meeting above norms shall be upto 0.05 % mass maximum sulphur content.
3. There shall be no crankcase emissions for petrol driven vehicles
4. Evaporative emission shall not be more than 2.0 g/test from petrol driven vehicles.
5. For the above vehicles when fitted with catalytic convertor deteri oration factor shall be as follows :-
   Gasoline engines : CO = 1.2; (HC + Nox) = 1.2;
   Diesel engines : CO = 1.1; (HC + Nox) = 1.0; PM = 1.2.

Provided that the vehicle manufactures may opt for an aging test of 80,000 kms for evaluating deterioration factor, as per procedure that may be laid down by the Central Government.

6. For diesel engine vehicle, the emission of visible pollutants (smoke) shall not exceed the limit value to smoke density, when expressed as light absorption coefficient for various nominal flows as in Annexure-1 to Rule 115(9) when tested at constant speeds over full load.

(F.No RT.11011/9/99 - MVL)
ASHOKE JOSHI, Secy.

9.9 ANNEX: SUPREME COURT ORDER

IN THE SUPREME COURT OF INDIA
CIVIL APPELLATE JURISDICTION
WRIT PETITION (CIVIL) NO. 13029 OF 1985

M.C.Mehta ... Petitioner

Versus

Union of India and Others ...Respondents

ORDER

Articles 39 (e), 47 and 48A by themselves and collectively cast duty on the State to Secure the health of the people, improve public health and protect and improve the environment. It was by reason of the lack of effort on the part of the enforcement agencies, notwithstanding adequate laws being in place, that this Court has been concerned with the state of air pollution in the capital of this country. Lack of concern or effort on the part of various governmental agencies had resulted in spiraling pollution levels. The quality of air was steadily decreasing and no effective steps were being taken by the administration in this behalf.

It was by reason of the failure to discharge its constitutional obligations, and with a view to protect the health of the present and future generations, that this Court, for the first time, on 23rd September, 1986, directed the Delhi Administration to file an affidavit specifying steps taken by it for controlling pollution emission of smoke, noise, etc. from vehicles plying in Delhi. The concern of this Court in passing various orders since 1986 has only been one, namely, to protect the health of the people of Delhi. It is only with this objective in mind that directions had been issued in an effort to persuade the governmental authorities to take such steps as would reduce the air pollution. It is as a result of intervention by this Court that the following measures were taken in controlling pollution to some extent.

a) lowering of sulphur content in diesel, first to 0.50% and then to 0.05%;
b) ensuring supply of only lead free petrol;
c) requiring the fitting of catalytic converters;
d) directing the supply of pre-mix 2T oil for lubrication of engines of two-wheelers and three-wheelers;
e) directing the phasing out of grossly polluting old vehicles;
f) directing the lowering of the benzene content in petrol; and
g) ensuring that new vehicles, petrol and diesel, meet Euro-II standards by September, 2000.

It was during the course of these proceedings that the Bhure Lal Committee was established under Section 3 of the Environment (Protection) Act, 1986. The Environment Pollution (Prevention and Control) Authority is a statutory authority constituted under Section 3 of the Environment (Protection) Act, 1986, and its directions are final and binding on all persons and organisations concerned. This position has been reiterated by this Court in Sector 14 Residents' Welfare Association and Others Vs. State of Delhi and Others, (1999) 1 SCC 161. It is this authority which had directed the phasing out of non-CNG buses. It is the Bhure Lal Committee which has also

recommended the conversion to CNG mode and issued directions that non-CNG buses should be phased out.

It is the report of the Bhure Lal Committee which was accepted, and orders were passed by this Court on 28th July, 1998, fixing the time limit within which the switch-over to CNG was to take place. It may be mentioned here that the need for finding an alternative fuel to diesel had been drawing the attention of this Court for quite some time. This is evident from the order dated 21st October, 1994, in which it was observed as follows:- "On an earlier occasion when these matters came up before this Court it was suggested that to begin with of Government vehicles and public undertaking vehicles including public transport vehicles could be equipped with CNG cylinders with necessary modification in the vehicles to avoid pollution which is hazardous to the health of the people living in highly polluted cities like Delhi and the other metros in the country." Again, in the order dated 28th March, 1995, and 9th February, 1996, long before the receipt of the Bhure Lal Committee report, there is a reference to conversion of government vehicles to CNG, as well as to the installation of CNG stations a d kits. It is unfortunate that the efforts of the governmental authorities have not kept pace with the orders passed by this Court. For more than one year, under one pretext or the other, first the NCT of Delhi and then the Union of India have been seeing extension of time for conversion of commercial vehicles to CNG.

While the anxiety of the Delhi Government, to give it the benefit of doubt, was to see that bus services in this city were not disrupted which was the reason that it had sought extensions of the time limit, the response of the Union of India in this regard is baffling, to say the least. With a view that the disruption in bus services does not take place and unnecessary hardship is not caused, this Court has been extending the time with regard to the conversion of commercial vehicles. Time was first extended to 30th September, 2001, and then to 31st January, 2002. It is during the period January, 2001, to February, 2002, that action has been taken by the Union of India, which leaves us with no doubt that its intention, clearly, is to frustrate the orders passed by this Court with regard to conversion of commercial vehicles to CNG. The manner in which it has sought to achieve this object is to try and dis-credit CNG as the proper fuel and, secondly, to represent to this Court that CNG is in short supply and, thirdly, delay the setting up of adequate dispensing stations. In 2001, the Union of India hurriedly set up a Committee headed by Mr. R.A. Mashelkar to give a report with regard to vehicular pollution. It was surprising that since 1986, the Union of India had not thought of setting up such a Committee until after 31st January, 2001, when an order was passed in which the apathy on the part of the Government in carrying out the orders of this Court was taken note of, and the authorities were required to comply with the orders passed.

The composition of the Mashelkar Committee was such that none of its members was either a doctor, or an expert in public health. The said Committee submitted its report, which does not show any serious concern in protecting the health of the people. The Committee recommended that emission norms should be laid down, and that the choice of the fuel should be left to the users. The Committee seemed to have overlooked the fact that such norms had been in place for a long time with hardly any compliance thereof. For instance, the emission norms with regard to the quality of air and water have been statutorily provided for but despite this, prior to 1996, Delhi was the third most polluted city in the world. It will not be out of place to mention that there are various emission and there norms and regulations which are in place, but are invariably breached.

The existence of building regulations have not been able to control rampant unauthorised and illegal construction, just as the existence of norms relating to effluents have not prevented pollution. Yamuna is no more a holy river, it has been relegated to a sewage drain. Norms regarding quality of water and the various orders passed by this Court in another case have not been successful in adding any oxygen in the water, the BOD level being zero. Therefore, it is naïve of the Mashelkar Committee to expect that merely laying down fresh emission norms will be effective or sufficient to check or control vehicular pollution. One of the principles underlying environmental law is that of sustainable development. This principle requires such development to take place which is ecologically sustainable. The two essential features of sustainable development are (a) the precautionary principle and (b) the polluter pays principle.

The "precautionary principle" was elucidated thus by this Court in Vellore Citizens' Welfare Forum Vs. Union of India and Others, (1996) 5 SCC 647, inter alia, as follows:

(1) The State Government and the statutory authorities must anticipate, prevent and attack the causes of environmental degradation.
(2) Where there are threats of serious and irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
(3) The "onus of proof" is on the actor or the developer to show that his action is environmentally benign.
(4) It cannot be gainsaid that permission to use automobiles has environmental implications, and thus any "auto policy" framed by the Government must, therefore, of necessity conform to the Constitutional principles as well as over-riding statutory duties catch upon the Government under the EPA.
(5) The "auto policy" must, therefore,
   (a) focus upon measures to ".Anticipate, prevent and attack." the cause of environmental degradation in this field.
   (b) In the absence of adequate information, lean in favour of environmental protection by refusing rather than permitting activities likely to be detrimental.
   (c) Adopt the "precautionary principle" and thereby ensure that unless an activity is proved to be environmentally benign in real and practical terms, it is to be presumed to be environmentally harmful.
   (d) Make informed recommendations which balance the needs of transportation with the need to protect the environment and reverse the large scale degradation that has resulted over the years, priority being given to the environment over economic issues.

Norms for emission and norms for the fuel have existed for over the last two decades - and the state of the environment is dismal despite the existence of these norms. The emission norms stipulated by the Government have failed to check air pollution, which has grown to dangerous levels across the country. Therefore, to recommend that the role of the Government be limited to specifying norms is a clear abdication of the constitutional and statutory duty cast upon the Government to protect and preserve the environment, and is in the teeth of the "precautionary principle".

The recommendations made by the Bhure Lal Committee and the directions issued in 1998 have not been challenged by the Union of India. The directions issued by the Bhure Lal Committee are statutory and continue to be in force. It is not, therefore, open to the Union of India to seek variation of the same without any justifiable reason. Prior to the

filing of its affidavit of 26th April, 2001, the Union of India never opposed the changeover to CNG. Its application being I.A. No. 116 for variation was dismissed on 27th April, 2001. In the order dated 17th September, 2001, this Court observed, while dealing with another application being I.A. No. 142 in which prayer (d) was that the bus operators should have an option of using either CNG or diesel with 0.05 sulphur content, that "we do not see any justification to grant prayer (d) at this stage". Mr. Rohtagi, Addl. Solicitor General submitted that the use of
the expression "at this stage" meant that such a request could be met or made at a subsequent point of time and that is why the present application filed on 5th February, 2002 for modification had been filed by the Union of India. The said plea of Mr. Rohtagi cannot be accepted and is not in accordance with the orders passed by this Court. As a ready noticed, a prayer to this effect was first made by the Union of India in I.A. No. 116. In the order of 27th April, 2001, it was observed that The Court did not think that any modification of its order dated 26th March, 2001 was required.

The application was disposed of and the request for modification was not accepted. While disposing of the application I.A. No. 142 it was first observed in the order as follows:-

"Our order dated 28.7.1998 with regard to conversion of entire city bus fleet (DTC and private) to single fuel mode of CNG (direction 'G') does not require any modification or change. That direction stands." When in this order, it was observed that there was no justification to grant prayer (d) "at this stage" it only meant that the question of considering such a request did not arise specially when similar plea for modification had been rejected earlier. The expression "at this stage" only meant at this late stage. The use of the expression "at this stage" cannot be interpreted as permitting the Union of India to once again ask for modification of the Court's order with regard to conversion of the city bus fleet to CNG mode. The plea of the Government that CNG is in short supply, and that it is unable to supply adequate quantity is incorrect, and this is clearly a deliberate attempt to frustrate the orders passed by this Court. Particulars filed in Court show that as of today no CNG is being imported. The indigenous produce is far in excess of what is supplied to the transport sector. It is only a small fraction of the CNG produced in India which is earmarked for non-industrial use. Overwhelming quantity is allocated to industries, including the power sector. That there is no shortage of CNG is also evident from the fact that even during the dependency of these proceedings, while on the one hand it was being represented to this Court and the Mashelkar Committee that CNG was in short supply, there was an increase in the allocation of the CNG to industries.

Even when CNG was not being supplied to the Pragati Power Station in Delhi, as the same has not been commissioned, the CNG earmarked for the power unit instead of being allocated to the transport sector, was iverted to the industries in the neighborhood of Delhi. If there is a short supply of an essential commodity, then the priority must be of public health, as opposed to the health of the balance sheet of a private company. To enable industries to cut their losses, or make more profit at the cost of public health, is not a sign of good governance, and this is contrary to the constitutional mandate of Articles 39(e), 47 and 48A. While the industries get natural gas at the rate of about Rs. 3.55 per KG, a commercial vehicle owner in Delhi has to pay about Rs. 13.11 per KG which is four times more than what the industry pays. It was contended by Mr. Rohtagi that natural gas is supplied to the IGL at the same price at which it is supplied to the industries. This argument conveniently overlooks the fact that IGL is a government

company and, therefore, the sale price which the Government and its company gets on sale of CNG in the transport sector is at least four times more than what it gets from the industries.

It is indeed surprising that, ostensibly, with a view to provide more CNG to the transport sector in Delhi, the allotment of CNG to Maruti Udyog Limited (MUL) has been sought to be cancelled. Normally, it would have been surprising that if there is shortage of an essential commodity, then the supply or the sale to the public sector undertaking would be cut, but here, not only is the supply to the PSU being cut, but also at the same time, supply to at least two big business houses has been increased. It would, under the circumstances, not be incorrect to presume that the proposal to cut supply of CNG to MUL was for some oblique purpose. Why should the Government, which is proposing to dis-invest its share in MUL, take the action of cutting supply of CNG, which would result in increasing its expenses and decreasing its value? It is not as if there has been a prorata cut of all the industrial units in and around Delhi, including MUL, with a view to increase supply to the transport sector. The proposed cut appears to be nothing more than an attempt to punish MUL because its Managing Director is a member of the Bhure Lal Committee, which had recommended CNG and, therefore, the Managing Director and this company must suffer. It is clear that there is desire to benefit private industries at the cost of public health and the public exchequer. A major portion of the CNG goes to industries, and the government and its undertakings get less than what it would realise from supplying CNG to the transport sector. Such economics is baffling, to say the least. Not only is there no shortage of CNG as far as the transport sector is concerned, but even if there be such a shortage, if crude oil can be imported and supplied to the refineries for manufacture of petrol and diesel, there is no reason why CNG, if needed, cannot be imported so as it ensures less pollution. During the course of arguments, literature was filed in Court giving data from cities all over the world which co-relates increased air pollution with increase in cardiovascular and respiratory diseases and also shows the carcinogenic nature of Respirable Particulate Matter (RSPM) - PM10 (i.e. matter less than 10 microns in size). The scientific studies indicate that air pollution leads to considerable levels of mortality and morbidity. Fine particulate matter, or respirable particulate matter (RSPM) PM10 (i.e. matter less than 10 microns in size) - is particularly dangerous.

The Journal of American Medical Association (JAMA) has published in its recent issue the findings of a study involving over 500,000 people, conducted over 16 years, in different cities of the US. The researchers find that fine particle related pollution leads to lung cancer and cardiopulmonary mortality. Their research indicates that with an increase of every 10 microgramme per cum (mg/cum) of fine particles, the risk of lung cancer increases by 8 per cent. The USEPA has mandated that annual average levels of PM 2.5 particles in air should not exceed 15 mg/cum.

The Indian annual national average standard for PM10 is 60 mg/cum, but most cities, including Delhi register PM10 levels above 150-200 mg/cum on an annual basis. A study conducted with regard to children in Bangalore show that the incidents of asthma in percentage of children rose from 9% in 1979 to 29.5% in 1999, thereby corresponding increase in vehicles from 1.46 lacs in 1979 to 12.23 lacs in 1999. Similarly, a study by the Chittaranjan Cancer Institute and Environmental Biology Laboratory of the Department of Zoology of Kolkata University done between November, 1997, and May, 1999, found that about 43% of the children in Kolkata are suffering from respiratory disorders compared to 14% among the rural children. Alarmingly 94-96% of the children were

found producing sputum which would usually be reflective of habitual smokers though only 5.5% of the children were found to be smoking and that too occasional. As per the study reflected in the Indian Journal of Medical Research July, 2000, the culprit for the aforesaid was pollution in the ambient air. According to an estimate by the World Bank study using 1992 data, the annual health cost to India was up to about Rs. 5,550 crores due to ambient air pollution. Out of this, the health cost of air pollution in Delhi alone was found to be about Rs. 1000 crores. The increase in respiratory diseases specially amongst the children should normally be a cause of concern for any responsible government. The precautionary principle enshrined in the concept of sustainable development would have expected the government and the health authorities to take appropriate action and arrest the air pollution. However, children do not agitate or hold rallies and, therefore, their sound is not heard and the only concern of the Government now appears to be is to protect the financial health of the polluters, including the oil companies who by present international desirable standards produce low quality petrol and diesel at the cost of public health. The statistics show that the continuing air pollution is having a more devastating effect on the people, than what was caused by the Bhopal gas tragedy. In that case, the nation, including the Union of India, was rightly agitated and sought action and compensation from the multinational company, who was held to be responsible for the same.

Here, in the case of CNG, the shoe is on the other foot because the government is not facilitating measures for clean air and water including the supply of CNG or an other clean unadulterated fuel. It is due to the lack of proper concern on the part of the governmental authorities that people are suffering from respiratory and other diseases. The Bhopal gas tragedy was a one time event which, hopefully, will not be repeated, but here, with not enough concern or action being undertaken by the Union of India, far greater tragedies in the form of degradation of public health are taking place every day. Under these circumstances, it becomes the duty of this Court to direct such steps being taken are necessary for cleaning the air so that the future generations do not suffer from ill-health. As in the past, it is imperative, while reiterating the order of 28th July, 1998, to issue further directions in an attempt to improve public health by decreasing air pollution. We are conscious of the fact that vehicular pollution is only one of the cases of air pollution, but statistics show that, at least in the metropolitan towns, this is the major source of pollution. In the September, 2001 issue of 'PARIVESH' a magazine published by the Central Pollution Control Board relating to air pollution and human health, dealing with diesel exhaust particles and its health effects, it was stated at page 34 of the said issue as follows:

"The popularity of the diesel engine in heavy duty applications in trucking, rail road, marine transport, DG sets and construction industry is due to both its fuel efficiency and long service relative to the gasoline engine. Compared with gasoline engine, diesel emissions are lower in carbon monoxide (CO), hydrocarbon (HC) and carbon dioxide (CO2), but higher in oxides of nitrogen (NOx) and particulate matter (PM). Diesel exhaust is a complex mixture of both particulate and gaseous phase. Diesel exhaust has particulate with mass median diameter of 0.05 to 1.00 micrometer, a size rendering them easily respirable and capable of depositing in the airways and alveoli. The particles consist of a carbonaceous core with a large surface area to which various hydrocarbons are absorbed, including carcinogenic polycyclic aromatic hydrocarbons (PAHs) and Nitro-PAHs that have elicited the most concern with respect to human health. The gaseous phase contains various products of combustion and hydrocarbons including some of the PAHs present in the particle phase. Once emitted, components of diesel exhaust undergo atmospheric transformation in ways that may be relevant to human health. For

example, nitro-PAHs, created by the reaction of directly emitted PAHs with hydroxyl radicals in the atmosphere can be more potent mutagens and carcinogens and more bioavailable than their precursors. A study undertaken by a Swedish Consultancy, Ecotraffic (Peter Ahlvik and Åke Branberg, 1999) shows that the cancer potency of diesel vehicles is more than two times than that of petrol vehicles in India.

But if only the most harmful of the exhaust emissions, that is particulate emission is considered, the carcinogenic effect of one new diesel car is equivalent to 24 petrol cars and 84 new CNG cars on the road." In the same issue, particulars are given with regard to major air pollution related diseases in India which are as follows:-

"(1) ACUTE RESPIRATORY DISEASE: 12% of Deaths; 13% of NBD. Largest fraction in the world. Indian ARI in children alone under 5 is responsible for more than 2% of entire GBD.
(2) CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD):
1.5% of Deaths; 0.9% of NBD (3) LUNG CANCER
0.4% of Deaths; 0.1% NBD (4) ASTHMA:
0.2% of Deaths; 0.5% of NBD (5) TUBERCULOSIS:
8% of Deaths; 5% of NBD; Largest in the world (6) PERINATAL:
6% of Deaths; 7.5% of NBD; Largest in the world (7) CARDIO VASCULAR DISEASE:
17% of Deaths; 5% of NBD (8) BLINDNESS:
0% of Deaths; 1% of NBD; Largest in the world NBD/GBD: National/Global Burden of

Disease" From the aforesaid extracts from the publication of the Central Pollution Control Board, it is evident that there was need to control air pollution, and one of the measures was to reduce the use of diesel. It was with this object in view that the Bhure Lal Committee recommended the use of CNG which was accepted by all the parties including the Union of India when orders were passed to that effect in July, 1998. It was submitted on behalf of the Union of India that diesel and CNG are not materially different in the matter of air pollution and instead of 100% switchover to CNG if there was a mix of CNG and diesel buses of equal proportion the difference would only be of 2% in the pollution levels. We do not find any valid basis for the aforesaid submission. Data from the Automotive Research Association of India, Pune shows that the pollution potential of emissions from CNG is far less than even the Euro-IV standards. This is evident from the following table compiled on the basis of the said data. Comparison of CNG certified test data from automotive research association of India (ARAI) with emissions norms for buses

	Sulphur level in diesel	Hydrocarbon	CO	NOx
1992 standards 1		3.5	14.4	18
1996 standards 1		2.4	11.2	14.4
Bharat Stage 1, April 2000		1.23	4.9	9
Bharat Stage II (EURO 2 standards) October 2001	500 ppm (0.05 %)	1.1	4.0	7
EURO 3	350 ppm	0.66	2.1	5

Standards	(0.035 %)			
EURO 4 standards	50-10 ppm (0.005-0.001) %	0.46	1.5	3.5
Ashok Leyland CNG bus		0.04*	2.92	2.91
Telco CNG bus		0.25*	1.68	3.42

References:
1. CPCB 2000, Environmental Standards for Ambient Air Automobiles Fuels and Noise, July, PCLS/4/2000-2001, p 20, p 29, p 37, New Delhi.
2. Ministry of Road Transport and Highways, The Gazette of India Notification, April 24, 2001, GSR 286 (E), New Delhi, mimeo.
3. J S McArragher et al 1999, Fuel quality, vehicle technology and their interactions, CONCAWE, Brussels, p 7.
4. Ashok Leyland 2001, Emissions certification data of ARAI, mimeo. TELCO 2001, Emissions certification data of ARAI, mimeo.

With the emissions from the CNG vehicles being more than comparable with the EURO-IV standards, the contention of the Union of India that a mix of diesel buses and CNG buses would make a difference of only 2% in the pollution levels is patently untenable. In the case of particulates, current CNG vehicles are 15 times better than Euro-II diesel vehicles (with 500 ppm sulphur) and only Euro IV diesel vehicles are comparable to CNG vehicles. In fact, the certificate issued by the Automotive Research Association of India (ARAI) to the bus manufacturers says that particulate emissions were negligible and could not be measured. The aforesaid analysis emphasize the need for change to non-liquid fuel like CNG or LPG so as to improve the air quality in this country and not merely of Delhi. Such change-over may perhaps obviate the need to manufacture vehicles meeting Euro III or Euro IV standards. It was as a result of the various orders passed by this Court that the air pollution level in the city has been stabilised. In 2000, the levels of annual average levels of RSPM declined to 186 mg/cum from 222 mg/cum. This is no small achievement as the city continues to add over 2,00,000 vehicles each year and its total vehicular fleet is larger than that of Kolkata, Mumbai and Chennai put together. But even with these efforts, its RSPM pollution remains roughly 3 times above the national standard for annual average concentration of RSPM mandated under the Air Act, 1981.

It was repeatedly contended on behalf of the Union of India that no other city in the world had introduced CNG buses at the scale directed by this Court. Both the State Government and the Union of India had urged that the CNG technology was still evolving and experimental. It is no doubt true that most of the cities of the industrialised world do not have large numbers of CNG buses, but the share of natural gas buses, needed to meet the stringent norms in the future, are growing. The data filed indicates that in the United States, CNG buses account for 18 per cent of the current bus orders and 28 per cent of the potential orders. Under pressure to clean up the air because of the approaching Olympic Games in 2004, Beijing has resorted to an alternative fuel strategy. Latest figures from Beijing indicates that there will be 18,000 buses fuelled by CNG, LPG and electricity in that city. By 1999, Beijing had 1300 CNG buses and the numbers are growing rapidly to meet the Olympic deadline. Similarly, the Ministry of Environment in South Korea - partly to meet the targets in time for 2002 World Cup Soccer aims to induct 20,000 natural gas buses in its fleet and already 3000 such buses are plying. [Source: Moon-Soo Ahn 2000, Korean CNG bus programme The environmental

Benefits, Ministry of Environment, Korea, Automotive Pollution Control Division, mimeo.]

From the aforesaid, it is clear that the alternative fuel of CNG, LPG and electricity is a preferred technology which critically polluted cities like Delhi need as a leapfrogging technological option. This Court has shown concern about the reports relating to adulteration of petroleum products in Delhi. A report was called for from the Bhure Lal Committee. The said report confirms that adulteration is taking place. The sample failure rate in the study which has been carried out was 26 per cent. The report also indicates that the existing fuel specification standards and the tests specified are inadequate for detecting adulteration. Two dummy samples - one with 10 per cent and the other with 20 per cent kerosene were sent to the Fuel Testing Laboratory, Noida. The result of the test report of the test laboratory showed that the product met the specification of HSD. However, a third sample with 15 per cent contamination was declared as not meeting the HSD specification. This shows that reliance cannot be placed on such laboratories which puts in great doubt the entire mechanism for detection of adulteration. Considering the quantity of kerosene which is supplied to Delhi it is not improbable that this is one of the ingredients used, along with naphtha etc. for adulterating the fuel supplied to the customer. Under the circumstances, merely lowering the sulphur and the benzene content in diesel and petrol respectively will have a little effect unless and until the oil companies can guaranty that the fuel which was sold from the dispensing stations is pure and unadulterated. In fact, there is one public sector undertaking which advertises its petroleum products as "pure for sure". It guarantees hat the fuel which can be obtained from its dispensing stations is unadulterated. This by itself clearly indicates acknowledgement by the petroleum industry that adulteration in not a small measure is taking place and, therefore, the need to advertise the purity of the products sold by the Bharat Petroleum. It has been alleged, and there is strong basis for this, that as a result of adulteration, large amounts of illegal gains and profits are being made. There are various players in this racket. It is not surprising, therefore, that there is stiff resistance to the implementation of the orders of this Court for switch-over to gas which cannot be adulterated and will undoubtedly cause financial loss to the members of the unholy alliance of adulterator.

As per the available information there seems to be no apparent shortage of gas. The supply of gas from the South Bassein gas fields has increased over the past some years, from 38 mmscmd to 41 mmscmd. Major investment has already been sanctioned for expansion of infrastructure to supply natural gas as well as regassified LNG to northern India. The Union of India has argued that breakdown in the pipeline would lead to disruption in supply to the city and could paralyse the transport system which would be solely dependent on CNG. However, available information suggests that the possibility of the pipeline breaking down is remote. Furthermore, the pipeline itself stores up to 3 months of gas supply needed for Delhi. The Union Government has to allocate more gas to Delhi to implement the order of this Court. In January, 2002, the Union Government has roughly doubled its earlier allocation to Delhi's vehicular fleet. But even this increased allocation - by diverting gas from a single user, Maruti Udyog Limited - will be inadequate for implementing the Court's order. To meet the needs of current and projected vehicles in the city – the city requires a mere 4.8 per cent of the current supply of gas by the HBJ pipeline. The production of gas in the South Bassein gas fields has also increased over the last 2-3 years. But the increased production has been allocated to industries, instead of meeting the needs of vehicles arising out of this Court's orders.

According to available information

- Reliance Industries got an additional 0.7 mmscmd;
- Essar got an additional 0.4 mmscmd;
- Gujarat State Fertilizer Corporation got an additional 0.4 mmscmd;
- GIPCL (power generating company in Baroda) got 0.5 mmscmd (this gas is being reported supplied without any allocation by the government and as a "matter of favour"); · IPCL - Dahej got an additional 0.85 mmscmd.

As per the latest figures available, there are 3,727 CNG buses on the road. The additional number of buses, which have to be phased out are 6,338. Once this is done, the tota lnumber of CNG buses on the road will be 10,065. In the I.A. filed on behalf of the bus manufacturers, it is stated that 1500 chassis which had been ordered are ready for delivery but the persons who placed orders have not taken the delivery. Therefore, at least 1500 buses can be replaced immediately. As per the affidavit filed by the manufacturers, between Ashok Leyland and TELCO, they have an installed capacity of 1,100 buses per month. Assuming production of around 70 per cent of the installed capacity, it would be safe to proceed on the footing that between the two of them they can provide 800 buses a month. If all the bus operators chose to buy new buses then @ 800 buses per month, thee entire fleet of remaining 4838 buses, in addition to the 1500 chassis ready for delivery, can be phased out is not more than 7 or 8 months.

The request of the government for phasing out 200 buses a month appears to be based on some imaginary shortage in the availability of gas. There is no credible material placed before the Court to show that the distribution of gas is consistent with the principle of sustainable development. Conferring economic advantage upon industry by making available cheap gas in preference to the need for supplying gas for environmental reason is inconsistent with the settled Constitutional position. Even though the time for phasing out diesel buses had expired but in view of the situation created by the Government of not cooperating or complying with the Courts order, a different formula has to be worked out so as to cause as little inconvenience to the traveling public as possible, while at the same time punishing the wrong doer. Directions are, therefore, to be issued regarding the lifting of 1500 buses plus phasing out of 800 buses per month. The permits to be given are to be time bound and the continued operation of the diesel buses till they are replaced would require them to pay Rs. 500/- per bus per day for 30 days of operation and thereafter Rs. 1,000/- per day and the same is to be deposited with the Director of Transport, Delhi. Before concluding on this aspect, we may notice that on a query raised by the Court, the Union of India has informed the LPG has also been permitted to be used as fuel by the transport sector. This can and should be an alternate fuel to CNG available to the users as LPG is, at present, environmentally acceptable. It is for the Government to take steps so as to increase it's supply. We may here note that there are, as per CPCB data, at least nine other polluted cities in India where the air quality is critical. These cities are Agra, Lucknow, Jharia, Kanpur, Varanasi, Faridabad, Patna, Jodhpur and Pune. But there appears to be no effective action plan to address the problem of these cities and the Mashelkar Report ensures their suffering for quite some time. If no immediate action is taken, then it may become necessary for some orders being passed so as to bring relief to the residents of those cities.

Lack of adequate supply of CNG has been a cause of concern and has been referred to in the various orders passed by this Court from time to time. In the absence of proper response from the governmental authorities, there is no alternative but to issue the following directions:

1. The Union of India will give priority to transport sector including private vehicles all over India with regard to the allocation of CNG. This means that first the transport sector in Delhi, and in the other air polluted cities of India, CNG will be allocated and made available and it is only thereafter if any CNG is available, that the same can be allocated to the industries, preference being shown to public sector undertakings and power projects.

2. I.A. of the Union of India for extension of time to run diesel buses is dismissed with costs of Rs. 20,000/- (Twenty Thousand only). It is made clear, and it is obvious in our constitutional setup, that orders and directions of this Court cannot be nullified or modified or in any way altered by any administrative decision of the Central or the State Governments. The administrative decision to continue to ply diesel buses is, therefore, clearly in violation of this Court's orders.

3. Those persons who have placed orders with the bus manufacturers, and have not taken delivery of the same shall do so within two weeks from today, failing which their permits shall stand automatically cancelled.

4. As owners of diesel buses have continued to ply diesel buses beyond 31st January, 2002, contrary to this Court's orders, for the disobedience of the said orders, the Director of Transport, Delhi, will collect from them costs at the rate of Rs. 500/- per bus per day increasing to Rs. 1,000/- per day after 30 days of operation of the diesel buses with effect from tomorrow and the same shall be deposited in this Court by the Director of Transport by the 10th day of every month.

5. The NCT of Delhi shall phase out 800 diesel buses per month starting from 1st May, 2002. Till all the diesel buses are replaced the bus owners who continue to ply the diesel buses shall pay as per direction No. 4 herein above.

6. For implementing these directions, the Union of India and all governmental authorities, including IGL shall:-

a. Allocate and make available 16.1 lakh kg per day (2 mmscmd) of CNG in the NCT of Delhi by 30th June, 2002 for use by the transport sector;

b. Increase the above supply of CNG whenever the need arises;

c. Prepare a scheme containing a time schedule for supply of CNG to the other polluted cities of India and furnish the same to this Court by 9th May, 2002 for it's consideration;

d. It will be open to the Union of India to supply LPG in addition to CNG as an alternate fuel or to supply any other clean nonadulterable fuel as the Bhure Lal Committee may recommend.

7. The NCT of Delhi had announced a scheme for financing CNG vans, to be run as taxis, for SC/ST. We direct a similar financing scheme be framed by the Union of India jointly with the NCT of Delhi whereby those of the permits of owners of diesel buses are cancelled due to nonconversion to CNG the same should, in the first instance, be allotted to SC/ST and to the other weaker sections of the society. Such a scheme should be prepared and implemented and a compliance report be filed within four weeks. The costs deposited under direction (4) above can be utilised in implementing the proposed scheme. To come up on 9th May, 2002 for further orders by which date the Union of India and the N.C.T. of Delhi will file a further report.

.....J. (B.N. KIRPAL) .....J. (V.N. KHARE) .....J. (ASHOK BHAN)

New-Delhi; April 5, 2002

NOTES

NOTES