"Comparative Economical Study of Vehicle" Running on CNG Vs Petrol

A DISSERTATION REPORT

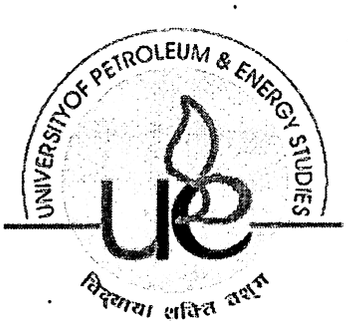
Submitted by
JAGDAMBIKA PRATAP SHAHI

In partial fulfillment for award of the degree
Of
MS (OIL TRADING)

College of MANAGEMENT

Under Supervision of

Dr.A.S.PANDEY



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

NCR CAMPUS - GURGAON

CERTIFICATE

This is to certify that the dissertation entitled "" which is being submitted in partial fulfillment for the award of Master of Science in Oil Trading by **Mr. Jagdambika Pratap Shahi** is a bonafide work carried out by him under my supervision and guidance. This work has not been published elsewhere or submitted for the award of any other degree.

Dr. A.S.PANDEY

UPES, GURGAON

Acknowledgement

Each vehicle requires the driver, without the driver the vehicle is worthless and cannot reach the destination in the same way my project also wouldn't be complete without the guidance of. *Dr.* **A.S.PANDEY, UPES, GURGAON.** It is a matter of great pleasure for me to get this opportunity of expressing my deep and sincere of gratitude for his guidance and generous support that gave me sufficient strength to prepare this project. And at last we are grateful to the **U.P.E.S. (Gurgaon), Academic Division** for their effort in completion of project.

Jagdambika Pratap Shahi
MS(Oil Trading)
University of Petroleum & Energy Studies

CHAPTER SCHEME

Chapter - 1

INTRODUCTION

- Alternative Transport Fuels
- Main Users of Alternative Fuels
- Conclusion
- Chemistry
- Production

At present near about four by fifth of the world's demands for transportation fuels -- road, rail, air and sea – is fulfilled from the fossil fuel, petroleum Petrol, which is one of the major derivatives of petroleum. Petrol is used throughout the world as a motor vehicle fuel.

There are various other petroleum derivatives including diesel and liquefied petroleum gas which can be substituted to petrol as can compressed natural gas, which often occurs in conjunction with petroleum deposits. Alternatives are derived from non-fossil, or partly renewable, sources such as grain or other agricultural crops. But these fertilizers made from fossil fuels are not fully renewable.

The major fossil fuel alternatives to petrol are:

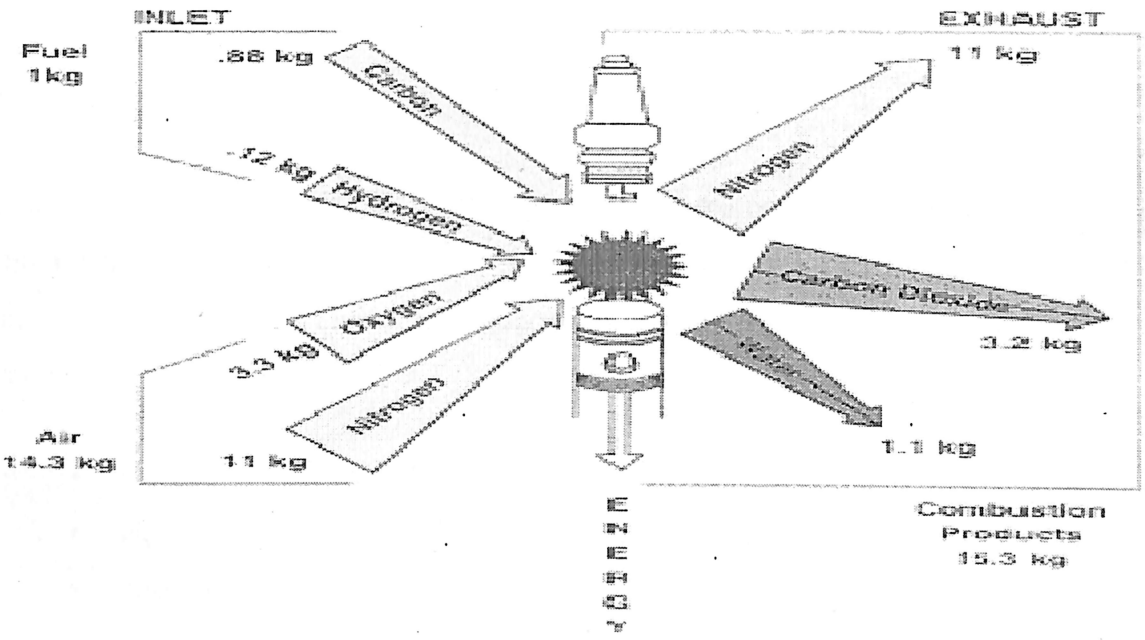
- Diesel
- Liquid Petroleum Gas (LPG)
- Compressed Natural Gas (CNG)
- Ethers - Methyl Tertiary Butyl Ether (MTBE) produced from Natural Gas and Butane.
- Electricity from Coal/Oil/Gas and

Methanol produced from natural gas or coal, and the major non-fossil alternative fuels:

- Ethanol
- Hydrogen.

Although nearly eight million vehicles worldwide currently run on blends containing alternative fuels, it is unlikely that any one of these fuels will achieve the worldwide usage of petrol in the foreseeable future, primarily because they are too expensive.

However the concerns about the impact of fossil fuels on the environment, is raising the issue regarding the suitable alternatives.


INLET
EXHAUST
Fuel
1kg
.86 kg
Carbon
.12 kg
Hydrogen
Oxygen
3.3 kg
Nitrogen
11 kg
Air
14.3 kg
11 kg
Nitrogen
Carbon Dioxide
3.2 kg
1.1 kg
Combustion
Products
15.3 kg
ENERGY

PETROLEUM

Petroleum, known as crude oil, is found in underground deposits in the entire world and contain near about 300 compounds of hydrogen and carbon, or hydrocarbons, as well as Sulphur and nitrogen. Its elemental composition is fairly constant but ther might be slight fluctuation

- Carbon -- 83 to 87%
- Hydrogen -- 10 to 14%
- Nitrogen -- 0.1 to 2%
- Oxygen -- 0.05 to 1.5%
- Sulphur -- 0.05 to 6%

Production

Earlier the refineries usually had a simple distillation process to separate crude oil into its components according to their boiling points. These simple distillation process are atmospheric and vacuum distillation these are known as topping units.The petrol produced by this method was only that naturally occurring in the crude oil.

As demand for motor spirit rose, engineers and chemists found that further severe heating of the higher boiling points hydrocarbons broke them down, or 'cracked' them, into smaller, lower boiling hydrocarbons more suitable for petrol production. This process was known as CRACKING. From 1913, thermal cracking was used to increase petrol production. But later on it was discovered that substances known as 'catalysts' found to do a better job of cracking hydrocarbons than heat alone, by speeding up the reaction and producing a greater yield of higher octane petrol.

COMPRESSED NATURAL GAS (CNG)

PRODUCTION

Natural gas is a mixture of gases, mainly hydrocarbons, found in geological formations. Methane is the major component in the mixture, generally comprising from 87 per cent to 97 per cent by volume of the hydrocarbons depending on the source of the gas.

CHEMISTRY

In addition to Methane (CH_4), Natural Gas comprised of small percentages of:

- Ethane (C_2H_6)
- Propane (C_3H_8)
- Butane (C_4H_{10})
- Pentane (C_5H_{12})
- Nitrogen, Oxygen and Carbon Dioxide

- It can be compressed and used as an automotive fuel.
- Its combustion is given by:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

CONCLUSION

No doubt, petrol is a convenient fuel for cars. It is easy to store and handle, as a petrol fuel tank takes up little space in a car. It is, like all other fuels, highly combustible and therefore potentially dangerous, particularly if a fuel tank ruptures.

But when it comes to the cost side, with exception of diesel fuels, alternative fuels at present are not commercially viable to use in cars in Australia, and nor indeed in other countries without any form of government assistance such as subsidies or tariffs. The cost of the alternatives used is high as compared with petrol. Petrol's current competitors in Australia -- CNG and LPG -- are subsidized through exemption from government excise, reducing their retail price by as much as 40 cents a litre.

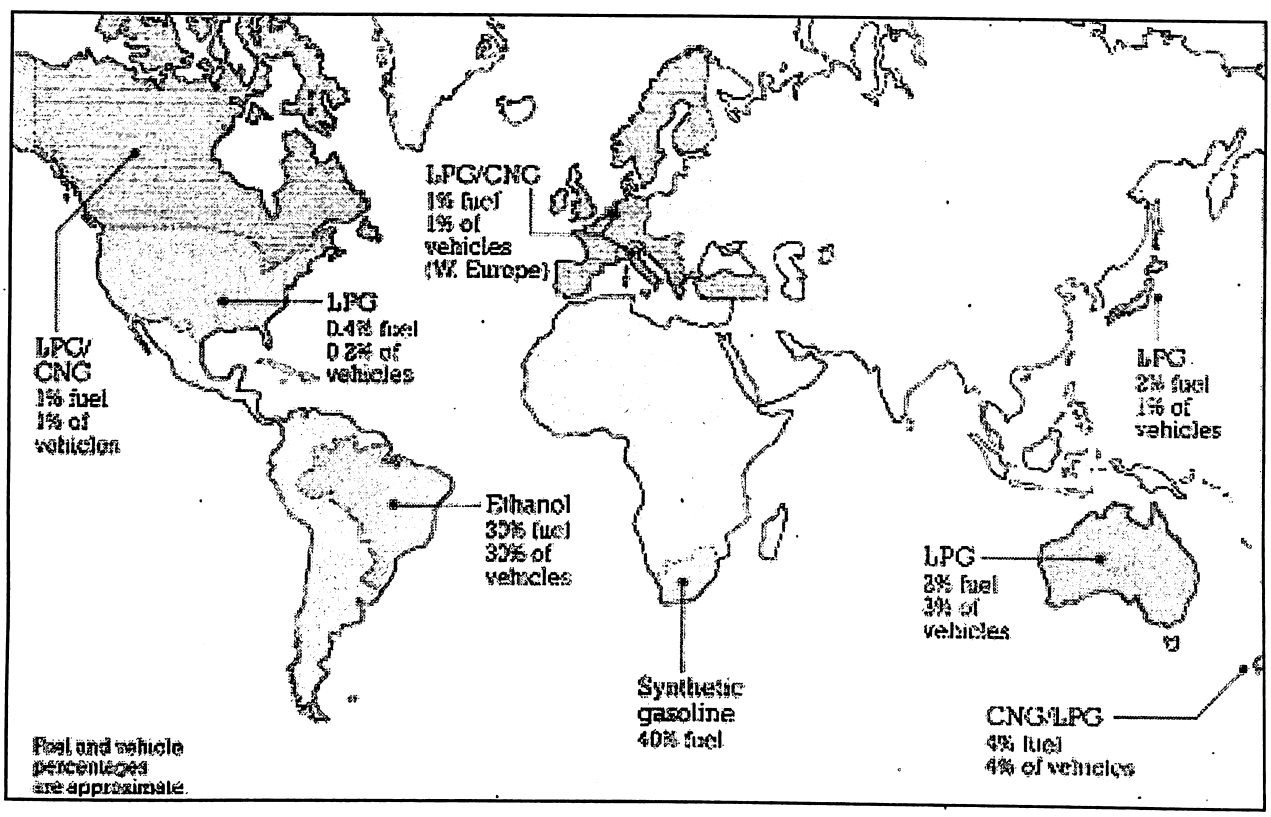
But using the alternative fuels also have specific problems associated with them. As gases, hydrogen, LPG and CNG pose hazards in storage and in refueling operations. Methanol is toxic and is therefore a health hazard. It also corrodes engines. With respect to safety, all fuels are hazardous but when correctly engineered the risk can be minimized and is probably similar for all.

At first instance, the blending of ethanol with petrol seems to be the best combination of convenience and safety but there is a limitation that it is uneconomic and restricted in supply. It decreases the vehicle range, poses some problems for existing car engines and produces levels of smog precursor emissions similar or greater to those of petrol. But it seems to be that CNG is the fuel, which is likely to penetrate into the transport fuel market in the near future, as city bus fleets are progressively replaced by CNG, powered versions in order to reduce particulate emissions.

The alternative fuels does not have significant impact worldwide, because they involve more compromises than does petrol, some have a potential role to play in areas of special requirements, such as cities with extreme air pollution, or in undeveloped countries with no indigenous petroleum deposits and an inability to participate in normal world trade.

Nevertheless, the lower cost of petrol and diesel and availability of new technologies to improve the emission performance of engines using these fuels, will ensure that for some time to come, petrol will continue to be the preferred and most widely used motoring fuel in the world closely followed by diesel.

Main Users of Alternative Fuels



Chapter - 2

REVIEW OF LITERATURE

Dursbeck, F., Erlandsson, L., Weaver, C. 2001, 'Status of Implementation of CNG as a Fuel for Urban Buses in Delhi':

It is explained that what standards are there for the CNG kit? Description regarding the pros & Cons for implementing CNG kit in Delhi Urban buses. It stated the economical and environmental benefits of CNG in comparison to other fuels.

1. **ESI International 1999, 'Diesel Emission Control Strategies Available to the Underground Mining Industry', Washington DC, United States of America. :**
   It is stated the Introduction of underground mining industry. Different strategies for controlling diesel emission also adding with the inn & outs of different strategies. This will also cover different alternate fuel that can be replaced in place of diesel. It also emphasized on economical benefits of alternate fuels.

2. **French, T. M. 1990, 'Compressed Natural Gas Vehicles', Department of Natural Resources, Louisiana, United States of America. :**
   Regarding methods of compressing the natural gas. Also we will learn how CNG is more efficient fuel then other sources of hydrocarbon. Benefits of using natural gas as fuel.

3. **National Transportation Library 2004, 'Clean Air Program: Summary Assessment of the Safety, Health, Environmental and System Risks of Alternative Fuel'. :**
   Pollutive contents in alternative fuel, in this we will study and find out how CNG is cleanest and environment friendly.

4. **Nicor Gas Inc. n.d., 'How does an NGV operate?', Nicor Inc., Illinois, United States. :**
   In this we will find out how NVG get operated. Its economical competitiveness. It also explained the technical viability of NG

Chapter - 3

OBJECTIVES OF THE CAMPAIGN TO RUN BI-FUEL CARS

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 enhance i.e.: CNG stands for Compressed Natural Gas which 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, economical and available in abundance globally.

Objectives for switching over to this alternate fuel are mainly:

1. **Economic benefit:** The cost of CNG is almost one third of the cost of Petrol in terms of calorific value leading to substantial saving in fuel cost, and investment on the CNG kit is paid back in a short period

2. **Environment friendly:** The CNG 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 the conventional fuel - Petrol. Carbon Dioxide emissions, a cause for global warming, are also reduced significantly by 10%

3. **100% Income Tax Depreciation:** Corporate Organizations, firms, etc. can avail the benefit of 100% depreciation on a CNG Conversion Kit as this is a pollution controlling equipment. Organizations that buy CNG Conversion Kits should consult their Income Tax Consultants and avail of the depreciation benefits

4. **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. There are very few CNG refueling stations. Of the ones that exist, there are three basic types. Fast fuelling stations, which take five to ten, minutes for refueling, ideal for retail roadside pumps. Slow fuelling stations that take from five to eight hours to fill, ideal for a fleet of vehicles that have a long idling time. Combined Fast and Slow fuelling stations that can cater to both the above categories. CNG is stored at compression stations that are

directly connected with the gas pipeline. Here the gas is compressed to a required pressure and aids fuelling. CNG can also be transported to other retail outlets by cylinder trucks. These trucks carry a number of cylinders that provide CNG to fuel stations that are not connected by pipelines. These fuelling stations could be placed alongside petrol and diesel pumps too. The whole process requires proper infrastructure and transportation.

Vehicles can also be operated in the dual mode like Petrol-CNG and Diesel-CNG. Telco, Kirloskar Cummins Ltd., Ashok Leyland, IBP, OIL have conducted experiments of these kinds on vehicles,

5. **Delhi transport Corporation and Gujarat Road Transport Corporation. The results were quite satisfactory.**

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.

Chapter – 4

FACTS ABOUT THE BUYERS

- **Alternative Fuel Vehicle Buyer's Guide**
- **Car benefit: bi-fuel or road fuel gas cars overview**

For prospective buyers interested in CNG vehicles in particular, the Natural Gas Vehicle Coalition's web site (www.ngvc.org) includes a 1998-99 Purchasing Guide that provides descriptions, by manufacturer, of light-, medium-, and heavy-duty dedicated CNG and bi-fuel vehicles, including specifications, availability, and cost. In the light-duty category:

- Ford offers, in addition to the Contour, a dedicated CNG version of the full – size Crown Victoria, as well as bi-fuel and dedicated vans and wagons. A dedicated CNG pickup truck is available now, and a bi-fuel version will be on the market early this year.
- The Cavalier from Chevrolet/GMC is another small bi-fuel passenger car. GMC also makes bi-fuel pickup trucks.
- Chrysler manufactures dedicated CNG vans and wagons.
- A dedicated CNG version of the Civic GX is available from Honda.

1. Locate dealers in your area that have alternative fuel vehicles for sale.

The AFV Fleet Buyer's Guide (also appropriate for individual buyers) on the DOE's Clean Cities web site (www.fleets.doe.gov) provides links to dealers by city/state, zip code, and area code/phone prefix. You can also call each manufacturer's alternative fuel number for information on local dealerships:

Ford: 800-A; T-FUEL	Honda: 888-CC-HONDA.
Chevrolet/GMC: 888-ALT-FUEL	Nissan: 800-222-5500
Chrysler: 800-999-3533	Toyota: 310-618-4484

2. **Make sure the alternative fuel of interest is available in your area and that public fueling stations are conveniently located.**

The Alternative Fuels Data Center web site contains a refueling station address locator that allows you to locate alternative fueling sites by fuel, city, and state and then obtain specific data, such as public accessibility and hours of operation, on individual stations.

Find out about state, local, and private incentives available to purchasers of alternative fuel vehicles.

Figure out the cost and benefits.

Once you've obtained the information above, assess the feasibility of investing in an alternative fuel vehicle by answering these basic questions:

- Are your driving needs compatible with the driving range and the recharging/refueling demands of an electric vehicle or a dedicated CNG vehicle?
- Are your driving needs compatible with the driving range of a CNG vehicle supplemented by gasoline (i.e., a bi-fuel vehicle)?
- How much will tax credits, rebates, and any other available financial incentives offset the additional cost of buying or converting to an alternative fuel vehicle?

If tax exemptions on alternative fuels are available in your state, how will they affect the cost of fuel?

❖ CAR BENEFIT: BI-FUEL OR ROAD FUEL GAS CARS OVERVIEW

Bi-fuel cars are those capable of running on either petrol or a road fuel gas that have separate fuel tanks for each.

There are two main types of road fuel gas, though they are both treated in the same way. In practice, most cars that currently run on road fuel gas use Liquefied (or Liquid) Petroleum Gas (LPG). People who drive cars of this sort often call them LPG cars rather than road fuel gas cars. The other main type is Compressed Natural Gas (CNG).

To avoid repetition, the guidance for these vehicles will refer to LPG. It applies equally to any other form of road fuel gas.

Types of bi-fuel or LPG car

For car benefit purposes LPG cars are divided into types B and C.

Type B (see EIM23445)

- Cars that run on gas alone (rare at present)
- Bi-fuel cars that were approved as bi-fuel cars and were first registered on or after 1 January 2000. These cars have two approved CO2 emissions figures, one each for petrol and gas (though only one may appear on the Vehicle Registration Document, V5, or the Vehicle Registration Certificate, V5C, which replaced it between January 2004 and June 2005).
- Type C (see EIM23450)

All bi-fuel cars not in type B but first registered on or after 1 January 1998. They are of two sorts (the names C1 and C2 are used only in EIM, not on the P46 (Car or P11D):

Chapter – 5

FACTS ABOUT BI-FUEL CARS

1. Are Bi-Fuel cars slower and less responsive?

Although there is a minimal drop in power when running on gas, there is no noticeable difference in performance when powered by gas under normal driving. Also, there is a very quick and smooth transition during the changeover between fuels.

2. Does the gas tank take up space in the boot?

The fuel system has been engineered by Volvo itself and is integral to the design of its cars. The gas tanks in the latest S60, V70 and S80 Volvos are completely hidden under the rear floor and offer exactly the same load space as the standard models, while there is only a small raised area in the floor of the S40 and V40 that still leaves a clear platform for carrying long loads, when required.

Note: The only limitations imposed by the gas tanks are:

- The optional extra seat in the rear of the V70 is not available
- There is no spare wheel. Volvo advises carrying a tyre fix spray can or tyre pump
- Some bass speakers under the rear floor of estates are unavailable

3. Where is it converted?

It's not. Unlike some other manufacturers Volvo produces its Bi-Fuel models on the same production lines as its standard models and are sold with the full Volvo Car Ireland 3 yrs, 60,000-mile warranty.

4. Why not just get my own car converted?

Volvo's own bi-fuel models are likely to always be superior to any after-market conversion as they are specifically designed for Volvo, produced in its own factories, sold with its full 3-year 60,000 mile warranty,. and fully integrated into the car with special switches on the dashboard and gas fuel gauge alongside the petrol one on the instrument panel.

5. Is a Bi-Fuel car safe?

Like any Volvo, Bi-Fuel models are rigorously collision tested in accordance with Volvo's high standards. The gas tanks are tested in a variety of extreme conditions (including heat, high pressure, fire and pistol shots) and to greater limits so they are stronger than the comparable petrol tanks to allay any safety concerns. A closed fuel system prevents fuel spillage and evaporation.

6. Is Volvo seriously committed to the environment and alternative fuels?

Yes. The environment is one of Volvo's three core values - Environment, safety and quality. As such it has devoted considerable resources into the constant monitoring and development of alternative fuels.

7. Hasn't Volvo sold Bi-Fuel models before?

Yes. Volvo has pioneered alternative fuelled vehicles and marketed earlier gas-powered vehicles. It is now the first manufacturer with a fully warranted Bi-Fuel range with the latest, discreetly integrated, under-floor gas tanks.

8. Is LPG/CNG available abroad?

Yes. LPG is widely available across Europe. Holland and the UK use the same LPG filler nozzle, while an adapter (supplied with the car) is required to refuel in other European countries. CNG is more limited – but more popular in some countries, such as Germany and Sweden. Refer to appropriate websites for refueling locations before travel. **Note:** Euro tunnel does not currently allow gas-powered cars to travel on its trains. It has issued this statement:

'LPG and dual-powered vehicles are currently prohibited from traveling on Eurotunnel shuttle services because of the safety problems associated with the design of fuel tanks fitted to some LPG-powered vehicles. We have never intended that the ban on these vehicles should be permanent. We do not believe there is anything inherently unsafe

about LPG-powered vehicles, which we acknowledge are an increasingly popular, clean, and efficient form of transport. Incidents on the Continent have confirmed our view that the prohibition should not be relaxed until new manufacturing standards for such vehicles are agreed and enforced throughout Europe. In order to carry such vehicles, we would need to seek approval from our independent safety regulator for an extension to our operating certificate to cover such vehicles.'

9. What is the towing capacity of a Bi-Fuel model?

Volvo Bi-Fuel cars have the same towing capacities as the equivalent petrol models.

Chapter – 6

COMPARATIVE STUDY : CNG - PETROL

Let us try to determine which is Economical: CNG or PETROL

Suppose a life span of a Maruti 800 Car is 50000 km. If we run it on CNG and run it on Petrol, we have to determine which fuel is economical.

Cost of running	
Cost of the CNG Kit	Rs.40000/-
Current Price of the CNG	Rs.22/Kg
Average of the vehicle running on CNG is around	22Km/Kg
Thus, Cost of running on CNG is	Re.1/Km

So, cost of running a vehicle on CNG:

(50,000 * 1 + 40,000) 50,000 = Rs.1.8/ Km

Current Price of Petrol	Rs.47/Liter
Average of the vehicle running on Petrol is around	18Km/Liter
Thus, Cost of running on Petrol is around	Rs.2.6/km

So, cost of running a vehicle on Petrol:

(50000*2.6)5,000 = Rs.2.6/Km

So, from the above analysis, it is clear that CNG is more economical than the Petrol.

It is always been matter of discussion that is there is any effect on the engine by using CNG. Although there is a minimal drop in power when running on gas, there is no noticeable difference in performance when powered by gas under normal driving. Also, there is a very quick and smooth transition during the changeover between fuels.

Chapter – 7

BENEFITS OF BI-FUEL CARS

❖ CAUSES OF AIR POLLUTION FROM VEHICLES

CAUSES OF AIR POLLUTION FROM VEHICLES:

Before going into what instruments can be used, it is instructive to see what causes the vehicular pollution. Vehicular pollution sources are not homogenous as there is a complete range of technological mix.

A number of factors can be identified as influencing the amount of emissions attributable to the transport sector, and an effective strategy will need to take all these factors into account. They include:

(a) Excessive vehicle use. Level of activity or vehicle use is an important factor to take into account in the overall analysis of transportation emissions, particularly in those cases where long-run solutions are envisioned to help avoid the development of a problem. In a number of developed countries (where data and information are more readily available), studies have shown that growth in activity has either significantly increased the amount of CO_2 emitted in the sector or substantially dampened the reduction of CO_2 emissions that would have occurred, the latter because of efficiency improvements during the last three decades of the twentieth century. In the absence of a policy to address vehicle use, growth in vehicle kilometers traveled in developing countries is projected to average between 2.5 and 4 per cent per year between 1990 and 2030.

Excessive car use is a particular and likely manifestation of excessive travel under conditions where a cultural phenomenon of car (or motorcycle) dependence develops, in combination with a number of potential price distortions that favor car use. These might include: fuel subsidies to other sectors with unintended but predictable effects on the transport sector; general subsidies to road users built into the financing of how roads are constructed and maintained, and ancillary services delivered; hidden and fixed costs in road infrastructure and land-use provision, which send unclear price signals to potential travelers; and secondary price distortions in land values that incorporate or capitalize these other (primary) distortions.

(b) Age of fleet and technology used. Older vehicles are associated with higher emissions of both global and local pollutants than newer vehicles, both because performance deteriorates as a function of age and because older vehicles are more likely to use obsolete, higher emitting technology.

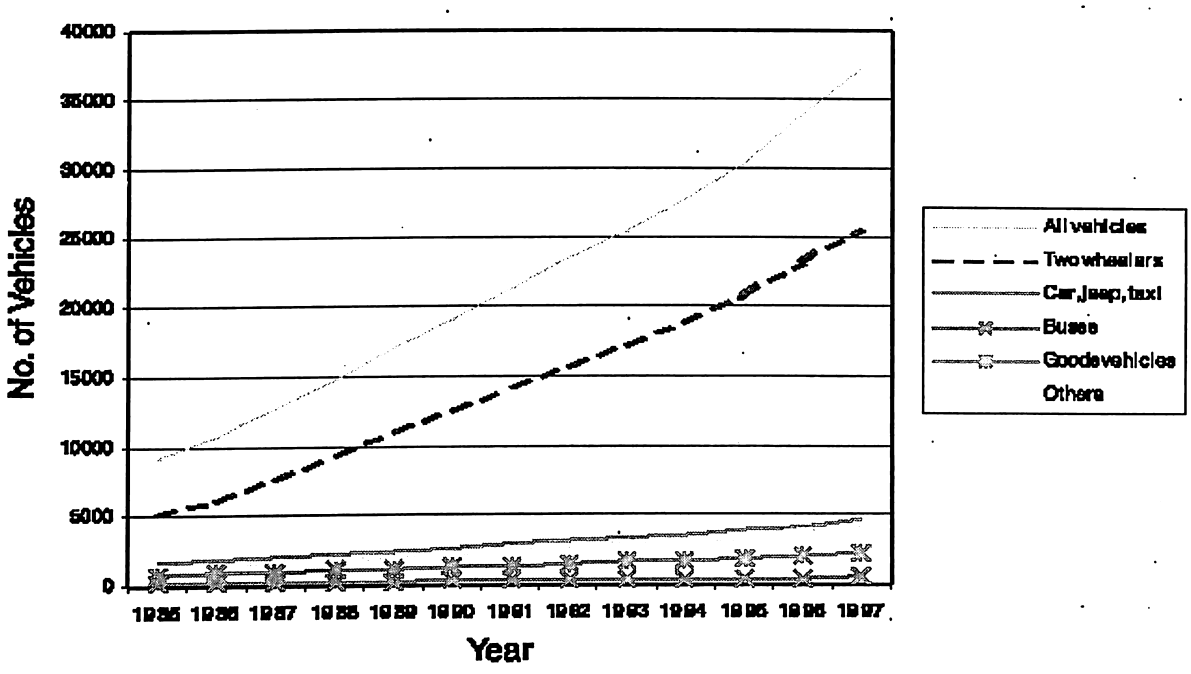


Figure2: Vehicular growth in India

(c) Poor maintenance of vehicles. Deterioration of emissions characteristics is linked to maintenance practices of owners, particularly for local pollutants, where catalytic exhaust after-treatment technology is used. Misfuelling of catalyst-equipped gasoline vehicles with leaded fuel, even once or twice, can seriously damage the ability of the catalyst to operate properly, and these catalysts can also degrade over time because of other natural contaminants in fuels. Without an effective system in place to ensure that these systems are well maintained, emissions due to neglecting exhaust after-treatment maintenance are likely to increase.

(d) Unavailability or improper use of appropriate fuels. Fuel is a factor for a number of reasons. Regulatory authorities may inappropriately specify fuel types for a given

area's conditions, leading to unnecessary emissions of certain kinds of pollutants. Vehicle owners may misfuel, out of ignorance or in response to a poorly established price signal. Finally, dishonest retailers might adulterate or substitute fuels, again often in response to an unfortunate price signal.

(e) Increase in urban population: Between 1951 and 1991, the urban population has tripled, from 62.4 million to 217.6 million, and its proportion has increased from 17.3% to 25.7%. Nearly two-thirds of the urban population is concentrated in 317 class I cities (population of over 100 000), half of which lives in 23 metropolitan areas with populations exceeding 1 million. The number of urban agglomerations/cities with populations of over a million has increased from 5 in 1951 to 9 in 1971 and 23 in 1991 (Pachauri and Sridharan 1998). This rapid increase in urban population has resulted in unplanned urban development, increase in consumption patterns and higher demands for transport, energy, other infrastructure, thereby leading to pollution problems.

Chapter – 8

MESSAGE STRATEGY OR MEDIA STRATEGY

- **GOVERNMENT STRATEGY TO PROMOTE GAS AS FUEL FOR VEHICLES.**
- **VOLKSWAGEN'S FUEL STRATEGY.**
- **TYPES OF FUELS & THERE PROPERTIES.**

Following strategies has been adopted by the Government to promote the use of natural gas as the source of fuel for Vehicles:

- To encourage the laying of natural gas pipelines and promote gas as a preferred fuel, the government has proposed to encourage private investment in this sector by introducing permit system. The subsequent competition in the natural gas market is also aimed at bringing down gas transmission prices.
- To begin with, the Ministry of Petroleum and Natural Gas has set up a gas cell, which has proposed regulatory framework to introduce transmission, distribution and supply of natural gas by pipelines on an open access and non-discriminatory basis, including third party access and competitive tariffs.
- According to information available, the proposed Petroleum and Natural Gas Regulatory Board will later issue permits to the transmission and distribution companies for different regions. It will make it obligatory for the permit holders to supply gas by charging at non-discriminatory transmission fee.
- The ministry has proposed these regulations on the recommendation of the Advisory Committee on Synergy in Energy headed by Dr V. Krishnamurthy. The committee, which submitted its report recently, has recommended the restructuring of state-owned gas supplier GAIL by unbundling its transmission activities into a separate entity.
- "It is necessary to unbundled the supply and transport services of GAIL. Unbundling of a gas monopoly in specific terms is required to facilitate competition and to reduce conflict among entities. Separate entities should be formed for inter-state transmission of natural gas as an activity, and other activities like supply to fertilizers and power," recommended the report of the committee.
- The government is currently studying the recommendations of the committee including establish a separate downstream regulator—Petroleum and Natural Gas Regulatory Board to monitor the oil market including third party access to

common carrier facilities. The Director General of Hydrocarbons (DGH) is expected to monitor and regulate the upstream activities.

- To bring down the administrative costs, the committee has recommended allow the public sector oil companies to devise attractive voluntary retirement scheme (VRS) packages, different from the standard VRS packages.
- Referring to develop the gas transmission market, the Petroleum Ministry has proposed that the board would determine the initial tariff for all pipelines on cost of service basis. The tariff for transportation would include a fixed charge (in Rs per km) for carriage of minimum committed volume of natural gas over a distance, and variable charge payable in relation actual transportation. The transmission companies and end-users will mutually fix the service charge for usage of essential transmission and/or distribution related facilities.

❖ VOLKSWAGEN'S FUEL STRATEGY

Synthetic fuels: the path to a sustainable future

- Volkswagen does not concentrate solely on the development of innovative drive concepts. The task that we are tackling in collaboration with the mineral oil industry is to develop fuels further, which yields great improvement potential. The goal is to use regenerative produced fuels instead of fossil energy resources. This will actively protect our climate and make economical use of our limited resources.
- As far as environmental aspects are concerned, vehicle and driveline development is being subjected to steadily more stringent exhaust emission standards. Measures for reducing consumption and CO_2 emissions are exerting more and more influence on optimized vehicle and driveline concepts. Another important aspect is rising worldwide demand for energy services coupled with the imminent decrease in availability of inexpensive fossil primary energy carriers, in particular mineral oil. Extreme concentration on crude oil as the primary energy carrier leads to major risks for the future. In order to guarantee energy-carrier supplies for individual transport in the long run, fuels must therefore be used as economically as possible and the energy sources devoted to fuel production must be diversified, in particular by using alternative and regenerative energies.
- Liquid synthetic fuels have a major role to play here, as they permit the use of a large number of the most diverse primary energies for fuel production.
- Large quantities of the world's gas reserves are to be found in parts of the world where there is relatively little demand for them. These gas fields can be used sensibly by synthesizing them into diesel fuels by a GTL ("gas to liquid") method such as "Shell Middle Distillates Synthesis" (SMDS), a modern form of Fischer-Tropsch synthesis. This process is used to make high-quality ecologically acceptable diesel fuel ("SynFuelÒ"), as well as other products.

- Using SMDS in a Volkswagen Bora TDI engine, 50 percent fewer particle emissions and 20 percent fewer NO_x emissions than with conventional diesel fuel were measured.
- The great flexibility of this process permits the production of customized fuels that meet the critical demands of modern engine families, for example the "Combined Combustion System", a homogenous combustion technology developed by Volkswagen that combines the respective advantages of diesel and spark-ignition engines.
- In a second phase, the most varied forms of biomass are used as well for fuel production by a biological GTL process. CO_2-neutral fuel ("SunFuel®") is produced by obtaining synthetic gas from biomass and combining the process with Fischer-Tropsch synthesis. The main advantage of this fuel is that today's fuel infrastructure can remain intact.
- As explained above, innovative engine combustion methods combining the consumption advantages of modern diesel engines with the emission potential of spark-ignition engines will be used in the medium term. The right kinds of fuels must be made specifically for these hybrid forms of combustion. Synthetic fuels (SynFuel® - the name was changed to SunFuel® later) offer the best means of satisfying the relevant preconditions.
- As far as hydrogen is concerned, it is to be due course long run. This will pave the way for the hydrogen-based economy, provided that overall evaluation reveals a sufficient number of advantages. The fuel cell will presumably replace today's combustion engines rather than complement it. However, this is not expected to happen within the next 20 years.
- Liquid synthetic fuels are the ideal transition from conventional fuels to the fuel cell operating on hydrogen. These two energy carriers complement each other excellently.

Drivelines

- Some of the essential elements of Volkswagen's driveline strategy are the further development of innovative drive concepts with optimized direct-injection engines and automated-shift transmissions.
- Carbon dioxide is suspected of contributing to the green house effect. Manufacturers within the VDA (German Motor Vehicle Industries' Association) committed themselves as early as 1990 to reducing fuel consumption by 25 percent by 2005 compared with the figure in that year.

- **ASG (automated-shift gearbox),**
- **DSG (direct shift gearbox)**

The area accounted for by combustion engines with higher efficiency ratings can be easily realized technically by using ASG and, even more so, with the innovative DSG transmission. These consume less fuel by avoiding shifts that take place too late or too early.

An essential characteristic that differentiates the DSG from a conventional automatic transmission is that no torque converter is used as a drive-off element. The DSG is in no way a derivative of the automated-shift gearbox fitted to the Lupo 3L TDI. In all cases an engine coupled to a DSG transmission is able to provide the desired pulling power spontaneously at all times, thanks to rapid automatic gearshifts. An equally decisive fact is that the new gearbox offers the high level of agility associated with a manual gearbox, but with significantly lower fuel consumption. The DSG-equipped Golf R32, for instance, consumes about 1.5 liters less than the version with manual-shift gearbox. A fuel consumption reduction such as this is usually only possible by using exceptionally lightweight materials.

TDI - optimizing injection technology and combustion

Volkswagen has succeeded in complying with future exhaust emission regulations (EU4) by further development work on the four-cylinder TDI engine, which uses new-generation injector nozzles that permit better atomization of the fuel spray and consequently optimize combustion, thanks to precision-formed nozzle holes.

Exhaust gas re-circulation

A new exhaust gas re-circulation concept yields a further reduction in NO_2 emissions. Additional progress has been made by adopting second-generation pump-jet injection with dynamic pressure increase (Pressure Backing).

Exhaust gas cooling

Cooling the exhaust gas that is re-circulated into the combustion process further reduces NO2 and particle emissions.

Exhaust gas after-treatment

It is currently foreseeable that development will progress fast enough to utilize all the potential for meeting Euro 4 standards with the required degree of reliability only in the case of smaller passenger cars. There is a danger of exceeding the maximum limits at some of the operating points at which larger, heavier vehicles are run. Exhaust gas purification is unavoidable in these cases in order to reduce gaseous oxides of nitrogen (NO_2) and solid particulates (PM).

Diesel particulars filters

Volkswagen's has set itself the target of looking into all aspects of emission reduction. The objective is to not only reduce any single value but to achieve an overall balance, which is ultimately the decisive criterion as far as the environment is concerned.

Volkswagen declared as much as two years ago that, apart from meeting the Euro 4 standard by way of implementing internal engine measures first, this goal can only be reached in the case of certain vehicle categories with the aid of a particulate filter. We are working intensively on this but cannot state an introduction date as yet.

Clean fuel

As proven by the introduction of sulphur-free Super Plus fuel for gasoline (petrol) engines, market-led changes in available fuels can become successful very quickly. This is why there is reason to hope that the widespread availability of sulphur-free diesel fuel will progress just as fast.

Accumulator catalytic converter for oxides of nitrogen (NO_2)

In order to meet the Euro 4 standard exhaust emission limits at all operating points in the case of larger passenger cars, the remaining gaseous oxides of nitrogen (NO_2) must be further reduced with the aid of a suitable catalyst, using the same principle as used on spark-ignition direct injection (FSI) engines. This converter has a catalyst coating that absorbs the oxides of nitrogen (NO_2) like a sponge and emits them again as harmless nitrogen during a regeneration mode.

FSI

In addition to satisfying high quality, reliability, safety and ecological demands, reducing fuel consumption and emissions is a significant development priority for Volkswagen. The company is implementing its principle of combining direct injection with a spark-ignition engine in three high-volume vehicle categories.

Fuel is supplied by a common-rail system and injected directly into the combustion chamber by an electromagnetic injector, at a pressure of up to 100 bar. This permits precise determination of the fuel injection intervals during the cylinder working cycle and the time required for the fuel to mix with the air. The use of direct injection makes it

possible to employ the so-called stratified charge principle. In this engine operating mode, fuel is injected very shortly before ignition and, due to the specific combustion chamber geometry and a defined internal cylinder flow, is concentrated below the spark plug, so that a combustible mixture only forms at that point.

The direct injection principle developed by Volkswagen represents substantial ecological progress. Thanks to the FSI's entirely new exhaust gas after-treatment system, with fully electronic monitoring by on-board diagnosis, all pollutant substances are converted into harmless gases. There is a pre-converter for emission control directly after starting the engine, a three-way catalytic converter and an innovative NO_2 storage catalyst for converting emissions of oxides of nitrogen in the presence of excess air. The world's first integrated NO_2 sensor monitors the FSI engine's exhaust gas quality online. The carefully planned flow path enables the engine to operate with high excess air without mixture burn problems occurring - this is the secret of the substantially reduced fuel consumption. An advantage of the FSI engine's compared with technical alternatives for minimizing fuel consumption is that it still possesses a great deal off development potential.

CCS - a hybrid combustion engine

This new Volkswagen combustion process is currently still under development. It combines the most important benefits of the TDI and FSI concepts in a hybrid internal combustion engine.

Fuel cell

Volkswagen is of the opinion that prospects for the fuel cell vehicle (driven by an electric motor supplied with current from a fuel cell) entering series production will be realistic in 2020 at the earliest.

Despite very high potential efficiency and extremely favorable exhaust emission properties, the following technical and economical obstacles have to be overcome:

- Hydrogen production by regenerative means, i.e. CO_2-neutral production
- Hydrogen distribution
- Storing hydrogen on the vehicle
- Acceptable weight
- Affordable fuel (cost)
- Affordable fuel cell system (driveline and H_2 storage).

Volkswagen is therefore pursuing a transitional strategy that involves reforming conventional fuels and the existing infrastructure. During this period, only prototype fuel cell vehicles will be built in order to master and refine the relevant technology.

TYPES OF FUELS & THERE PROPERTIES:

The evolution of fuels

Volkswagen considers hydrogen to be the energy carrier of the future, but only in combination with the more efficient fuel cell system. As a first step, conventional fuels, gasoline and diesel, will be complemented by those manufactured synthetically. In the next evolutionary step, these fuels will be made by regenerative sound principles from biomass. Volkswagen does not anticipate that a significant number of passenger cars will be fuelled by hydrogen and have a fuel cell driveline until 2020 at the earliest. By then, the missing infrastructures will have to be set up and considerable technological obstacles for the sustainable production, distribution and storage of elementary hydrogen as an energy carrier overcome.

- **Crude oil**

At present, crude oil satisfies approximately. 40 % of worldwide primary energy demand. The Gulf States in the OPEC have a particularly important role because of their large reserves and supply potential. Some 60 % of conventional crude oil reserves are located in the Near East (OPEC).

- **Natural gas**

Natural gas satisfies approx. 25 % of worldwide primary energy demand. Until the 1970s, natural gas was a "by-product" of primarily crude oil-orientated exploration in many countries. Some 70 % of conventional natural gas reserves are located in the Near East and the countries that were formed after the break-up of the Soviet Union.

- **Biomass**

Biomass is the only source of energy that is distributed relatively uniformly almost anywhere on earth. Every country can plant its own biomass and use it for mobility.

- **Wind / solar / water energy**

The share of regenerative energy production using wind, solar energy and water has increased in recent years and is currently at around 3 %. This trend will continue, particularly when fossil energy-carrier prices rise.

- **Fuels derived from crude oil Gasoline (petrol) and diesel Properties:**

In addition to the more desirable elements, these fuels contain aromatic and sulphur compounds which lead to increased exhaust emissions, particularly of particulates, during the combustion process in the engine.

Manufacture

Conventional fuels derived from crude oil, such as diesel and gasoline; consist of hydrocarbon compounds obtained by refining the crude oil.

- **Synthetic fuel (SynFuel) Properties:**

Synthetic fuels made of natural gas are free from sulphur and aromatics. They have high potential for a dramatic reduction in exhaust emissions caused by the combustion process, particularly NO_2 (oxides of nitrogen) and particulates. Synthetic fuels are also referred to as "designer fuels", since there properties can be influenced in very specific ways during production.

In tests of such synthetic diesel fuels carried out at Volkswagen, a decrease of up to 50 percent in the pollutant content of the exhaust emissions was measured in all diesel engines. These fuels are also a precondition for the development of homogenous combustion methods that avoid the creation of pollutant substances in the combustion chamber altogether and reduce consumption still further.

Manufacture

Synthetic gas is produced by a gasification process. It is converted into hydrocarbon compounds in a Fischer-Tropsch synthesizing reactor and refined specifically to obtain a designer fuel.

Technological state of the art

Gas-to-liquid plants (GTL plants) are the state-of-the-art technology for making synthetic gas out of natural gas. Synthetic fuel made from natural gas is of course not regenerative and is therefore to be regarded as an intermediate stage only. CO_2 is only saved if the gases accompanying the crude oil are not burned off and thus left unutilized.

- **SunFuel® Properties:**

SunFuel® is a high-quality fuel consisting of hydrocarbons and containing no sulphur and aromatic compounds; it is chemically identical with SynFuelÒ. In the first stage, diesel SunFuel® will be available. SunFuel® can be distributed through the same infrastructure as conventional mineral-oil fuels. It can be added to vehicles' tanks as an alternative to fossil diesel oil without any engine modifications. An important contribution toward CO_2 and exhaust emission reduction can be made immediately using SunFuel®.

Since the option of specifically changing SunFuel®' properties is available, future combustion methods and fuels can be optimally matched together. This opens up immense potential for further reductions in exhaust emissions, especially particulates.

Production

Biomass is the starting point for the production of SunFuel®. Since a wide variety of species can be used, biomass is available all year round. Highly resistant plants that require little attention and can be planted ecologically are used.

If specially planted, these plants grow particularly rapidly and need no intensive care. Biogenous waste material such as forest and industrial timber, but also biological and even animal waste can be used.

The Choren method is one option for producing synthetic gas. It is carried out in several steps. If necessary the incoming substances or mixtures are first shredded and dried if they contain more than 30 percent humidity. After shredding, the material runs through a low-temperature gasification plant that divides it into gas and coke at temperatures between 400 and 500 °C. Both the gas containing tar and the ground-up coke then pass to the Choren reactor, where they are converted into raw synthetic gas and slag at temperatures of up to 1,600 C. During this process, the gas produced by low-temperature gasification in the reactor is supplied to a burner, where it is broken down primarily into carbon monoxide with lesser quantities of hydrogen and even less carbon dioxide and water vapour by adding pre-heated air or pure oxygen. The coke dust is blown into the downward-facing flame.

The raw gas runs through a heat exchanger (recuperator) before the dust is removed and is scrubbed in another column. The finished synthetic gas is fed to the Fischer-Tropsch system. Here, in contact with a special cobalt catalyst, the synthetic gas reacts to become hydrocarbon chains, which are then "shaped" into the SunFuel^{O}designer fuel.

- **Biomass potential**

Some 50 percent of Germany' passenger car diesel oil consumption could be satisfied by cultivating the farmland currently subsidised by the EU to remain uncultivated (1.1 million hectares).

By utilizing the entire technical biomass potential, one could meet 80 percent of Europe's total diesel demand. It should be noted, however, that approx. 50 percent of the biomass would be used to provide power and heat supplies, so that the potential is in fact halved.

The long-term potential of satisfying a large proportion of fuel requirements can be achieved by re-structuring the agricultural system and adding more biomass sources (timber, straw etc.). This would also contribute toward securing farmers' incomes, particularly in future EU member countries.

- **Hydrogen Properties:**

Hydrogen is an odorless, highly explosive gas. Only short operating ranges are possible due to its low energy density.

Hydrogen is the ideal fuel for fuel-cell vehicles. It is converted into electricity directly in the fuel cell, and an electric motor drives the vehicle. Unlike H_2-fuelled internal combustion engines, there are no pollutants or CO_2 emissions with this system.

Such vehicles are very comfortable to drive, with features such as engine-independent air-conditioning and heating. The disadvantages are that a lot of complexity is involved in its manufacture, the storage system and the hydrogen filling procedure. Hydrogen can be stored under pressure at up to 700 bar and as a liquid at temperatures down to -253°C. No hydrogen infrastructure is currently available for all traffic areas; setting up a supply and filling station network will require an immense investment outlay.

In the long run, there is a good prospect of our vehicles running exclusively on hydrogen, provided that low-cost, regenerative hydrogen production facilities (powered by wind, water, or solar energy) exist, that the storage method in the vehicle is acceptable to customers and that a completely new infrastructure (which will be costly) can be established.

Manufacture

Hydrogen today is mainly made from natural gas. Large quantities of CO_2 are produced during reformation of the gas. When the technique is introduced on an industrial scale, the hydrogen needed for synthesis will be produced by electrolysis of water using electric

current obtained from regenerative energy sources (if enough is available). CO_2 emission can only be avoided if this hydrogen production method is based on regenerative produced electricity, but production of hydrogen on a regenerative basis results in considerably higher prices than conventional fuels. As crude oil is becoming scarcer (and crude oil prices continue to go up), this relationship could however be reversed in the long run in favour of alternative fuels (hydrogen).

Vehicle concepts:

- **Golf Variant Bi FUEL**

The positive environmental image possessed by natural gas and the fuel tax cut in effect for it temporarily until the end of 2009 have led to great interest in natural-gas vehicles.

Volkswagen began to promote the retrofitting of gasoline-powered vehicles for natural gas in the early 1990s. The Golf Variant Bi FUEL was premiered at the 2001 IAA. It offers the advantages of natural gas operation while retaining the option of running it on gasoline (petrol). Drivers can switch from the natural gas to the gasoline mode according to their requirements. By running on natural gas, the user's fuel costs are cut and the CO_2 emissions drop by around 20%. The car's 2.0-litre 85 kW (115 bhp) engine provides ample performance. When running on natural gas, the power output is slightly lower due to the engine concept.

The car features an additional 90-litre carbon-fibre natural gas tank located beneath the load-area floor to save space. The load area is thus almost as large as on the regular version of this model. The second tank filler pipe has a safety valve for convenient natural gas refilling. A distance of around 260 kilometers can be covered on the content of the 90-litre natural gas tank.

In Germany, there are now more than 300 public natural gas filling stations, currently serving approximately 10,000 natural gas vehicles.

- **Bora HY.POWER**

Volkswagen and the Paul Scherrer Institute (PSI) demonstrated the leading edge of today's state of research in 2002 in the form of the Bora HY.POWER, which is driven by a PSI hydrogen fuel cell and an electric motor, and was taken on a very severe run over the 2.005-meter Simplon Pass (between Switzerland and Italy).

The Bora prototype used for this test exhibited new qualities, particularly in terms of road dynamics; this was mainly due to a new-generation PSI fuel cell and the so-called "Supercaps". These are two high-performance condenser modules that provide a considerable power boost when peak road performance is called for, such as when overtaking. With these, the electric motor (which has a maximum torque of 255 Nm) can achieve a short-term power output of 75 kW / 102 hp. With this generous performance on tap, the Bora HY.POWER accelerates from 0 .to 100 km/h in just 12 seconds. The "Supercaps" can together absorb up to 360 watt-hours of energy generated and stored via the conversion of braking energy. The fuel cell is notable for an inexpensive new bipolar plate concept consisting of 125 individual cells; these are of low cost due to the fact that important steps can now be avoided during the manufacturing process. The background to this: the core element of any cell is the membrane located between the anode and cathode, where hydrogen and oxygen react and combine to become water through the thin membrane. This "cold combustion" process releases electrical energy. Clean water vapour is the only "exhaust emission". Nearly all fuel cells available on the market today use so-called Nafion® membranes, a perfluorized polymer that is comparatively expensive to manufacture. PSI has developed a membrane that, as stated above, is cheaper to produce and has a long life. Volkswagen and PSI have thus taken a big step towards the goal of making the fuel cell affordable for general private use.

- **The "1-litre" car**

The 1-litre car prototype was a closely guarded secret for a long time. Hardly anyone believed that it could actually be built, but on 14 April 2002, prior to the annual general

meeting of Volkswagen AG shareholders, this two-seat car was driven from Wolfsburg to Hamburg by Dr. Ferdinand Piëch, then Chairman of the Board of Management, and his designated successor Dr. Bernd Pischetsrieder. On this journey it consumed a sensational 0.89 litre per 100 kilometers.

This result was made possible by close cooperation with various suppliers. Almost all the technical and mechanical solutions were jointly optimized. One of the main tasks was to reduce weight without endangering the car's safety. The 290-kilogram vehicle, which was developed in the wind tunnel, is similar to a sports car and features a multitude of special developments under the skin. It could anticipate a whole new family of vehicles, from super-economical models and inexpensive every-day touring cars for young people to super-sports cars with excellent performance.

Chapter – 9

CONCLUSION

Bi-fuel vehicles are good for both: -

- The User,

  &

- The Economy.

They not only provide a good alternative to the user but also give a boost to the economy as a whole. With the introduction of usage to both kind of fuel, the economy is never under pressure in terms of demand and supply of any particular fuel. This way a balance remains in the economy. Therefore bi - fuel vehicles should be encouraged and promoted for the welfare of society as well as economy. As evident in today's modern world, all the developed states are employing this technique of dual fuel technology for the vehicles.

BIBLIOGRAPHY

REFERENCE BOOKS

1. **Dursbeck, F., Erlandsson, L., Weaver, C. 2001, 'Status of Implementation of CNG as a Fuel for Urban Buses in Delhi', New Delhi, India. <http://www.cleanairnet.org/infopool/1411/article35706_status_implementation.pdf>**

2. **ESI International 1999, 'Diesel Emission Control Strategies Available to the Underground Mining Industry', Washington DC, United States of America. <http://www.deep.org/reports/esi_final_report.pdf>**

3. **Exxon Mobil Corporation 2002. <http://www.exxon.com/USAEnglish/GFM/Products_Services/Fuels/Diesel_Fuels.asp>**

4. **French, T. M. 1990, 'Compressed Natural Gas Vehicles', Department of Natural Resources, Louisiana, United States of America. <http://www.dnr.state.la.us/SEC/EXECDIV/TECHASMT/data/alternative/cng.htm>**

5. **National Transportation Library 2004, 'Clean Air Program: Summary Assessment of the Safety, Health, Environmental and System Risks of Alternative Fuel'. <http://ntl.bts.gov/DOCS/afrisks.html#toc>**

6. **Nicor Gas Inc. n.d., 'How does an NGV operate?', Nicor Inc., Illinois, United States.**
<http://www.nicorinc.com/en_us/commercial/products_an services/appliances/ngv_works.htm>

7. **Ogawa, H., Miyamoto, N., Li, C., Nakazawa, S., Akao, K. 2001, 'Smokeless and Low NO2 Combustion in a Dual Fuel Diesel Engine with Induced Natural Gas as Main Fuel', Hokkaido University.**
<http://powerlab.mech.okayamau.ac.jp/~esd/comodia2001/3-06.pdf>