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# **DEVELOPMENT OF ALTERNATE FUELS IN INDIA**

**Regional Workshop on Fuel Quality and Alternate Fuels**

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**Organised by Asian Development Bank**

**By**

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# ALTERNATE FUEL OPTIONS

- ALTERNATE FUELS CURRENTLY IN USE
  - CNG
  - LPG / PROPANE
  - ALCOHOLS
- EMERGING ENGINE TECHNOLOGIES & FUELS
  - BIO FUELS
  - DIE METHYL ETHER
  - HYDROGEN
  - FUEL CELLS
  - SOLAR ENERGY
  - ELECTRIC VEHICLES
  - HYBRID VEHICLES

# **BACKGROUND OF CNG AS AUTO FUEL IN DELHI**

- **SUPREME COURT ORDER OF JULY 1998 RELATED TO CNG AND CLEAN FUELS DIRECTED AS FOLLOWS:**

*Replacement of all pre-1990 autos and taxis with new vehicles on clean fuels.* **31-3-2000**

*No 8 year – old buses to ply except on CNG or other clean fuels.* **1-4-2000**

*Entire city bus fleet (DTC & private) to be steadily converted to single fuel mode on CNG.* **31-3-2001**

# PRESENT STATUS-CNG VEHICLES IN DELHI

- **Number Of Vehicles As On 31.04.2001**

**BUSES**

DTC : 175

PRIVATE : 100

CARS/TAXIS/VANS : 11,100

AUTO : 13,500

- **CNG Requirement per day** : 1,00,438 kg
- **Average daily sale** : 95,000 kg
- **Compression capacity** : 1,96,072 kg

# PRESENT STATUS CNG STATIONS IN DELHI

STATIONS		TOTAL
• MOTHER - IGL	:	5
• MOTHER - DTC	:	3
• ON - LINE	:	13
• DAUGHTER	:	44
• DAUGHTER - BOOSTER	:	3
TOTAL	:	68

# STATUS OF IMPLEMENTATION

- Ashok Leyland and Telco introduced this technology in the country for buses and trucks
- Maruti Udyog Ltd. launched Omni operating on CNG fuel.
- Bajaj Auto Ltd. introduced 3-wheelers fitted with 4-stroke CNG engine
- There are about 15,000 CNG auto rickshaws plying on Delhi roads
- In Mumbai CNG fuel was accepted by taxi operators and there are around 20000 taxis operating on CNG
- DTC and private operators have already introduced about 300 CNG buses

# EXPERIENCES DURING IMPLEMENTATION

- Adequate infrastructure is not available for conversion of petrol and Diesel engine to CNG
- Number of CNG refueling stations at Mumbai and Delhi are not Sufficient to cater the demand of CNG
- Refueling takes longer time and there are long queues in almost all refueling stations
- Consumer complaints of low pressure CNG at refueling stations
- Limitations on taking the CNG vehicles outside the Mumbai and Delhi



# EXPERIENCES DURING IMPLEMENTATION

- Overheating problem were reported in buses introduced in Delhi
- The demand for CNG buses could not be met by Ashok Leyland and Telco
- Reports about the use of spurious cylinders and parts
- Expertise available with Transport Authorities not adequate to do the inspection of CNG buses
- Incidences of bursting / leakage of cylinders reported
- 3-wheeler operators concerned about higher maintenance cost of the vehicle

# ISSUES ON DIESEL VS. NATURAL GAS BEING DEBATED

• Criterion	Relative Advantage	
	Diesel	Natural Gas
Pollution		
Fine particulates		+
Ultra-fine particulates	?	?
Nitrogen oxides		+
Greenhouse gases	++	
Safety	++	
Reliability	++	
Performance	++	
Economics		
Short run cost	+	
Long run cost	+	

+ Advantage

++ High Advantage

? Uncertainty

# LPG / PROPANE AS AN ALTERNATE FUEL

- Shortly to be introduced as Auto Fuel in India.
- Many vehicles reported to be running illegally on Domestic LPG at present due to price advantage.
- As per orders of Supreme Court, a pilot project on propane 3-wheelers was allowed a couple of years ago. Two propane refueling stations were set up. However, the conversion kit approval from ARAI and other statutory approvals could not be obtained.

# INDIAN EXPERIENCE- ETHANOL

## IOC R&D

- **1979 - The Ministry of Petroleum, Chemicals and Fertilizers, constituted an Inter- Departmental committee to examine the use of alcohol as fuel in admixture with gasoline.**
  - R&D programme taken up to assess the performance of ethanol gasoline blends in motor vehicles.
- **1980 - Trials were conducted on 15 passenger cars in collaboration with IIP, Dehradun. Trials were also conducted on scooters, motor-cycles and three wheelers.**

**Test Vehicles - Ambassador-7, Fiat 1100-2, Premier-4 and Standard-2.**

**- Scooters-6, Motorcycles-3 and Three wheelers-12**

**Fuels - Neat gasoline, 10% and 20% anhydrous ethanol blends.**

**Driving cycles - City, Highway and Hilly terrains.**

**Tests - Fuel economy, startability and driveability.**

# INDIAN EXPERIENCE- ETHANOL

## IOC R&D

- **Results - Fuel economy deterioration 1.0 to 4.3% in cars.**
  - **Fuel economy improvement. 1.0 to 14.0% in 2/3 wheelers**
  - **Cold startability and driveability satisfactory even at 0 deg C.**
  - **Some hot startability and hot weather driveability problems experienced at higher temperatures in few cars.**

## CONCLUSIONS

- **Overall performance of vehicles using 10% and 20% ethanol blend in gasoline was satisfactory.**
- **Feasibility of using 10 and 20% anhydrous ethanol in passenger cars, 2/3 wheelers etc., was established.**

***Problems of storage, handling and distribution were to be looked into.***

***Availability of ethanol for blending in gasoline was a constraint.***

# INDIAN EXPERIENCE- ETHANOL

## IIT DELHI DEMONSTRATION TRIALS

- **1991 - Project sponsored by MNES.**
  - **Recommendation by the committee for development of Alternate fuels for surface transport.**
- **Fuels - Blends containing 5 to 10% of ethanol in gasoline.**
- **Test Vehicles - Fleet of 93 vehicles of Delhi Administration.**
  - Ambassador Cars - 18, Maruti Gypsy - 48,**
  - Maruti Vans - 13, Mahindra Jeeps - 14.**
- **Trials duration - February 93 to August 95.**
- **Cumulative KM - 17.87 Lakhs.**
- **Project Cost - Rs.19.12 Lakhs.**
- **Technical Inputs - Blending of fuels for trials**
  - **Determination of physico-chemical characteristics**
  - **Selection and optimisation of additives.**

# INDIAN EXPERIENCE- ETHANOL

## IIT DELHI DEMONSTRATION TRIALS

- **Stabilisation of blends.**
- **Denaturing of alcohols**
- **Overcoming the problem of phase separation.**
- **Optimisation of vehicle settings.**
- **Storage and Distribution**
  - **Monitoring : Indian Oil Corporation team.**
  - **Duration : Two and half years. Included 3 rainy seasons.**
- **Results :**
  - **93 Delhi Admn.vehicles logged 17.87 lakhs km. successfully.**
  - **Saving of around 20,000 ltrs. of scarce petrol.**
  - **Cooler and smoother operation of vehicles.**
  - **No adverse effect on engine oil.**
  - **Reduction in CO and HC emissions.**
  - **Overall fuel economy is comparable with neat gasoline operation.**

# IIP EXPERIENCE - DUAL FUEL OPERATION ON ETHANOL/METHANOL

	<b>ETHANOL</b>	<b>METHANOL</b>
• No. of Buses	25	10
• Make	Ashok Leyland	Ashok Leyland
• Total Km. Covered	21.28 Lakhs	6.43 Lakhs
• Diesel Replacement (Final Phase)	14.9%	14%
• Control trials diesel replacement	10.5 to 23.8%	21%
• Smoke Reduction	Upto 40%	33%
• Driveability	Better	Better/Comparable
• Wear	Comparable	Better/Comparable
• Deposits	Comparable	Comparable
• Oil Degradation	Comparable	Comparable/Improved.
• Oil Consumption	Comparable	Comparable.



# CURRENT STATUS OF ETHANOL USE IN MS IN INDIA

- Ethanol blending allowed as per current BIS spec. alongwith other oxygenates such as MTBE, TBA, TAME Methanol etc.
- SIAM viewed that blending of maximum 5% ethanol is acceptable subject to overall oxygen content less than 2.5%
- SIAM also wanted to examine and issue negative list of models which can not use ethanol blends
- While 5% ethanol blending is considered technically feasible the oil industry wanted assurance with regard to sustained supply at a price equivalent to MS (ex-refinery)
- To examine issue of suitability, availability, pricing, distribution etc. Oil industry has initiated R&D studies & pilot scale marketing of 5% blend.

# **ONGOING STUDIES WITH 5% ETHANOL - GASOLINE BLENDS**

## **R&D STUDIES**

- Chemical testing of blends
- Toxicity studies using alcohol blends
- Cold / hot startability and driveability studies
- Emission testing using alcohol blends
- Controlled field trials - fuel system compatibility and engine durability

## **PILOT PROJECT IN UP & MAHARASHTRA**

- Infrastructure for blending
- Transportation, storage, handling and distribution
- Customer feedback

# METHANOL EXPERIENCE - MARKETING OF PETROL-M AT BARODA

- Petrol-M is a blend of 3% Methanol in Petrol
- BIS standard was amended in the year 1992 to facilitate use of Methanol blended Petrol
- Oil industry commenced marketing of this product from November, 1993 on Pilot Scale
- This product was supplied from 10 selected retail outlets in the city of Baroda in Gujrat
- Duration of this trial was for one year

# MAIN FINDINGS OF TRIALS

- Blending, transportation and quality wise Petrol-M trial marketing successful
- A total quantity of 376 kl of the product was sold
- Petrol-M was successfully used by cars, two-wheelers and three-wheelers
- Vehicle manufacturers had apprehension about corrosive effect of Methanol on engine parts
- Oil industry used corrosion inhibitors to solve this problem
- No complaints pertaining to vapor lock problem
- Supply of Methanol at agreed price was disrupted resulting in termination of marketing of this product.

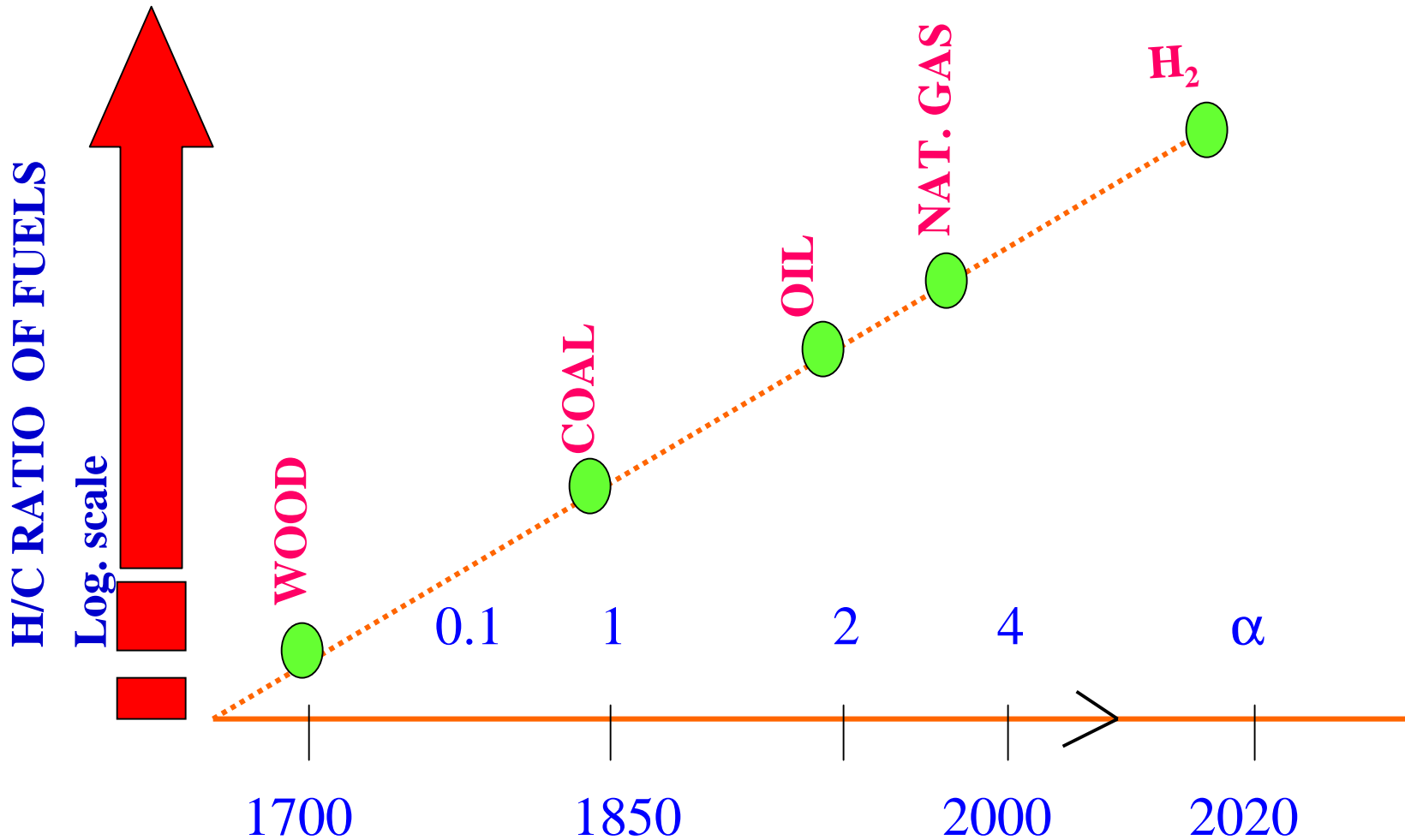
# **OTHER ALTERNATE FUELS AT R&D & DEMO STAGE IN INDIA**

- Bio - Diesel
- Hydrogen
- Fuel Cells
- Electric Vehicles

# BIO DIESEL

- BASICALLY THESE ARE ALKYL ESTERS PREPARED BY TREATING THE VEGETABLE OIL WITH ALCOHOLS
- IT CAN BE BLENDED WITH DIESEL AT ANY LEVEL TO PRODUCE BIODIESEL BLEND
- HIGH CETANE NO. (>50) & ACCORDINGLY LESS NOISE & SMOOTH RUNNING OF ENGINE.
- SULFUR FREE AND ACCORDINGLY NO SO<sub>x</sub> EMISSIONS.
- BIODIESEL IS OXYGENATED FUEL AND ACCORDINGLY GIVES LOWER EMISSIONS THAN CONVENTIONAL DIESEL

# FUELS & H<sub>2</sub> CONTENT



**WE ARE MOVING TO A HYDROGEN ECONOMY**

# SOLAR HYDROGEN VEHICLE

## SOLAR- H<sub>2</sub> : ULTIMATE SOURCE IN THE NEXT MILLENIUM

- SOLAR ENERGY CONVERTED TO ELECTRICITY BY PHOTOVOLTIC CELLS
- RENEWABLE ELECTRICITY USED TO SEPARATE H<sub>2</sub> FROM WATER MOLECULES BY ELECTROLYSIS
- SOLAR-H<sub>2</sub> STORED AT ON-SITE FUELLING STATIONS
- THE ONLY EXHAUST EMITTED IS WATER VAPOUR
- XEROX CORPN. IN US IS OPERATING A SOLAR H<sub>2</sub> FLEET.



# STATUS OF HYDROGEN ENERGY AT IT - BHU

- BHU has carried out work in the following areas of Hydrogen Utilization:
  - Hydrogen as a supplementary fuel in a SI engine
  - Hydrogen as a supplementary fuel in a CI engine
  - Hydrogen fueled motorcycle with storage of H<sub>2</sub> as hydride
  - Hydrogen engine simulation

# FUTURE WORK PLANNED AT IT - BHU

- To reduce the weight of hydride tank and to give higher range, hydride materials with higher storage capacities have to be developed
- Use of engine optimally designed for hydrogen (e.g. higher compression ratio, large valve diameter and lift etc.)
- Detailed performance studies to optimise operating parameters
- Engine simulation studies to optimise hydrogen engine design
- Develop high plateau pressure hydride so that two stroke engine can be converted to run on hydrogen

# FUEL CELL VEHICLES

## INTERNATIONAL SCENARIO

- DBB GmbH, THE JV BETWEEN DAIMLER CHRYSLER, FORD & BALLARD TO DEVELOP FUEL CELL ENGINES FOR ELECTRIC VEHICLES IS WORKING WITH SHELL INTERNATIONAL OIL PRODUCTS
- AIM IS TO INVESTIGATE FEASIBILITY OF CONVERTING LIQUID FUEL TO GAS WITH HIGH H<sub>2</sub> CONTENT.
- SUCCESS WILL MEAN FUEL CELL VEHICLES COULD REFUEL AT CONVENTIONAL GAS STATIONS.
- MOBIL HAS TIED UP WITH FORD, AMOCO-BP & CHEVRON ALSO TIED UP WITH AUTO CO's IN DEVELOPING FUEL CELL TECHNOLOGIES
- FORD WANTS TO PUT 100000 CARS ON FUEL CELLS BY 2003

# INDIAN INITIATIVE IN FUEL CELL DEVELOPMENT

- MNES has been promoting this project
- BHEL-R&D, SPIC and TERI are developing indigenous fuel cell technology
- BHEL R&D has developed fuel cell of 50 kW
- SPIC Science Foundation is working on fuel cells
- Various Indian vehicle manufacturers & Indian Oil interested in this technology
- A concept of constituting a Research Consortium would be ideal for undertaking the cost intensive project of development of indigenous fuel cell technology

# ZERO EMISSION VEHICLES

- NO TAILPIPE EMISSIONS
- NO EVAPORATIVE EMISSIONS
- NO EMISSIONS FROM GASOLINE REFINING OR SALES
- NO ON-BOARD EMISSION CONTROL SYSTEM WHICH MAY DETERIORATE OVER TIME
- CARB REQUIRES 10% NEW VEHICLES IN CA TO BE ZEV's BY 2003

# ELECTRIC VEHICLES

## INTERNATIONAL SCENARIO

- CURRENTLY EVs AVAILABLE FROM GM, HONDA, FORD TOYOTA, CHEVROLET
- SEVERAL FLEETS OPERATING IN UNITED STATES
- BENEFITS
  - QUIET, CLEAN DRIVING EXPERIENCE
  - HIGH PERFORMANCE
  - LOWER OPERATING COSTS
  - NO GAS STATIONS REQUIRED
  - ENVIRONMENT FRIENDLY
  - ENERGY SECURITY

# INDIAN EXPERIENCE ON ELECTRIC VEHICLES

## # BHEL - ELECTRAVAN

- This is a battery operated 16 seater mini bus
- The range per charge of this vehicle is 70 Kms
- Maximum speed of the vehicle - 40 kph
- 15 kW separately excited DC motor
- Electronic chopper controller for speed control
- Two trays of 300 AH 48 Volt, lead acid batteries
- Off board automatic battery charger to charge the battery set in about 10 hours

# Mahindra & Mahindra also developed Electric Vehicle called Bijlee in India.

# SUMMARY

- Several alternate fuels are being tried presently but none has universal acceptance.
- Alcohol fuels like ethanol and methanol have been tried several times but could not be used on a large scale due to issues of sustained availability and pricing.
- CNG has been popular as a fuel for taxis and autos due to price advantage over conventional fuels. However, its acceptability in the post APM scenario is being debated.
- Sustained availability of CNG, safety and availability of reliable conversion kits are the issues of concern for buses.
- The higher cost of CNG buses as compared to diesel buses and that of conversion kits are the issues related to affordability of buses for common man.
- LPG is likely to be allowed as automotive fuel but its sustained availability is doubtful as it is also used as a domestic cooking gas.
- Other alternate fuels like Bio-diesel, hydrogen, fuel cell and electric vehicles are in the development stage.



**Thank you**