

# ACTION PLANS FOR REDUCING VEHICLE EMISSIONS

Regional Workshop: Fuel Quality and Alternative Fuels  
2-4 May 2001, New Delhi, India

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## POTENTIAL OF ADVANCED TECHNOLOGY VEHICLES IN ASIA

by  
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In this presentation Japan is not considered as advanced vehicles already are in use there. Japan is in forefront for development and production of advance technology vehicles

ASIAN Countries	Vehicle Mix In Order of Transportation Preference
Developed	Cars/Heavy Vehicles/ Motor Cycles
Developing	Motor Cycles/ Heavy Vehicles/Cars
Under- Developed	Heavy Vehicles/ Cars/ Motor Cycles

## PRODUCTION OF VEHICLES IN SOME ASIAN COUNTRIES

YEAR 1997, 10<sup>6</sup> UNITS

COUNTRY	CARS	2-WHEELERS	HDV
1. CHINA	1.8	10.04	NA
2. INDIA	0.486	3.02	0.260
3. INDONESIA	0.375	1.9	NA
4. JAPAN	10.5	2.67	10.975
5. PHILLIPINES	0.465	0.225	NA
6. S.KOREA	2.4	0.377	0.510
7. THAILAND	0.403	1.081	NA
8. TAIWAN	0.465	1.524	NA

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### Automotive Fuel Consumption in India (Million Tones)

Product	91/92	93/94	95/96	97/98	99/2000
Gasoline	3.57	3.89	4.71	5.15	6.50
Diesel	22.68	25.87	32.36	36.22	42.0

### CONSUMPTION OF PETROLEUM IN ASIAN COUNTRIES

- *In Developing Asian Countries Petroleum Consumption in the Year 2000 Increased by 170% of 1983 and Projected to Grow further by 40 % in the Year 2010*
- *In Asia Pacific Region the corresponding growth are 100 % and 25 % respectively*
- *Rest of the world has seen only about 10-12 % increase since 1983 and next 10 years are projected to witness about the same growth*
- *In India Petroleum Consumption is Expected to grow by more than 50% during the period 2000-2010*
- *In Developing Asia, Consumption of Diesel is almost 5 to 6 times of Gasoline*
- *In India during 1999-2000, Diesel Consumption was 42 MMT compared to 6.5 MMT of Gasoline*
- *In Europe, Diesel and Gasoline Consumption are of same order while in the USA Diesel is significantly lower than Gasoline.*

### MAJOR FACTORS PROMOTING INTRODUCTION OF ADVANCED TECHNOLOGY VEHICLES

- *Air Quality Considerations*
- *Global Environment- Greenhouse Effect And Renewable Energy*
- *Fuel Economy*
- *Customer Demand Of More Power And Comfort (Larger Vehicles)*
- *Safety*

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**VEHICLE POWER- PLANT IS THE PRINCIPAL VEHICLE MODULE WHICH HAS SEEN MAJOR ADVANCEMENTS IN TECHNOLOGY IN THE LAST TWO DECADES AS INFLUENCED BY THE ABOVE FACTORS**

### **ADVANCED VEHICLE POWERPLANTS**

- *New Generation SI Engines*
- *New Generation CIDI Engines*
- *Hybrid-Electric Power Plants*
- *Fuel Cells*

### **NEW GENERATION SI ENGINES**

- *Homogeneous Charge, MPFI, Liquid Fuelled*
- *Homogeneous Charge CNG Fuelled especially Heavy Vehicle Engines*
- *Gasoline Direct Injection (GDI)*

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### **HOMOGENEOUS CHARGE SI ENGINE**

#### **MAIN FEATURES:**

- *Multi-Valves*
- *Variable Valve Lift And Timing, VTEC(Honda), VVTi(Toyota), 0-50 CA Valve Overlap*
- *Turbocharged*
- *Variable Swept Volume- Cylinder Cut Off*
- *Light Wt., Al- Crankcase, Mg Intake Manifold, Welded Sheet Exhaust Manifold, Al-Si Cylinder Liners Etc. Wt Reduction By 22 %*
- *Knock Adaptive Control - CR Going Up To 11.7:1 (Honda S2000)*
- *Power Output As High As 93kW/L(Honda S 2000)*
- *On-Board Diagnostics (OBD) for Functioning of Engine and Emission Control Modules*

### **GASOLINE DIRECT INJECTION ENGINE**

*(Mitsubishi, Toyota, Nissan, Renault Etc.)*

*By 2007 Every Second Engine is Predicted to be GDI*

#### **MAIN FEATURES:**

- *Less Prone to Knock CR up to 12.5:1*
- *Stratified Charge under Load, Homogeneous Combustion at High Loads*
- *A/F Ratio 20 to 40:1*
- *Fuel Savings of 40% under part load and 15% at high loads than MPFI*
- *Dual -bed Catalyst, a Nitrogen Oxide Trap or Selective NOx reduction for lean operation followed by 3-W Catalyst for reduction under stoichiometric operation.*

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### **CNG HOMOGENEOUS CHARGE SI ENGINES**

- *Engine Design Features are similar to Gasoline Engines*
- *New On-Board Fuel Storage ( Heavy Weight) and Engine Fuel System*
- *Being Preferred for Passenger Bus Application in place of Diesel Engine due to Practically nil PM Emissions*
- *CO, HC and NOx are controlled by 3-Way Catalytic Converters*
- *High CR upto 11 to 12:1 possible giving high energy efficiency even better than IDI diesels*
- *Availability of CNG to be assured*
- *Can be considered primarily for city vehicles only*
- *New Fuel Distribution Infrastructure required, hence additional Investments*

### **CIDI HIGH SPEED ENGINES**

**1990:** Diesel Cars made 14% of Total European Sales

**2000:** Diesel Cars to be 27% of Total European Sales  
of which 75 % powered by CIDI

*In Developing Asian Countries all Freight by Road is Transported by Diesel Vehicles and All Passenger Buses are Powered by Diesel Engines  
Even in the USA, 94 % of All Freight is Moved by Diesel Trucks, Trains and Boats*

*In the Last Decade NOx and PM reduced by 85 to 90 % in the USA and Europe  
By 2007-2010, US Proposes Heavy Vehicles to run more than 90% cleaner than today. PM reduced to 0.01, NOx to 0.20 and Non-Methane Hydrocarbons to 0.14 g/bhp.hr. In comparison current requirements are:*

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### **MAIN FEATURES OF CIDI ENGINES:**

- *Multi Valves with Central Injection*
- *VVT*
- *Variable Geometry Turbochargers*
- *Common Rail Injection System being Preferred*
- *Injection Pressures:*  
*Common Rail upto 160 MPa*  
*Unit Injectors upto 205 MPa*
- *Multiple (Pilot) Injection using Piezo- Actuators on common rail system and Injection Rate Shaping to reduce Noise and Emissions.*
- *Electronic Control of Injection Quantity and Timing*
- *Lean de-NOx Catalyst*
- *Particulate Traps*
- *Combined Particulate and NOx Reduction ( DPNR) System using Catalysed Particulate Filter with NOx Storage Developed by Toyota*
- *VW Lupo 3- Cyl Car, Unit Injectors, Fuel Economy 2.99 L/100 km, 90g/km CO<sub>2</sub>, HC and CO lower by 75 % and 85%, respectively. Thermal Eff. 45%*

### **HYBRID ELECTRIC POWERPLANTS**

- *ULEV Standards and 80 MPG (3L/100 km) are the Targets*
- *Prime Mover Operates in Steady Load Speed Conditions,*
- *Energy Storage Devices- Battery takes care of transient operation needs*
- *Emissions are easy to control*

### **TYPES OF HEV**

- *Parallel HEV*
- *Series HEV*

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### **MAIN FEATURES:**

- *Gasoline Engine- Electric Motor*
- *CIDI- Electric Motor*
- *Regeneration Electric Motors, Integrated Motors with Engine Crank shaft (Honda Insight)*
- *Ultra Lean Burn SI Engines - A/F 23 to 24:1*
- *Ni- Metal Hydride Batteries*

### **HEV ALREDY DEVELOPED**

- *Honda Insight: Gasoline Electric Hybrid 83 MPG (35 km/L) on Japan urban test cycle*
- *Toyota Pirus: Gasoline-Electric Hybrid*
- *GM Percept: CIDI-Electric Hybrid*

### **FUEL CELL AS AUTOMOTIVE POWERPLANT**

- *An Electro-Chemical Device of Potentially High Energy Efficiency*
- *Hydrogen as Fuel*
- *Power Density of 1.31 kW/L Comparable to IC Engines Reached*
- *PEM and SOFC Types for Automotive Applications*

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## ENERGY SOURCES

<u>TYPE</u>	<u>INFRA-STRUCTURE</u>	<u>REMARKS</u>
<i>H<sub>2</sub> Storage</i>	<i>New Infrastructure</i>	<i>Reforming of Natural Gas or Electrolysis of Water using Hydro-Electric Power or Solar Energy, No Emissions Preferred where ZEVs are mandated</i>
<i>Methanol-Water Reformer</i>	<i>New Infrastructure</i>	<i>No NO<sub>x</sub> or HC but CO<sub>2</sub>, Low temperature Reforming (280 C) Already Developed Bio-Mass Source Renewable</i>
<i>Gasoline Reformer</i>	<i>Existing Infrastructure</i>	<i>High Reforming Temp.( 800-1000 C) Lower Efficiency, Some CO ,High CO<sub>2</sub>, Likely by 2010 in Series Production</i>

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### PROTOTYPE FUEL-CELL VEHICLES

<u>NAME</u>	<u>CHARACTERISTICS</u>
1. <i>GM Percept</i>	<i>H<sub>2</sub> Storage - Metal Hydride 400 Cell -PEM Stack 100 kW Peak, 75 kW Continuous Power</i>
2. <i>Ford P2000</i>	<i>H<sub>2</sub> Storage, PEM, 100kW</i>
3. <i>Honda</i>	<i>H<sub>2</sub> Storage as Hydride, PEM, 60 kW</i>
4. <i>Daimler-Chrysler Necar-3</i>	<i>Compressed H<sub>2</sub>, PEM, 160 km Range, 60 MPG Gasoline equiv. in City,</i>
<i>Necar-4</i>	<i>Liquid H<sub>2</sub>, 450 km range</i>
5. <i>Nissan FCEV</i>	<i>Methanol Reformer</i>
6. <i>Daihatsu Move</i>	<i>Methanol Reformer, PEM, 12 kW</i>
7. <i>Opel- Zafira</i>	<i>Methanol Reformer, PEM</i>
8. <i>Georgetown Univ. Transit Bus</i>	<i>Methanol Reformer, PEM, 571 L storage, 563 km range</i>

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### **CONSTRAINTS FOR INTRODUCTION OF ADVANCED TECHNOLOGY VEHICLES IN ASIAN COUNTRIES**

- ***AVAILABILITY OF RIGHT QUALITY FUELS viz.,***

#### ***UNLEADED GASOLINE***

***LOW SULPHUR GASOLINE AND DIESEL( .05% WT MAX)***

***GASOLINE WITH DEPOSIT CONTROL ADDITIVES***

***HIGH DIESEL IGNITION QUALITY (50 CN)***

***LOW AROMATIC CONTENT IN GASOLINE AND DIESEL***

***NARROW DENSITY AND VISCOSITY RANGE FOR DIESEL***

- ***AVAILABILITY OF RIGHT QUALITY LUBRICANTS***
- ***VEHICLE SERVICING INFRASTRUCTURE AND TRAINED MANPOWER***
- ***INFRASTRUCTURE FOR DISTRIBUTION OF ALTERNATIVE FUELS e.g., CNG***
- ***ECONOMIC CONSTRAINTS, COST OF VEHICLE***

### **OPPORTUNITIES AND ADVANTAGES**

- ***ADVANCED VEHICLES ARE MORE ENERGY EFFICIENT***

***Most Asian Countries except Middle East, Indonesia and China are Energy defficient and nety importers of petroleum***

- ***ADVANCED DIESEL ENGINES ARE ALMOST 10 to 15% MORE EFFICIENT THAN THOSE BUILT DURING 1980s.***

***Asian countries have opportunity to conserve precious energy Resources and benefit from the resulting economic gain. In countries like India, a 10% reduction in diesel consumption in next 5 to 7 years also would give significant economic gains***

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- **ADVANCED VEHICLES ARE LESS POLLUTING**

*Already Many Mega-Cities Are Highly Polluted. If Introduction Of Advanced Technology Vehicles Is Delayed Any Further It Will Be More Expensive To Clean-Up The Asian Cities*

- **DEMAND OF VEHICLES IN USA, JAPAN AND EUROPE IS NEAR SATURATION**

*Major Vehicle Manufactures In West Now More Willing To Start Production Units In Asia Than Before*

- **INTRODUCTION OF ADVANCED TECHNOLOGY IN ANY SPHERE OF ACTIVITIES PROVIDES MORE TECHNICAL EDUCATION OPPORTUNITIES AND IMPROVES GENERAL AWARENESS and UP-LIFTMENT OF SOCIETY AS A WHOLE**