International Experience in Improving Fuel Efficiency and Reducing Greenhouse Gases

Workshop on Fuel Efficiency Opportunities in São Paulo
2 December, 2004

Outline

- Vehicles Are Important
- Countries Have Different Motivations
- Many Different Policy Instruments Are Being Used
- A Variety of Technologies are Already Available

Share of worldwide CO₂ emissions from the combustion of fuel, by sector

World Transport Vehicle CO₂ Emissions By Mode

Megatons Thousands

WBCSD
Various Motivations For Countries

- Reduce Climate Change
- Reduce Oil Imports
  - Energy Security
  - Balance of Payments
- Sustainability

Approaches To Reducing Fuel Consumption - Greenhouse Gases Around The World

- Tax Policy
- Fiscal Incentives
- Traffic Incentives
- Fiscal Penalties
- Regulation
  - Fuel Economy/Consumption
  - CO2 Emissions
  - Greenhouse Gases
- Voluntary Agreements
- Renewable Fuels Requirements/Incentives
- Vehicle Technology Mandates/Incentives
- Joint Government/Industry Research

Selected Programs Around the World
To Reduce Fuel Consumption and/or Greenhouse Gases

- No Active Program
- Program in Effect

High Oil Prices Are Increasing Urgency in Many Countries

NYMEX Sweet Crude - Daily Price in 12 previous months

[Graph showing NYMEX Sweet Crude price trend]
Fuel Prices in Selected Countries (2002$/Gal)

<table>
<thead>
<tr>
<th>Country</th>
<th>Gasoline</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Canada</td>
<td>$1.00</td>
<td>$1.00</td>
</tr>
<tr>
<td>France</td>
<td>$2.00</td>
<td>$2.00</td>
</tr>
<tr>
<td>Germany</td>
<td>$3.00</td>
<td>$3.00</td>
</tr>
<tr>
<td>Japan</td>
<td>$4.00</td>
<td>$4.00</td>
</tr>
<tr>
<td>UK</td>
<td>$5.00</td>
<td>$5.00</td>
</tr>
</tbody>
</table>

Pump Prices in Rio

<table>
<thead>
<tr>
<th>Year</th>
<th>Gasoline</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>186</td>
<td>186</td>
</tr>
<tr>
<td>2005</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>2010</td>
<td>120</td>
<td>120</td>
</tr>
</tbody>
</table>

European Agreement (g CO₂/km)

- Some 120 g/km Cars in 2000
- Target Range of 165-170 g/km in 2003
- Review Feasibility of 120 g/km for Average car by 2012 in 2003

Production of Diesel Passenger Cars

Western Europe

- Diesel-share in overall passenger car production in %
- Direct Injection
- Indirect Injection
Vehicle Climate Change

Emission Sources
- Black Carbon
- Methane
- Nitrous Oxide
- CO2
- HFC

Climate Forcings

Forcing Agent
- Carbon Dioxide
- Methane
- Nitrous Oxide
- Chlorofluorocarbons
- Ozone
- Black Carbon
- Reflective Aerosols
- Cloud Droplet Changes

Aerosol Effects Are Not Known Accurately

Source: Hansen, Scientific American, March 2004

Yearly Car Tax in Denmark

- 24 Different Car Classes Based On Kilometers Per Liter of Fuel
- Diesel Taxed More Than Gasoline
- Annual Increase with Inflation Plus 1.5% Per Year

Tax Incentives for Low Emission Vehicles and High Fuel Economy Vehicles in Japan

<table>
<thead>
<tr>
<th>Emissions+ Fuel economy</th>
<th>Emissions: 50% lower emission vehicles</th>
<th>Emissions: 75% lower emission vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles: achieving fuel economy standard in 2010</td>
<td>No incentives</td>
<td>*25% annual tax reduction +200,000 yen purchase tax deduction</td>
</tr>
<tr>
<td>Vehicles: 5% higher fuel economy than the standard in 2010</td>
<td>*25% annual tax reduction +200,000 yen purchase tax deduction</td>
<td>*50% annual tax reduction +300,000 yen purchase tax deduction</td>
</tr>
</tbody>
</table>

*: compared to the new long-term standard in 2005
A technical committee has been organized in Japan by METI and MLIT to discuss the possibility of a fuel economy standard on heavy-duty vehicles.

The purpose is to reduce fuel consumption and eventually CO2 emission of heavy-duty trucks and buses, starting in 2015 or later.

Fuel economy will be evaluated based on engine test data and numerical simulation models, taking into account a variety of vehicle types.

It is expected that diesel engine and vehicle technologies will be enhanced to meet the regulation.

Engine Technologies with Potential to Improve Vehicle Fuel Economy

- 5,4 or 3 valves per cylinder
- variable valve timing
- idle stop/start
- cylinder deactivation
- variable compression ratio
- variable displacement
- advanced IC engines (diesel, DI gas)

Additional Technologies with Potential to Improve Vehicle Fuel Economy

- Transmissions
  - lockup 6/5/4 speed
  - automatically shifted manuals
  - CVTs
- Advanced Powertrains
  - integrated starter alternatives
  - hybrids
  - fuel cells

Summary and Conclusions

- Many Technologies to reduce mobile source fuel consumption and GHG emissions available today
- The technology is evolutionary – not revolutionary
- Some already in use or in product plans; others under development and available soon
- Technology costs could be paid for through fuel savings
- Reducing fuel consumption does not require sacrifices in performance and other attributes that consumers value
- Reducing fuel consumption does not require compromises in vehicle safety or emission regulations
- Starting To Look Beyond Cars