CAR FUEL ECONOMY

Automobile Industry Perspective

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Executive Advisor, Engineering
Maruti Suzuki India Limited

Workshop Series on Transport and Climate
New Delhi, 24th July 2013
1. Challenge for India
2. Industry Initiatives and Improvements
3. Fuel Efficiency Regulation for India
4. Need for an All round improvement – Integrated Approach
Challenges before Auto Industry

1. Global Warming
2. Energy Security
3. Local Emissions
4. Customer Demands
Challenges before Auto Industry

1. Global Warming
2. Energy Security
3. Local Emissions
4. Customer Demands
CO₂ Emission: Global Trends

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>China</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
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<td></td>
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<tr>
<td>EU27</td>
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<td></td>
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<tr>
<td>India</td>
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<tr>
<td>Russian Federation</td>
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<tr>
<td>Japan</td>
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<td>Germany</td>
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<tr>
<td>South Korea</td>
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<tr>
<td>Canada</td>
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</tbody>
</table>

India is the 3rd largest emitter for the CO₂

Source: PBL – Netherland Environmental Assessment Agency
CO2 Emission: India’s Position

<table>
<thead>
<tr>
<th>SECTOR</th>
<th>CO2 (Million Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>715.83</td>
</tr>
<tr>
<td>Transport</td>
<td>138.86</td>
</tr>
<tr>
<td>Other Energy Activities</td>
<td>138.15</td>
</tr>
<tr>
<td>Cement</td>
<td>129.92</td>
</tr>
<tr>
<td>Iron &amp; Steel</td>
<td>116.96</td>
</tr>
<tr>
<td>Other Manufacturing Industries</td>
<td>158.98</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1398.7</strong></td>
</tr>
</tbody>
</table>

Road Transport is the Largest CO2 Emitter

Road Transport Sector contributes – 8.5% of the total CO2 emissions

Source: Kirit Parikh report

Increase In Transport Emission

- 1994: 80
- 2007: 138
- Projected by 2020: 323

Source: Internal estimates of MSIL based on Fuel consumption estimates of PPAC

87% Road Transport is the Largest CO2 Emitter

Source: Central Road Research Institute, Delhi
- CO₂ emitted by all cars running in India ~ 2.1%
- Estimated CO₂ emitted by new cars in one year is about 0.32%

New Passenger Vehicles contributes – 0.32 % of the total CO₂ emissions
Challenges before Auto Industry

1. Global Warming
2. Energy Security
3. Local Emissions
4. Customer Demands
Energy Security : Indian Fuel Scenario

Is The Growth in Automotive Sector in line with Our Domestic Oil Production?

Gap of 4~5 times b/w Production & Import

Source: Ministry of Petroleum
Challenges before Auto Industry

1. Global Warming
2. Energy Security
3. Local Emissions
4. Customer Demands
Emissions: Need to look at all sources

According to ICAP Study Auto industry not a major contributor of PM10 Emissions
Challenges before Auto Industry

1. Global Warming
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Mobility Requirement In India

1. Urban Need
   - BRT Corridor (Delhi, Ahmadabad)

2. Rural Need
   - State Roadways

Public Transport must to Balance Urban & Rural India’s Growth.. But Demand of Personal Mobility Can’t be Ignored !!!
In India, fuel price as a pocket pinching factor is highest.

**Consumers Perspective**

Fuel efficiency is already a strong competitive development parameter.

**SOURCE:** Fuel Price - SIAM Data
Per capita Income - World Bank Data

*Average Ratio – 0.3 times*
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Industry Initiatives and Improvements

1. Technology Focus

2. Consumer Focus
Industry Initiatives - Vehicle Technology Focus

New Model Fuel Efficiency Improvements

Engine Efficiency

Transmission Efficiency

Vehicle Weight & Shape

Rolling Resistance of Tires

Alternative Fuel

Alternate Fuel Vehicles

Industry improved CO2 performance by 8% from 2007 to 2010
Vehicle Weight Reduction: Industry Initiative

Commitment Towards Weight Reduction

Weight Reduction makes business sense to reduce cost!
Impact of using low carbon Alternate fuels

Cumulative CO\textsubscript{2} Reduction From Maruti’s Alternate Fuel Vehicles

Sales of CNG Vehicles from MSIL alone saved over 1.50 lakh Ton of CO\textsubscript{2}

Source: internal data
Emissions: Future Roadmap required

80 % Reduction of emissions from vehicles from 2000 till 2010
Adoption of OBD Regulations from 2013 for all categories of vehicles

Beyond 2013 no Roadmap is available for the Oil and Auto Industries to follow
Industry Initiatives – Consumer Focus

Consumer Information

- Fuel efficiency Consumer information Label started from Jan 2009
- Comparative label started from 2010

Driver Training

- Driver’s can influence Fuel Efficiency on road by upto 30%
- Driver education

Consumer information and education is key to achieve fuel savings in actual road conditions
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Fuel Efficiency Regulation for India

Industry supports the Fuel Efficiency Regulation for India

But the regulation has to:

- Consider the uniqueness of Indian Industry
- Consider the differences of Indian testing procedure
- Consider Indian Road and Infrastructure Conditions
- Consider that India adopts technology from Japan/Korea/Europe
- Consider the acquisition cost and Price sensitivity of customers
Indian Industry - Polarization

- Polarization of Manufacturers / Classes of vehicles/ Fuel Technologies
- Indian Auto industry needs to mature

Initial Target definition in India should consider this polarization.
## Comparison of Key Test Parameters

<table>
<thead>
<tr>
<th></th>
<th>EU</th>
<th>Japan</th>
<th>India</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Road Load</strong></td>
<td>Measured values due to:</td>
<td></td>
<td>Higher test mass</td>
<td>Higher Emissions</td>
</tr>
<tr>
<td></td>
<td>a) Lower test mass</td>
<td>Kerb Weight + 100kgs</td>
<td>Higher rolling tyres</td>
<td>Higher CO₂ Emissions</td>
</tr>
<tr>
<td></td>
<td>b) Lower rolling tyres</td>
<td>Kerb Weight + 110kgs</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Inertia Simulation</strong></td>
<td>Kerb Weight + 100kgs</td>
<td>Kerb Weight + 110kgs</td>
<td>Kerb Wt + <strong>150kgs</strong></td>
<td>Test with higher road load (due to 50kg extra)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inertia Weight Category may increase (~110kgs or higher)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Higher emissions, CO₂</td>
</tr>
<tr>
<td><strong>Driving Cycle</strong></td>
<td>NEDC Max Speed 120kph</td>
<td>JC08 Max speed <strong>82kph</strong></td>
<td>Mod. IDC Max Speed 90kph</td>
<td>The two cycles of EU and India are equivalent.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>In fact Higher inertia in Indian cycle poses greater challenges</td>
</tr>
<tr>
<td><strong>Weightage of Cold and Hot Tests</strong></td>
<td>Cold: 100%</td>
<td>Cold : 25%</td>
<td>Cold: 100%</td>
<td>European and Indian CO₂ test values are higher than Japan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hot: 75%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cycles are not comparable. Need to rationalize before comparing targets.
Infrastructure: Constraint For Technology

1. Fuel Quality: Lack of High Octane Value
   Due to non-availability of high quality fuel, OEMs can not develop high compression ratio engine
   Impact on CO₂ (Per Vehicle): 4.76 g/km

2. Low Resistance Tire
   Lack of right infrastructure is bottlenecks for low resistance tyres in India
   Impact on CO₂ (Per Vehicle): 2.83 g/km

3. Aerodynamic Design: Improve Drag (Cd)
   Less Aerodynamic Vehicles due to higher ground clearance
   Impact on CO₂ (Per Vehicle): 1.41 g/km

Fuel Quality, Road Infrastructure limit improvements in India significantly

Source: SIAM Internal Result
Comparison of India and Japan Targets

Comparison of Japan and India

- BEE Target (2011)
- New BEE Proposal
- Japan 2020 Corrected Cold Only

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>New BEE Proposal CO₂, g/km</th>
<th>Japan Target Corrected for Cold Emission CO₂ g/km</th>
<th>BEE Proposal 2011 CO₂, g/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>700kgs Gasoline Vehicle</td>
<td>91.9</td>
<td>104.3</td>
<td>104.5</td>
</tr>
<tr>
<td>1700kgs Diesel Vehicle</td>
<td>141.7</td>
<td>166.6</td>
<td>162.3</td>
</tr>
</tbody>
</table>

Targets set for India are more stringent as compared to Japan 2020 targets
Technology Acquisition Cost

Technology Over Base Engine

Evolutionary Path
+ RR Improvement
+ Engine Friction
+ Weight Reduction
+ Aerodynamic
+ DVVT

Revolutionary Path
+ Start Stop
+ CVVL
+ GDI
+ Micro Hybrid with Regenerative Braking

Technology Cost (Right Side)

Source: TNO Final Report (Modified for Indian Context)

Acquisition Cost is High For Revolutionary Technology, Not Relevant For Developing Country
Lead Time and Rates of Reduction in Japan

2. Fuel efficiency standard 2015

<table>
<thead>
<tr>
<th>P'nger vehicle</th>
<th>Base year</th>
<th>Enforcement notification</th>
<th>Target year</th>
<th>Improvement*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol</td>
<td>'95</td>
<td>'96</td>
<td>'07</td>
<td>22.8%</td>
</tr>
<tr>
<td>Diesel</td>
<td>'95</td>
<td>'96</td>
<td>'07</td>
<td>14.9%</td>
</tr>
<tr>
<td>Petrol Diesel</td>
<td>'95</td>
<td>'96</td>
<td>'07</td>
<td>23.5%</td>
</tr>
<tr>
<td>LPG</td>
<td>'95</td>
<td>'96</td>
<td>'07</td>
<td>11.4%</td>
</tr>
</tbody>
</table>

Target year: Year when goal standards have to be accomplished after that
Base year: Year which is adopted for example selection of top runner when goal standards were planned

Source: JAMA

Industry needs lead time to develop vehicles/Engines to meet the regulation targets
Regulation Roadmap

- **Attempt 1**: Target – Define Targets for 2010, 2015 and 2020
- **Attempt 2**: Target – Define Targets for 2012, 2015 and 2020

- Targets for 2010 and 2012 could not be defined.
- Considering lead times for development, India is losing time to get its first fuel efficiency regulation.
- FE Regulation definition is not a one-time affair.
- Should conclude the first phases of regulation.
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More than 70% of fuel consumption can be attributed to:

Driver behavior

Road infrastructure and driving conditions
Infrastructure – Impact on Vehicle Efficiency

Road Infrastructure (In million Km)

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles on Road (In million)</td>
<td>2.52</td>
<td>3.32</td>
</tr>
</tbody>
</table>

Source: MSIL’s Internal Test Result

60% Reduction in CO2 If Avg. Speed is Improved From 10 km/h to 30 km/hr

Average Vehicle Speed and CO2 Emissions

Impact on Vehicle Efficiency

Average CO2 output per kilometer (10 km/h = 100):

- 10kph
- 20kph
- 30kph

Delhi wastes Rs 11.5cr in traffic jams daily
Infrastructure: Constraint For Technology

Total Extra CO₂ Emission Per Year: 324,000 Tons
Total Extra Fuel Consumption Per Year: 136 Million Ltr

- Fuel Quality For Higher CR: 171,360
- Low Resistance Tyre: 101,880
- Lower Ground Clearance to Improve Drag: 50,760

India Can Save 136 Million Liters of Fuel Per Year

Source: MSIL’s Internal Test Result
Example: Japanese Approach To Reduce CO₂

Million tons


Without any countermeasures

With Countermeasure

Note: About 90% of CO₂ emissions generated by Japan's transport sector are caused by road transportation. JAMA had set a Target of 31 Mtons CO₂ reduction from 2000 to 2006.

Japan Achieved 70% of CO₂ Reduction by Road Infrastructure (Improved Traffic Flow & Eco Driving)
Emissions Improvement Roadmap

1. Fuel Improvement
2. Vehicular Technology
3. Inspection & Maintenance
4. Road Infrastructure

Vehicular Technology is becoming highly sensitive to Fuel Specifications

10ppm Sulfur is required for ensuring durability of Engine and After Treatment systems

Enactment of Inspection and Maintenance centers to ensure compliance
Overall Improvement of Emissions:

- **Improvement of Emissions from Existing vehicle Fleet**
- **Early adoption of 10ppm Sulfur Fuel**
- **Vehicle retirement policy**
- **Strong Inspection and Maintenance setup**

**Source:** ICCT[2012]

- **Consumer Awareness**
- **Vehicle Maintenance and OBD awareness**

12% Improvement per year in PM emissions is possible from existing vehicles with ULSF
Ethanol: Challenges

- Blending not mandatory in all places.
- Blending dependent on Supply condition of Ethanol
- Supply condition not favorable for even 5% blend.

Fuel Variations for Manufacturers

- BSIII
  - E0
  - E05
  - E10
- BSIV

Inconsistent Ethanol content = Compromise on vehicle performance
## E10 Case Study

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Drive, kms</th>
<th>Fuel Eff., kpl</th>
<th>Fuel Consumed, lit</th>
</tr>
</thead>
<tbody>
<tr>
<td>E0 (Gasoline)</td>
<td>1000</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>E10 Blend</td>
<td>1000</td>
<td>9.6</td>
<td>104.2</td>
</tr>
</tbody>
</table>

10% of ethanol in gasoline will increase running cost for a consumer although it will help in reduction of Gasoline consumption by 6.2% approx.
Policy Intervention: For Future

Roadmap for Diversified Fuel Type For Transportation

Encouragement of Hybrids

NEMMP 2020 (Govt. of India) Under Discussion

Scrapage schemes and Policy for Fuel efficiency and Emission Improvements

Policy for Fleet Renewal

Improve Public Transport

Policy Intervention is Must to Optimize the Consumption
Reduce Fuel Consumption & Emissions

Integrated Approach: Govt.'s/OEM's/End User

- Vehicle Technology
- Infrastructure
- Policy Intervention
- Driver Behavior
Working towards Sustainable mobility

Manufacturing Processes

Product Fuel Efficiency

Recyclability

Urban Development

Modal Shift: Mass Transportation

Driver Education

Infrastructure Development
- Roads
- Diversified Fuel
- Inspection & Maintenance

All Stakeholders to work for a common goal of sustainable mobility
Thank You for Your Attention