CSE WORKSHOP ON TRANSPORT AND CLIMATE

REGULATORY PREPAREDNESS

By

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Automotive Research Association of India (ARAI)
Presentation Layout

• Global Scenario – Mobility

• Indian Scenario – Mobility

• Challenges And Concern Areas

• Current Regulatory System

• Way Forward for Regulatory Preparedness
Global Scenario

Mobility
Global Scenario – Mobility

Global vehicle fleet expected to grow to 2 billion by 2050

Asia witnessing a growing demand for personal mobility

Source: Clean Air Asia Center, Presentation, Dec 2012
Global Scenario – Mobility

Road Transport accounts for 16% of CO₂ Emissions

Road Transport (Cars, Trucks & Buses)

Conventional technology vehicles still expected to dominate even in 2030

Source: OICA Website & Urban Mobility in the 21st Century A Report

Source: BP Energy Outlook 2030, Jan 2012
Indian Scenario
Mobility
Indian Scenario – Mobility

1982 - 92
- 0.6 million units in 1992
- 0.4 million units in 1982
- Closed Market
- Seller’s Market
- JV between Indian Govt. & Suzuki established

1993 - 2007
- 11 million units in 2007
- Sector de-licensed in 1993
- Imports allowed from April 2001

2008 Onwards
- 20.7 million units in 2013
- Removal of most import controls
- Indian companies gaining global identity

Sales – Indian Automotive Industry
(Million Units)

<table>
<thead>
<tr>
<th>Year</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-13</td>
<td>20.7</td>
</tr>
<tr>
<td>2011-12</td>
<td>20.3</td>
</tr>
<tr>
<td>2010-11</td>
<td>17.9</td>
</tr>
<tr>
<td>2009-10</td>
<td>14.1</td>
</tr>
<tr>
<td>2008-09</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Source: SIAM Database & IBEF Presentation
Indian Scenario – Mobility

- 125 million registered vehicles in India
- Automobile production to double by 2020-21
- Vehicle density per 1000 population in India expected to grow to 65 by 2030

Source: SIAM and ACMA Presentations

Source: BP Energy Outlook 2030, Jan 2012
Indian Scenario – Mobility

But, Indian Vehicle Population has far outgrown compared to the infrastructure

Source: Estimation of Automobile emissions and control strategies – K. S. Nesamani, University of California, 2009
Indian Scenario – Mobility

Automobiles are clean

But, still Road Transport alone accounts for about 70% of CO₂ emission in Transport sector

Adapted from SIAM Presentation 2012 on Emissions & Fuel Efficiency
So, trends are relatively clear

By 2050, Passenger VKT is expected double and Freight VKT triple

Resulting in increased Transport related fuel usage and CO₂ emissions

Source: Transport and Sustainability – CRA International
Resulting in ‘Transportation Imbalance’

- Environmental Impacts
- Growing Transportation Needs
- Urbanization
- Population Concentration

- Infrastructure
- Technological Developments
Challenges And Concern Areas
So, what does the Environment have in store for the Future??

Climate Change

Resource Depletion

Congested Roads
Green House Gases – Transport Sector
CO₂ Emissions per Unit Load by Transport Mode

<table>
<thead>
<tr>
<th>Transport Mode</th>
<th>Units</th>
<th>CO₂ Emissions per Unit Load (g/mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Tanker</td>
<td>1</td>
<td>25g/mile</td>
</tr>
<tr>
<td>Large Containership</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Railway</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Coastal Carrier</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Standard-size Commercial Truck</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Small-size Commercial Truck</td>
<td></td>
<td>226</td>
</tr>
<tr>
<td>Airplane</td>
<td></td>
<td>398</td>
</tr>
</tbody>
</table>

Units Relative
# Main Greenhouse Gases and Characteristics

<table>
<thead>
<tr>
<th>Greenhouse gases</th>
<th>Chemical formula</th>
<th>Pre-Industrial concentration</th>
<th>Concentration in 1994</th>
<th>Atmospheric lifetime (years)***</th>
<th>Anthropogenic sources</th>
<th>Global warming potential (GWP)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon-dioxide</td>
<td>CO₂</td>
<td>278 000 ppbv</td>
<td>358 000 ppbv</td>
<td>Variable</td>
<td>Fossil fuel combustion, Land use conversion, Cement production</td>
<td>1</td>
</tr>
<tr>
<td>Methane</td>
<td>CH₄</td>
<td>700 ppbv</td>
<td>1721 ppbv</td>
<td>12.2 +/- 3</td>
<td>Fossil fuels, Rice paddies, Waste dumps, Livestock</td>
<td>21**</td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>N₂O</td>
<td>275 ppbv</td>
<td>311 ppbv</td>
<td>120</td>
<td>Fertilizer industrial processes combustion</td>
<td>310</td>
</tr>
<tr>
<td>CFC-12</td>
<td>CCl₂F₂</td>
<td>0</td>
<td>0.503 ppbv</td>
<td>102</td>
<td>Liquid coolants, Foams</td>
<td>6200-7100 ****</td>
</tr>
<tr>
<td>HCFC-22</td>
<td>CHClF₂</td>
<td>0</td>
<td>0.105 ppbv</td>
<td>12.1</td>
<td>Liquid coolants</td>
<td>1300-1400 ****</td>
</tr>
<tr>
<td>Perfluoromethane</td>
<td>CF₄</td>
<td>0</td>
<td>0.070 ppbv</td>
<td>50 000</td>
<td>Production of aluminium</td>
<td>6 500</td>
</tr>
<tr>
<td>Sulphur hexa-fluoride</td>
<td>SF₆</td>
<td>0</td>
<td>0.032 ppbv</td>
<td>3 200</td>
<td>Dielectric fluid</td>
<td>23 900</td>
</tr>
</tbody>
</table>

Note: ppbv: 1 part per trillion by volume; ppbv: 1 part per billion by volume; ppmv: 1 part per million by volume.

* GWP for 100 year time horizon. ** Includes indirect effects of tropospheric ozone production and stratospheric water vapour production. *** On page 15 of the IPCC SAR. No single lifetime for CO₂ can be defined because of the different rates of uptake by different sink processes. **** Net global warming potential (i.e., including the indirect effect due to ozone depletion).

Source: IPCC radiative forcing report; Climate change 1995. The science of climate change, contribution of working groupe 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.
But does this not mean, we step back in technology...

Rather, we require a systems approach to counter these challenges and to ...
Some of foreseen ‘Concerns’ for Mobility in

Concerns are addressable through ...

**Government**
- Promote R&D
- Infrastructure: Road, Rail, Ports, Power AND ITS
- Promote ‘Brand India’
- HR

**Industry**
- Upgrade Quality Standards
- Upgrade Manufacturing Technology
- Cost Competitiveness
- Develop R&D Capability
- Target Overseas Markets
Reducing $\text{CO}_2$ emissions
The situation in Europe
An integrated approach

1. Vehicle Technology
   Delivering *majority* of new car CO2 reductions

2. Alternative Fuels
   Sustainable production

3. Driver Behaviour
   Influencing demand in a harmonised way

4. Infrastructure Measures
   Reducing congestion

5. CO₂-Related Taxation
Japan’s Approach to CO$_2$ Reduction
Adopting an Integrated Sectoral Approach to CO₂ Reduction

Improving automotive fuel efficiency and traffic flow is not enough to reduce CO₂ emissions in the road transport sector. An integrated approach is required, which includes the development and supply of alternative fuels and a more efficient use of vehicles. The adoption of these measures will ultimately make CO₂ reduction efforts compatible with economic growth. All stakeholders concerned should identify their individual responsibilities and make their best efforts to carry them out, in a framework of mutual cooperation.
Current Regulatory System
Regulatory Scenario – Emissions

Vehicle Emissions

- Emission norms for Catalytic Vehicles
  - BS-I (Country)
  - BS-II (Metros)
  - BS-III (Country)
  - BS-IV (13 Cities)

1991 to 2000
- BS-II (Country)
- BS-III (11 Cities)

2001 to 2005

2006 to 2010

By 2015
- Another 50 Cities to be included by 2015 for BS IV

Diesel Sulphur Reduction

- Sulphur 2500 ppm for entire Country
- Sulphur 50 ppm (13 Cities) & 350 ppm for entire Country

1991 to 2000
- Sulphur 500 ppm for entire Country & 350 ppm (11 Cities)

2001 to 2005

2006 to 2010
## Application of Test Requirements for Type-Approval and Extensions – 4 wheelers

<table>
<thead>
<tr>
<th>Emission Level</th>
<th>BS IV</th>
<th>Vehicles with Positive Ignition</th>
<th>Vehicles with Compression Ignition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vehicle Category</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reference fuel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mono Fuel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petrol</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td>LPG</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td>CNG</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td>Bi fuel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petrol</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td>Petrol</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td>Mono Fuel</td>
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<td></td>
</tr>
<tr>
<td>Diesel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPG</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td><strong>Type I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Gaseous Pollutants)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td>THC</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td>NMHC</td>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>NOX</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td>THC+NOX</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PM</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>PN</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Type II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idle CO &amp; HC</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td>High Idle Co &amp; Lambda</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Free Acceleration Smoke</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Type III</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crank case emission</td>
<td>✓</td>
<td>-</td>
<td>-</td>
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<tr>
<td><strong>Type IV</strong></td>
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<tr>
<td>Evaporative Emission</td>
<td>✓</td>
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<td>-</td>
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<tr>
<td><strong>Type V</strong></td>
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<td></td>
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</tr>
<tr>
<td>Durability</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td>OBD</td>
<td>✓</td>
<td>✓</td>
<td>✓ (both fuels)</td>
</tr>
<tr>
<td>In-service conformity</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emission Level</th>
<th>EURO V(BS V)/EURO VI(BS VI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vehicle Category</strong></td>
<td><strong>Vehicles with Positive Ignition</strong></td>
</tr>
<tr>
<td></td>
<td>Mono Fuel</td>
</tr>
<tr>
<td>Reference fuel</td>
<td>Petrol E5</td>
</tr>
<tr>
<td></td>
<td>CNG</td>
</tr>
<tr>
<td>Type I</td>
<td></td>
</tr>
<tr>
<td>(Gaseous Pollutants)</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>✓</td>
</tr>
<tr>
<td>THC</td>
<td>✓</td>
</tr>
<tr>
<td>NMHC</td>
<td>✓</td>
</tr>
<tr>
<td>NOX</td>
<td>✓</td>
</tr>
<tr>
<td>THC+NOX</td>
<td>-</td>
</tr>
<tr>
<td>PM</td>
<td>-</td>
</tr>
<tr>
<td><strong>Particle Number</strong></td>
<td>✓</td>
</tr>
<tr>
<td>Type II</td>
<td></td>
</tr>
<tr>
<td>Idle CO &amp; HC</td>
<td>✓</td>
</tr>
<tr>
<td>High Idle Co &amp; Lambda</td>
<td>✓</td>
</tr>
<tr>
<td>Free Acceleration Smoke</td>
<td>-</td>
</tr>
<tr>
<td>Type III</td>
<td></td>
</tr>
<tr>
<td>Crank case emission</td>
<td>✓</td>
</tr>
<tr>
<td>Type IV</td>
<td></td>
</tr>
<tr>
<td>Evaporative Emission</td>
<td>✓</td>
</tr>
<tr>
<td>Type V</td>
<td></td>
</tr>
<tr>
<td>Durability</td>
<td>✓</td>
</tr>
<tr>
<td>OBD</td>
<td>✓</td>
</tr>
<tr>
<td>In-service conformity</td>
<td>✓</td>
</tr>
<tr>
<td>CO2/FE regulations</td>
<td>✓</td>
</tr>
</tbody>
</table>
## European Regulation - Application of Test Requirements for Type-Approval and Extensions – 2 wheelers (Euro IV,-2017, Euro V-2021)

<table>
<thead>
<tr>
<th></th>
<th>Vehicle with PI engines including hybrids</th>
<th>Vehicles with C.I. engines including hybrids</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reference Fuel</strong></td>
<td>Mono fuel</td>
<td>Bi fuel</td>
</tr>
<tr>
<td>Petrol (E5)</td>
<td>LPG</td>
<td>NG/ Biomethane</td>
</tr>
<tr>
<td>Petrol (E5)</td>
<td>Petrol (E5)</td>
<td>Petrol (E5)</td>
</tr>
<tr>
<td><strong>Type I Test</strong></td>
<td>Tailpipe emissions after cold start</td>
<td>Yes</td>
</tr>
<tr>
<td>Emissions at idling and increased idling speed &amp; Smoke opacity for CI only</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Type III test</strong></td>
<td>Crankcase Emissions</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Type IV Test</strong></td>
<td>Evaporative emissions</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Type V Test</strong></td>
<td>Durability of pollution control devices</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Type VII test</strong></td>
<td>CO2 emissions</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Type VIII test</strong></td>
<td>OBD tests</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Chassis Dynamometer Facilities – Euro V / Euro VI

4W Chassis Dynamometer 4 x 2

HCV Chassis Dynamometer

2W Chassis Dynamometer

4W Chassis Dynamometer 4 x 4

Transient Dynamometer

50 kW

2W/3W Chassis Dynamometer

SHED

Particle Number Measurement

Mileage Accumulator Dyno with Robot 4 x 4
## Establishment – New Facilities

<table>
<thead>
<tr>
<th>Description</th>
<th>VTC</th>
<th>CVTC</th>
<th>MACD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>4W Mass emission testing</td>
<td>Climatic chamber to carry out Type-VI test - measurement of CO and HC at -7 °C</td>
<td>Mileage accumulation chassis dyno.</td>
</tr>
<tr>
<td>Base Inertia</td>
<td>4 x 4</td>
<td>4 x 4</td>
<td>4 x 4</td>
</tr>
<tr>
<td>Base Inertia</td>
<td>1200 kg per axle</td>
<td>1200 kg per axle</td>
<td>1300 kg per axle</td>
</tr>
<tr>
<td>Inertia simulation range of unit</td>
<td>454 to 5448 Kg</td>
<td>454 to 5448 Kg</td>
<td>454 to 5448 Kg</td>
</tr>
<tr>
<td>Max Speed</td>
<td>250 km/h</td>
<td>250 km/h</td>
<td>250 km/h</td>
</tr>
</tbody>
</table>

This total facility will be ready for customers by April 2014

Particle Number measurement for Euro 5 and Euro 6

SHED (Evaporative Emission Determination)

Climatic chamber for temperatures from -30°C to + 55°C and 20% RH to 75 % RH

Export Homologation
Organization Structure for WP.29

WP29

- GRPE
  - GRB
  - GRE
  - GRRF
  - GRSG
  - GRSP

EFV
- EVE
- FQ
- GFV
- HDH
- HFCV
- MACTP
- NRMM
- OCE
- PMP
- REC
- WHDC
- WLTP
- WMTC
- WWH-OBD

DTP
- DHC
- VTF

ICE
- EV/HEV
- PMP
- AP
- RF
India’s Position

• Active participation in WP.29 & GR meetings

• Signatory to 1998 agreement under which GTRs (Global Technical Regulations) are being formulated

• Our national standards are being updated for alignment with ECE regulations
Policy Initiatives of Government of India (GoI)

- Inspection and Certification Program
- National Electric Mobility Mission Plan (NEMMP) 2020
- Traffic Management through Intelligent Transport Systems
- Auto Fuel Vision & Policy 2025 Committee – Four Working Groups formulated already
Inspection and Certification Program for In-use Vehicles

10 Model Test Centers being established

- Centers to be facilitated by ARAI
- Centers to be facilitated by NATRiP
- Center to be facilitated by SIAM
## Inspection and Certification Program for In-use Vehicles

### Benefits:

<table>
<thead>
<tr>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="Inspection.png" alt="Image" /></td>
<td>Safer &amp; Cleaner Vehicles</td>
</tr>
<tr>
<td><img src="Reduced.png" alt="Image" /></td>
<td>Reduced Accidents &amp; Fatalities</td>
</tr>
<tr>
<td><img src="Identification.png" alt="Image" /></td>
<td>Identification &amp; Reduction of Gross Polluting Vehicles</td>
</tr>
<tr>
<td><img src="Improved.png" alt="Image" /></td>
<td>Improvement in Fuel Consumption</td>
</tr>
<tr>
<td><img src="Establishment.png" alt="Image" /></td>
<td>Establishment of Desired facilities for Test Centres and Garages</td>
</tr>
<tr>
<td><img src="Input.png" alt="Image" /></td>
<td>Inputs for End of Life of Vehicles</td>
</tr>
<tr>
<td><img src="Networking.png" alt="Image" /></td>
<td>Networking of Data</td>
</tr>
</tbody>
</table>
Above lane requirements are based on following assumptions:
2 shift operation and 80% lane occupancy
75% operating efficiency and 300 working days in one year.
Based on the vehicle population data available from year 2009 by MoRTH- Provisional (10% vehicle growth for every year is considered.)
National Electric Mobility Mission Plan (NEMMP) 2020

- Encourage Reliable, Affordable and Efficient xEVs
- Enable Indian Automotive Industry to achieve xEV manufacturing leadership
- Contribute towards National Fuel Security
- Emerge as world leader in xEV 2-Wheeler and 4-Wheeler market by 2020
- Total projected sales of 6-7 million units
National Electric Mobility Mission Plan (NEMMP) 2020

- **Working Group on R&D**
  - BMS & Battery
  - Power Electronics & Motors
  - Testing Infrastructure, Human Resources, Energy efficient Technologies

- **Working Group on Infrastructure**
  - Technology & Standards
  - Infrastructure Rollout

- **Working Group on Demand & Supply**
  - Demand Incentive Scheme
  - Incentive Delivery & Monitoring Mechanism
  - Promotion of Hybrid Retro-fitment Kits
Everyone has a role to play

- Technology mapping, synergy in R&D efforts & innovation
  - DST

- Grid Strengthening
  - DoE

- On road taxation & incentives
  - MoRTH

- Renewable energy
  - MNRE

- EV manufacturing
  - DHI

- Environmental effects/ LCA
  - MNRE
**CO₂ benefits**

- **Diesel Engine**
  - Vehicle Cost: +1.5%
  - CO₂: -4.2%

- **Improved Gasoline Engine**
  - Vehicle Cost: +5.8%
  - CO₂: -23%

- **12V Stop/Start Belt Starter/Alternator**
  - Vehicle Cost: +1.5%
  - CO₂: -4.2%

- **12V/42V Micro Hybrid Belt Starter / Alternator / Motor**
  - Vehicle Cost: +5.8%
  - CO₂: -23%

- **42V /120V Mild Hybrid Integrated Starter / Alternator / Motor**
  - Vehicle Cost: +13.3%
  - CO₂: -34%

- **Full Parallel Hybrid 1 or 2 High voltage motor, ZEV mode**
  - Vehicle Cost: +23.5%
  - CO₂: -45%

- **Fuel Cell Hybrid Vehicle Hydrogen Fuel**
  - Vehicle Cost: +29.7%
  - CO₂: -56%

- **Auxiliary Power Unit as ZEV range extender Fuel Cell-Liquid or Hydrogen Fuel**
  - Vehicle Cost: +27.5%
  - CO₂: -52%

- **Improved Parallel Hybrid Batteries, Motors, Control, Exhaust Energy recovery**
  - Vehicle Cost: +24.3%
  - CO₂: -49%
Traffic Management

- Improved On-road Safety
- Increased Capacity and Throughput
- Enhanced Personal Mobility and Convenience
- Reduced Fuel Consumption
- Reduced Emission
- Improved Transport Efficiency
- ITS

Convenience
Traffic Management

Intelligent Transport System (ITS) one of the key technologies which can contribute to mitigating climate change

- ITS is designed to achieve
  - Improvement of road safety and reduction of traffic accidents –
  - Increase of traffic efficiency;
  - Improvement of freight and public transportation efficiency;
  - Reduction of CO$_2$ emissions.
  - Driver assist and management
Traffic Management

V2V and I2V Communication
Traffic Management

Advanced Public Transportation Systems

Advanced Vehicle Control Systems - Intelligent Cruise Control System
Traffic Management

Intelligent Transportation Systems – Technologies supporting ITS

- Global Positioning System (GPS)
- Dedicated Short Range Communications (DSRC)
- Wireless Networks
- Mobile Telephony
Traffic Management

Intelligent Transportation Systems – Technologies supporting ITS Cont..

- Radio Wave or IR Beacons Recognition

- Roadside Camera

- Probe Vehicles or Devices
Traffic Management

Thereby, leading to improved fuel economy, reduced congestion and more road safety

Source: IEA_Technology_Roadmap_Fuel_Economy_2012
Traffic Management

Intelligent Transportation Systems – World Experiences: South Korea

- Started in 2000 with 20 years blue print
- Investment US$ 1.3 billion
- Started in a model city in 1998, expanded to 25 cities by 2007
- Economic benefit of US$ 109 m every year due to reduced transportation time, accidents, environmental pollution
Traffic Management

Intelligent Transportation Systems – World Experiences: Japan

• Started in late 90s
• US$ 640 m every year
• Extensive use of real time traffic information
• Extensive use of probe vehicles
Traffic Management

Intelligent Transportation Systems – Benefit : Cost studies

- ITS deployment in Tucson, Arizona
  - 6% decrease in congestion
  - 70% decrease in incident related delay on freeways
  - Reduction in annual fuel by 11%
  - CO, HC, NOx reduction between 10~16%
  - Benefit:Cost ratio of 6.3:1
Traffic Management

Intelligent Transportation Systems – Benefit : Cost studies

- ITS systems 9:1 as against 2.7:1 for addition of conventional highway capacity
- Florida University: US$ 142 m annually 14:1 ratio
- Texas: optimization of traffic signal operation 38:1
- Generally the benefits far outweigh the investments
Traffic Management

Intelligent Transportation Systems – Efforts in India

• Location Technologies
  GPS based tracking for public transport in use in Delhi, Bangalore, Indore

• Fare collection Technologies
  Delhi Metro

• Electronic Toll Collection
  Delhi-Noida Highway, Bangalore Electronic City Highway
Traffic Management

Bus Population in India Comparison (2012)

Chart 10: Number of Buses per 1,000 persons across select countries

- U.S.A.: 2.77
- U.K.: 2.93
- Japan: 1.80
- Germany: 0.91
- France: 1.35
- Mexico: 3.14
- Malaysia: 2.37
- South Africa: 6.50
- Brazil: 10.34
- China: 1.84
- India: 1.29
Why Public Transport: Because Transporting 10,000 People for 1 km requires...

<table>
<thead>
<tr>
<th>Passengers (numbers)</th>
<th>Vehicles (numbers)</th>
<th>Space (m²)</th>
<th>Fuel (liters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>2000</td>
<td>24000</td>
<td>200</td>
</tr>
<tr>
<td>25</td>
<td>400</td>
<td>8800</td>
<td>120</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
<td>3400</td>
<td>50</td>
</tr>
<tr>
<td>175</td>
<td>57</td>
<td>2850</td>
<td>35</td>
</tr>
<tr>
<td>270/300</td>
<td>37</td>
<td>2370</td>
<td>26</td>
</tr>
</tbody>
</table>

To carry 50,000 people per hour per direction requires:
- 175 m wide road used only by cars, or
- 35 m wide road used only by buses.

*Source: Report of UTIP*
Traffic Management

Why Public Transport:

20% people using 80% roads?

80% people using 20% roads?
Traffic Management

Why Public Transport?

A comparative study of CO₂ emissions per passenger indicates:

• Similar amount of emissions for bus with 50% occupancy vis-à-vis car with 75% occupancy
Steps required for Improving Air Quality in Urban Areas

**Roads:**
- Better Maintenance
- Paving of Roads
- Footpaths or low-elevation concreting of unpaved surfaces
- Use of fly ash bricks for pavement
- Road construction & maintenance guidelines by concerned authorities

**Minimizing vehicular emissions:**
- Implementation of progressive norms
- Road map for fuel quality improvement

One country One fuel quality and One regulation….

*Continued...*
Steps required for Improving Air Quality in Urban Areas

- Management options like:
  - Synchronizing traffic signals
  - Staggering business hours
  - Restricting vehicular movements in high pollution level areas
  - Fiscal incentives / disincentives
  - Banning odd/even vehicles on major roads

- Development of mass rapid transportation system.
Summing up.... Integrated Approach for Clean Air

Auto Industry
- Adoption of Advanced Technology
- Fuel Efficient Vehicles

Policy Makers
- Policy Framework
- Transport Management
- I & M Regime
- ITS
- Vehicle scrapping policy

Vehicle Owners
- Good Maintenance Practices
- Better Driving Habits

Oil Industry
- Provision of Clean Fuel
To Conclude............

- AIR QUALITY WILL ONLY REMAIN A DREAM UNLESS AN INTEGRATED APPROACH AND SIMULTANEOUS ACTIONS ARE TAKEN IN IMPLEMENTING NEW VEHICLES IMPROVEMENTS, I&M, ITS. MULTIMODAL TRANSPORT.

- CONSIDERING LONG GESTATION PERIOD THE ACTIONS NEED TO BE TAKEN IMMEDIATELY.

- NEED TO ALSO PROMOTE INLAND WATER TRANSPORTATION, RAILWAYS. WE ARE A WAY BEHIND THE WORLD IN USING THESE MODES OF TRANSPORT WHICH ARE CLEANER, THOUGH SLOWER, THAN AUTOMOBILE TRANSPORT.
Conclusion contd.

• NECESSARY TO HAVE A ‘SOUND & ROBUST ROADMAP’ SINCE ALL ARE LONG GESTATION PROJECTS

• REGULATIONS FOR ALL OF THEM NEED TO BE DEVELOPED

• RESPONSIBILITY LIES WITH EVERYONE, I.E. GOVERNMENT, CORPORATES AND CITIZEN FOR CLEAN AIR
Thank you
Problems associated with Particle Number Measurement

- Maturity of the PN measurement method.
- Long term stability of the complete particle counter instrument.
- Repeatability of the calibration and validation methods.
Integrated Approach to reduce Road Transport CO₂

- Vehicle technology and its penetration
- Improved traffic management
- Fuel infrastructure
- Final consumer –
  - ECO driving

Government policies:

<table>
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<tr>
<th>Clear</th>
<th>Coherent</th>
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<tbody>
<tr>
<td>Predictable</td>
<td>Stable</td>
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</table>
Overview of Current Fuel consumption targets in EU, US and Japan

<table>
<thead>
<tr>
<th>EU</th>
<th>US</th>
<th>Japan</th>
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<tbody>
<tr>
<td><img src="image1" alt="Flag" /></td>
<td><img src="image2" alt="Flag" /></td>
<td><img src="image3" alt="Flag" /></td>
</tr>
</tbody>
</table>

- **Corporate Average Fuel Economy (Uniform Target)**
  - Present target: 27.5 mpg
    - \( \approx 204 \text{ gCO}_2/\text{km} \) (US Cycle)
  - Penalties: 5.5 $ per 0.1 mpg
    - \( \approx 5 \text{ € per gCO}_2/\text{km} \times \text{vol. cars} \)
  - Future Target: 35 mpg by 2020
    - \( \approx 160 \text{ gCO}_2/\text{km} \) (US Cycle)

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- **Parametric approach: Weight (segmentation)**
  - Future Target: 16.8 km/l by 2015
    - \( = 138 \text{ g CO}_2/\text{km} \) (Japan Cycle)
  - Penalties: \( \approx 6.000 \text{ €/manufacturer} \)

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- **Integrated Approach: Approximately 50% CO2 reduction by infrastructure**

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- **Parametric approach: Weight (segmentation)**
  - Target: 120 gCO2/km by 2012
    - (130 g through Vehicle Technology - 10 g through Complementary measures & biofuels)
  - Penalties: 2012 / 2013 / 2014 / 2015
    - 20 / 35 / 60 / 95 € / g CO2/km x vol. cars

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- **Integrated Approach: 5 gr CO2 reduction by biofuels – NO reduction by Infrastructure**

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Total & Surfaced Road Length (1950-51 to 2007-08)

Category-wise Road Length in India- 2008

Summing up the ‘Focus Areas’

Vehicle:
- IC Engines
- Use of alternate fuels
- Electric mobility
- Implementation of I&M

Infrastructure:
- Uniform fuel specifications
- Establishing robust I&M system
- Conceptualization of ITS Roadmap and time-bound implementation with necessary funding
- Generation of gaseous fuel from waste

Driver:
- Training of drivers for Eco-driving
Mass emission standards (Draft Bharat Stage IV) for Two wheelers

A. Two Wheeled Vehicles fitted with Gasoline engines

I. Mass emission standards (Bharat Stage IV) for two wheelers, with engine capacity exceeding 50 cc and a maximum design speed exceeding 50 km/hour:

<table>
<thead>
<tr>
<th>Class</th>
<th>TA=COP norms (g/km)</th>
<th>HC + NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO</td>
<td>If the evaporative emission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>complies with 2 g/test</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Class 1 &amp; Sub class 2-1</td>
<td>1.403</td>
<td>0.890</td>
</tr>
<tr>
<td>Sub class 2-2</td>
<td>1.970</td>
<td>0.690</td>
</tr>
<tr>
<td>Sub class 3-1 &amp; Sub class 3-2</td>
<td>1.970</td>
<td>0.420</td>
</tr>
</tbody>
</table>

Definition of class

<table>
<thead>
<tr>
<th>Class</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>50 cm³ &lt; engine capacity &lt; 150 cm³ and Vmax ≤ 50 km/h or engine capacity &lt; 150 cm³ and 50 km/h &lt; Vmax &lt; 100 km/h</td>
</tr>
<tr>
<td>Sub Class 2-1</td>
<td>Engine capacity &lt; 150 cm³ and 100 km/h ≤ Vmax &lt; 115 km/h or Engine capacity ≥150 cm³ and Vmax &lt; 115 km/h</td>
</tr>
<tr>
<td>Sub Class 2-2</td>
<td>115 km/h ≤ Vmax &lt; 130 km/h</td>
</tr>
<tr>
<td>Sub Class 3-1</td>
<td>130 km/h ≤ Vmax &lt; 140 km/h</td>
</tr>
<tr>
<td>Sub Class 3-2</td>
<td>Vmax ≥140 km/h subclass 3-2.</td>
</tr>
</tbody>
</table>
II. Mass emission standards (Bharat Stage IV) for two wheelers with Spark Ignition engines, other than those specified above:

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>TA=COP norms (g/km)</th>
<th>Deterioration Factor (D.F.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>CO</td>
<td>0.75</td>
<td>1.2</td>
</tr>
<tr>
<td>HC + NOx</td>
<td>0.75</td>
<td>1.2</td>
</tr>
</tbody>
</table>

B. BSIV emission norms Two Wheeled vehicles fitted with diesel engines:

The mass emission standards shall be same as those applicable for Diesel Three-wheelers.