Fuel efficiency of light duty vehicles in India: Uncertainties in transforming stock

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Outline

1. Vehicle types in India
2. India in the global context: Fuel consumption by road transportation
3. Vehicle stock development
4. Fuel consumption in Future
5. Fuel efficiency of LDV: Measurements, bottom up stock average
6. Actions and challenges in the future
7. Conclusions
1. Vehicle types on roads in India

Motorized two wheelers
- Scooter
- Motorcycle

Motorized three wheelers
- Auto-rickshaw
- Freight three wheeler

Light duty vehicles (this presentation)
- Passenger car
- Jeep (SUV)
- Light duty truck (≤3.5 t)
1. Vehicle types on roads in India- 2

Medium and heavy duty vehicles

Bus

Mini (Medium duty) trucks (3.5-7.5 t)

Heavy duty trucks >7.5 t

Photos by Suman Baidya (y2006 and y2007, Locations: Delhi, Agra, Pune, and Jaipur)
2. India in the global context

- **y2000 already old for India and China**
- **Fuel consumption (road, year 2000): 2.3% of global total**
- **Per capita LDV very low in India** (lower level of motorization, small cars, and lower mileage)

**CO₂ emissions (road) by world regions, y2000**

**Comparison of per capita CO₂ emissions by LDV, y2000, India=1**

Source: Borken et al., 2007
3. Stock development in India

- Two and half decades of rapid growth of vehicle sales

![Graph showing vehicle sales in India (domestic)]

Vehicle sales in India (domestic)

Self calculation based on SIAM, 2006

Future: Huge potential for growth in road transportation
→ Major energy consumer: increased global competition for fossil fuels
→ Major emitter: both air pollutants and greenhouse gases

High growth scenario A1: High growth rates of LDV and HDT (vkm and fuel) in (~SRES 2000_A1)

Source: Baidya, 2007
5.1 Fuel efficiencies of light duty vehicles: General

- **Definition:**
  Fuel consumption rate = fuel consumed / vehicle kilometres travelled (i.e. l/100km)

- **Estimation of fuel efficiencies**
  - Lab (regulation) cycle vs. real world
  - Point/ single vehicle measurement vs aggregate stock estimate
  - New vehicles vs. average stock
  - Base values vs. corrected values (e.g. load, slope)

- **Recent developments in India:**
  - **Fuel efficiency database** by Automotive Research Association of India (ARAI), Pune
  - **Real world** emission/fuel consumption measurement: Central Institute of Road Transport (CIRT), Pune / EU project QUANTIFY
5.2 Fuel efficiencies of light duty vehicles: New vehicles

1. ARAI test results
   - State of the art results for India: for BS I, II, and III (New vehicles); by engine size and fuel type
   - General impression: large variation; fuel efficiency differ by engine size
   - Usability: regulatory test cycle, lacks time development and detailed information
5.2 Fuel efficiencies of light duty vehicles: Real world measurements

2. On road vs certification test performances

- Vehicle characteristics: age, Inspection & Maintenance etc.
- Real world versus certification cycles: Pune real world DC (CIRT, 2007)
  - Sharp acceleration and deceleration in India => Higher FC!!

<table>
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<tr>
<th>Driving Cycles</th>
<th>Acc&lt;sub&gt;avg&lt;/sub&gt; (m/s&lt;sup&gt;2&lt;/sup&gt;)</th>
<th>%time in Acc &lt; 1 m/s&lt;sup&gt;2&lt;/sup&gt;</th>
<th>%time in Acc &gt; 1 m/s&lt;sup&gt;2&lt;/sup&gt;</th>
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<tr>
<td>ECE-15</td>
<td>0.65</td>
<td>21.6</td>
<td>21.6</td>
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<tr>
<td>ECE-15+EUDC</td>
<td>0.54</td>
<td>18.3</td>
<td>18.3</td>
</tr>
<tr>
<td>Pune (CIRT)</td>
<td>1.85</td>
<td>14.4</td>
<td>7.3</td>
</tr>
</tbody>
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Comparison between Pune real world DC and NEDC

Source: CIRT Pune, Sep. 2007
5.3 Stock and mileage of LDV: Modelling age structure

- **Circulating vehicle stock and VKM composition: NEW results!!**
- 25%-28% diesel cars in 2005
- More than half mileage by ≤ 4 years old (Lab FC data available), Other half: source of uncertainty!
- Low but rapidly increasing number of LDT
5.3 Fuel efficiencies of cars: Stock average

- Dynamic but uncertain stock average values
  - Future => Tata-Nano effect and LDTs??

- Usability (literature values):
  - accuracy/ transparency (top down?)
  - representativeness (about 70% car and SUV outside mega-cities)
  - petrol vehicles: averages almost fit to German cars
5.4 Higher fuel economy: Actions and challenges in future

Discussions/debates

- Fuel economy regulations
  - Possible/Sensible? <= ARAI data shows variations
  - Who? => Energy Conservation Act, PCRA/UMiPNG and BEE/UMiP
  - Structure? => Simple but effective, Target new vehicles or stock average?

- Other challenges/barriers
  - Regulated oil price
  - Trade off: more stringent emission norms vs. fuel economy
  - Monitoring: baseline data (fuel efficiency)
  - Enforcement: inspection and maintenance system
  - Shrinking share of mini cars
  - Rapid dieselization of cars: fuel efficiency gain vs air pollution/social impacts
  - Freight transportation in urban areas: understudied
6. Conclusions

- Monitoring fuel efficiency standards can provide data for:
  - Spatially differentiated traffic activity data[
  - Real world fuel economy

} Future(s) also

- Hierarchy of actions (fuel security/ energy independence):
  Development in traffic volume (vkm)> Improvements in fuel efficiency > Alternative fuels
  (Higher technical potential??)

Different degrees of challenges for stakeholders!!

- Fuel economy improvement (LDV)
  - Link policy targets on auto industry, air quality control (diesel cars), and fuel efficiency
  - Important: on road performance (older and larger vehicles), light duty trucks
  - Trend: substitution of more fuel efficient vehicles (e.g. motorcycles to mini car, increasing avg. size/power) vs. FE improvement
References


