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)

Photos by Suman Baidya (y2006 and y2007, Locations: Delhi, Agra, Pune and Jaipur)

1. Vehicle types on roads in India- 2

Medium and heavy duty vehicles

Bus

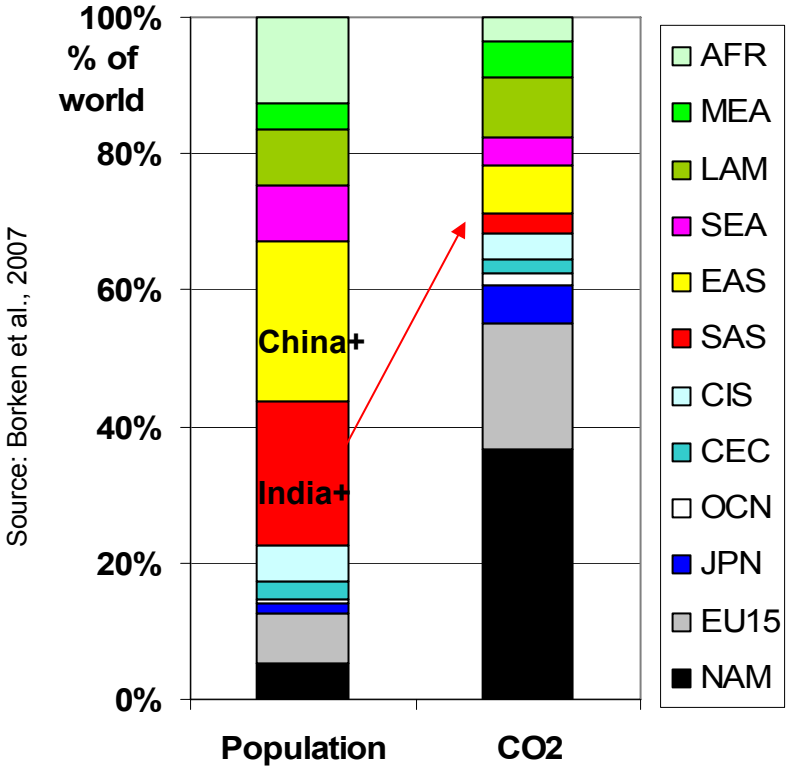
Mini (Medium duty) trucks (3.5-7.5 t)

Heavy duty trucks >7.5 t

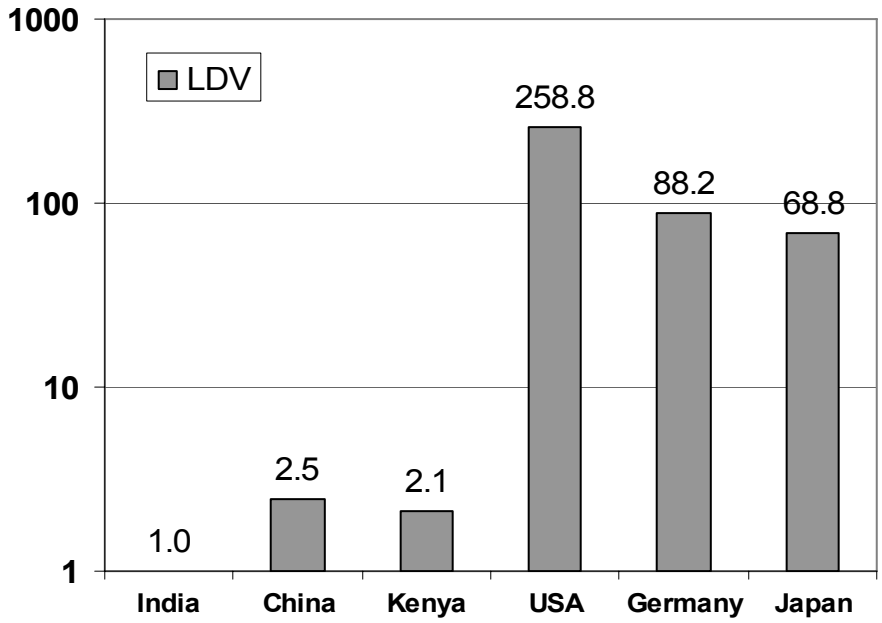
Photos by Suman Baidya (y2006 and y2007, Locations: Delhi, Agra, Pune, and Jaipur)

2. India in the global context

CO_2 emissions (road) by world regions, y2000



Comparison of per capita CO_2 emissions by LDV, y2000, India=1

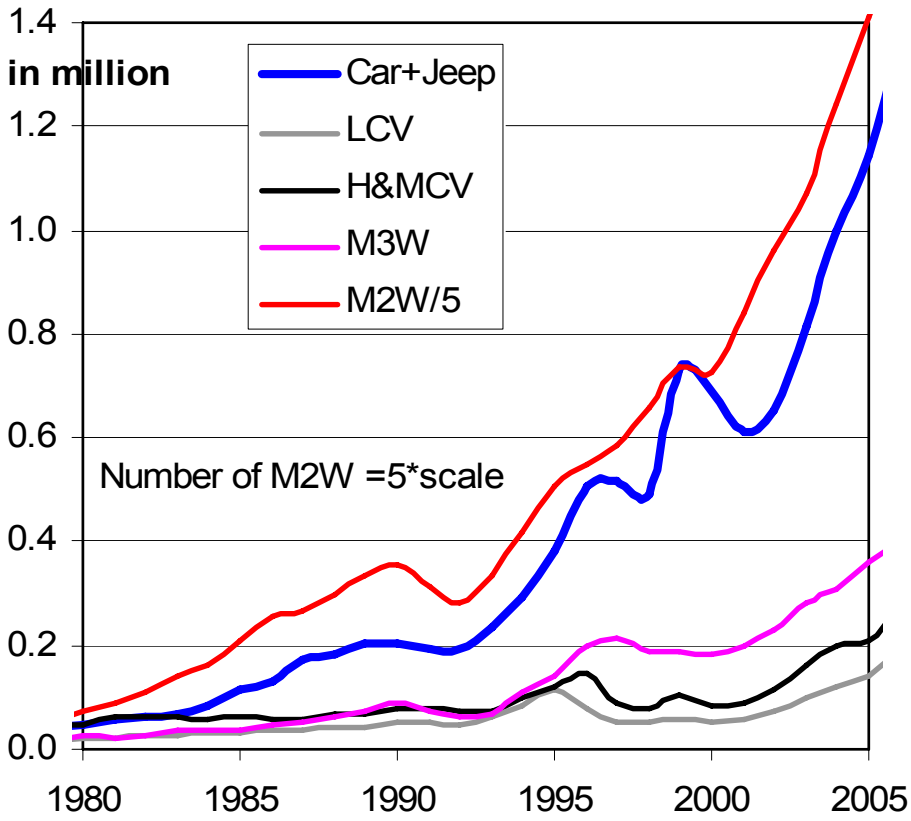


- **y2000 already old for India and China**
- **Fuel consumption (road, year 2000) : 2.3% of global total**

- **Per capita LDV very low in India** (lower level of motorization, small cars, and lower mileage)

3. Stock development in India

- **Two and half decades of rapid growth of vehicle sales**

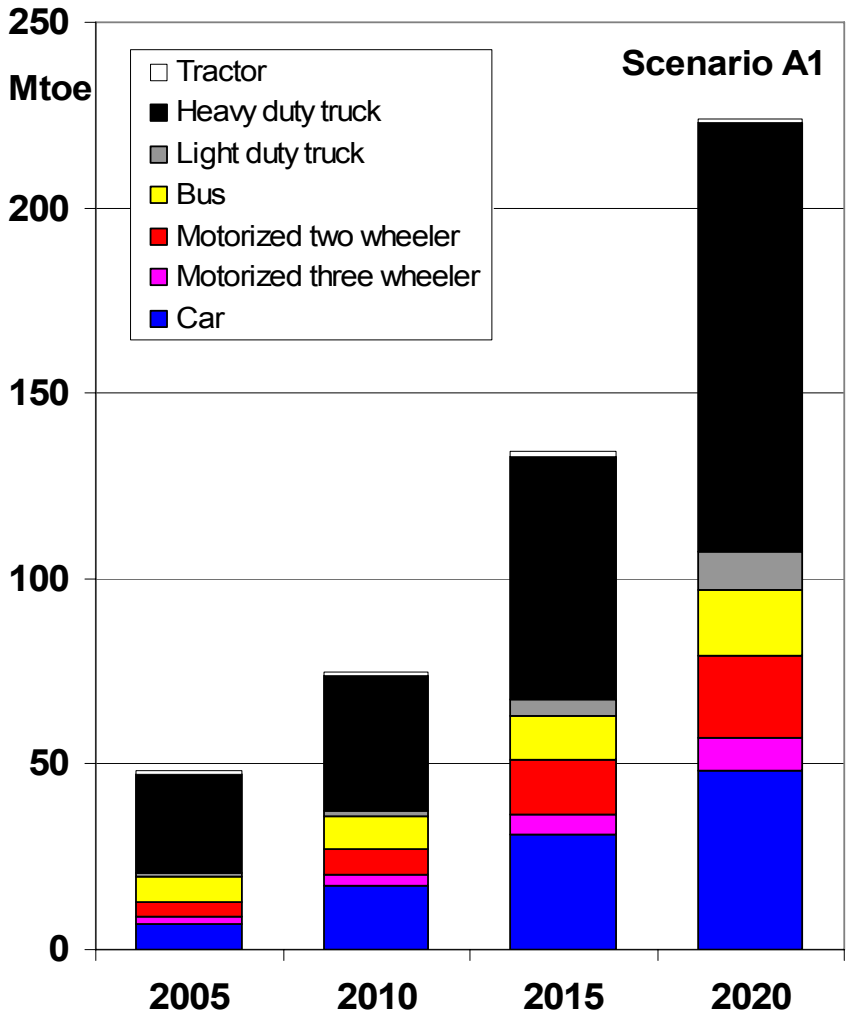


Self calculation

based on SIAM, 2006

Vehicle sales in India (domestic)

4. Fuel consumption in India: y2005 - y2020



Source: Baidya, 2007

- **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)**

5.1 Fuel efficiencies of light duty vehicles: General

- **Definition:**

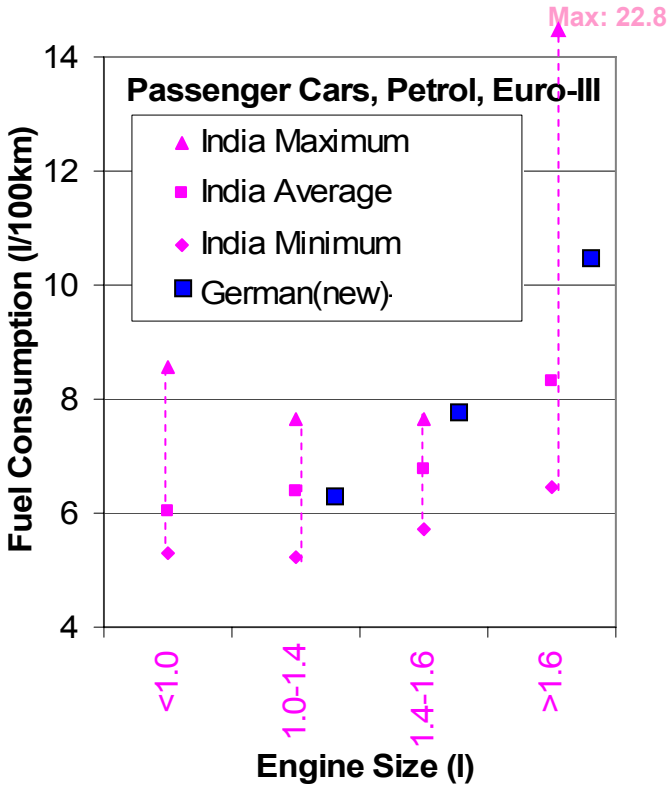
  Fuel consumption rate= fuel consumed / vehicle kilometres travelled (i.e. l/100km)
- **Estimation of fuel efficiencies**
  - **Lab (regulation) cycle vs. real world**
  - **Point/ single vehicle measurement vs aggregate stock estimate**
  - **New vehicles vs. average stock**
  - **Base values vs. corrected 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**

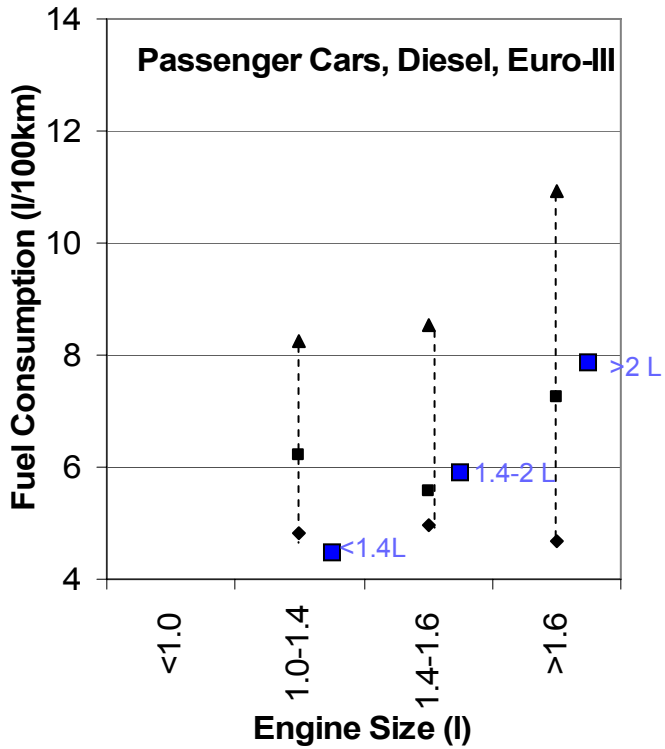
5.2 Fuel efficiencies of light duty vehicles: New vehicles

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



German Cars: registered in y2005

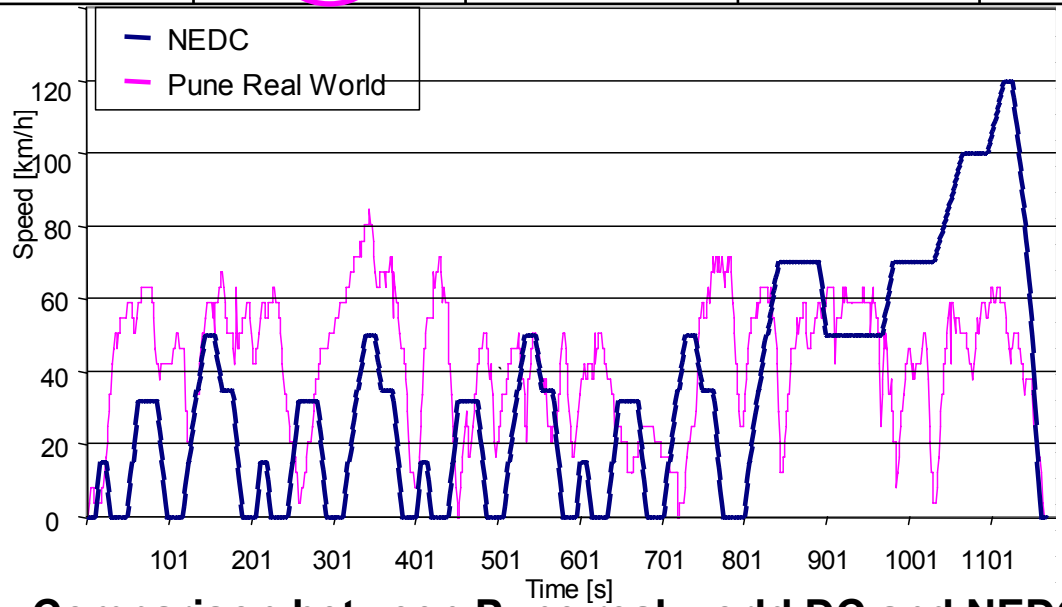


5.2 Fuel efficiencies of light duty vehicles: Real world measurements

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!!

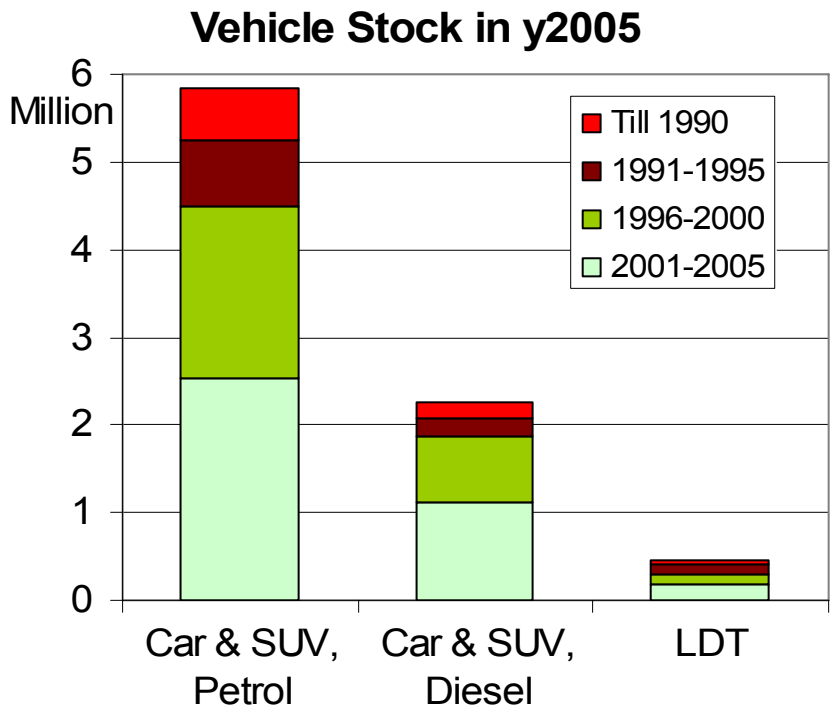
Driving Cycles	Acc_{avg} (m/s^2)	%time in Acc	%time in Acc < 1 m/s^2	%time in Acc > 1 m/s^2
ECE-15	0.65	21.6	21.6	0
ECE-15+EUDC	0.54	18.3	18.3	0
Pune (CIRT)	1.85	14.4	7.3	7.1

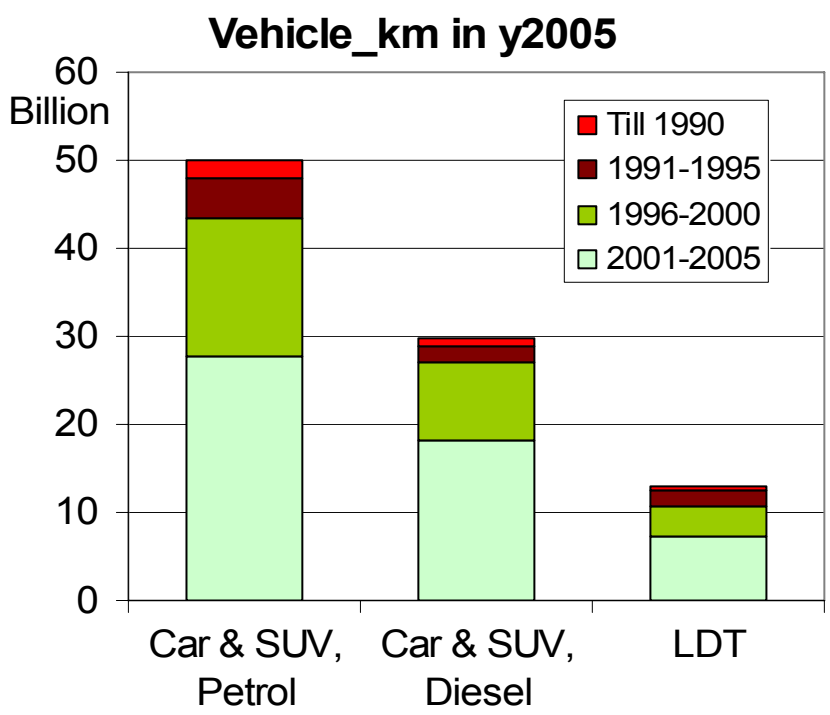


Source:
CIRT Pune, Sep. 2007

Comparison between Pune real world DC and NEDC

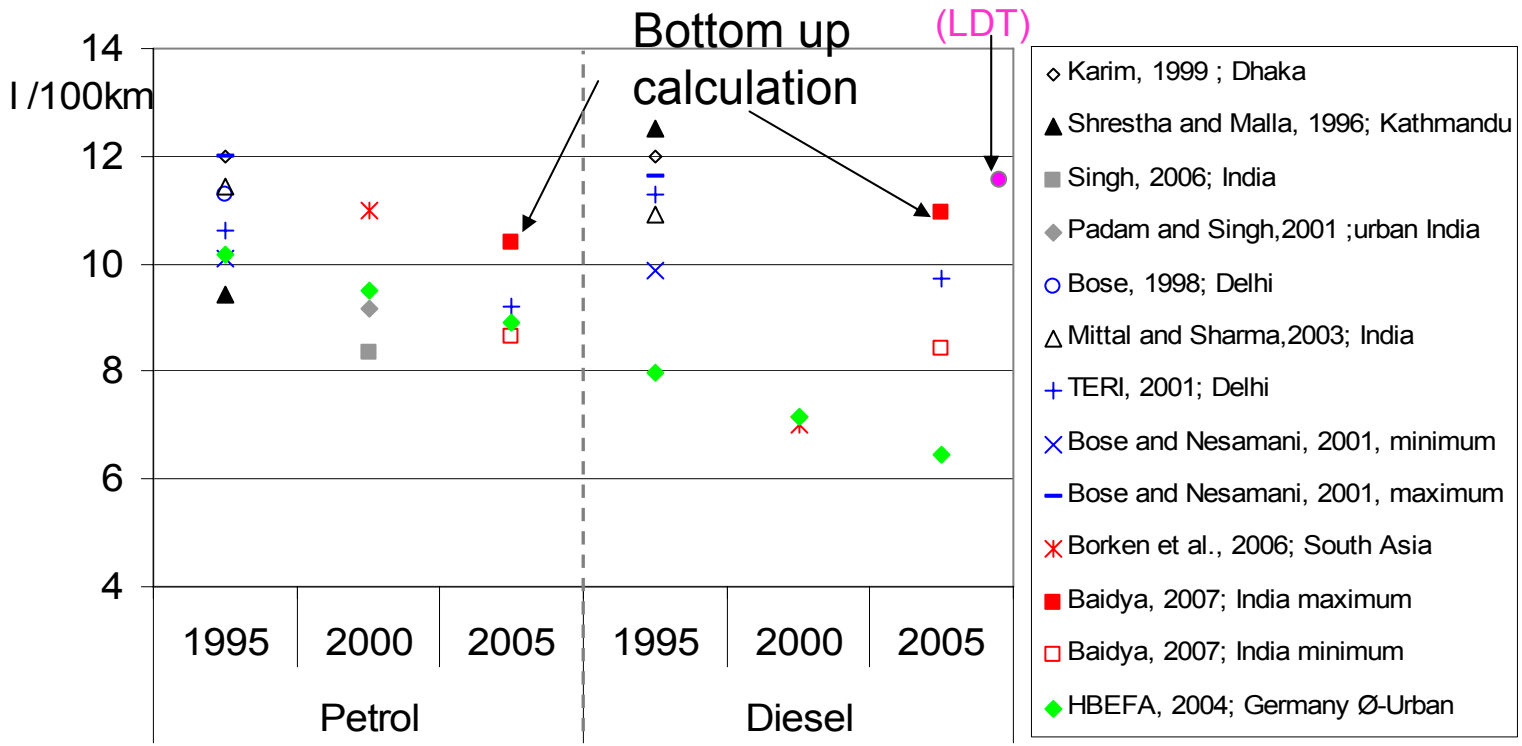
5.3 Stock and mileage of LDV: Modelling age structure





- **Circulating vehicle stock and VKM composition: NEW results!!**
- **25%-28% diesel cars in 2005**
- **More than half mileage by ≤ 4years 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?
  - **Targets and Timing?** => Vehicle categories, lags for phases and 'best practices', Target values for 2010, 2020??

- **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 **(Higher technical potential??)** > Alternative fuels

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**

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