

# 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



Auto-rickshaw



Freight three wheeler

## Light duty vehicles (this presentation)



Passenger car



Jeep (SUV)



Light duty truck ( $\leq 3.5$  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)

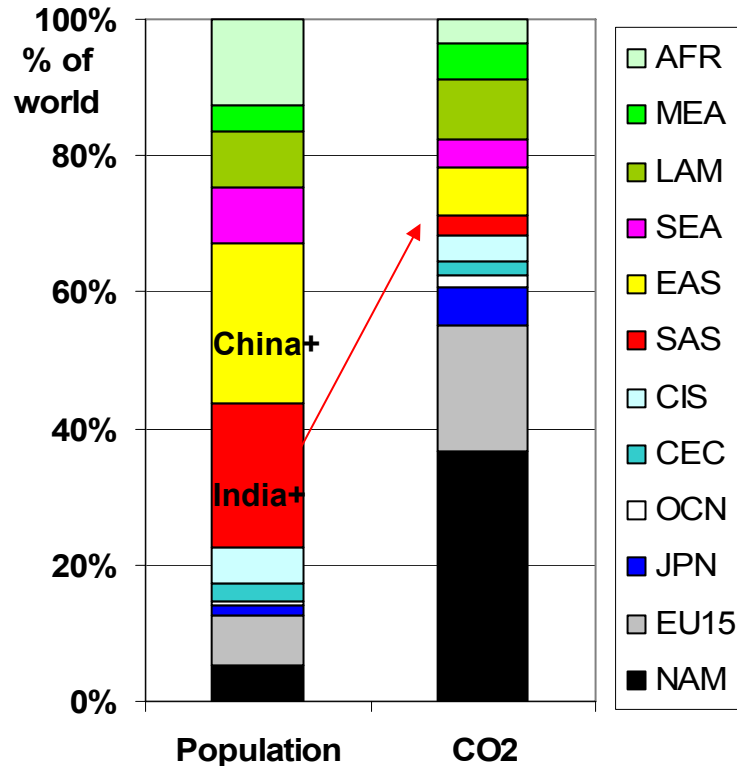
Photos by Suman Baidya (y2006 and y2007, Locations: Delhi, Agra, Pune, and Jaipur)



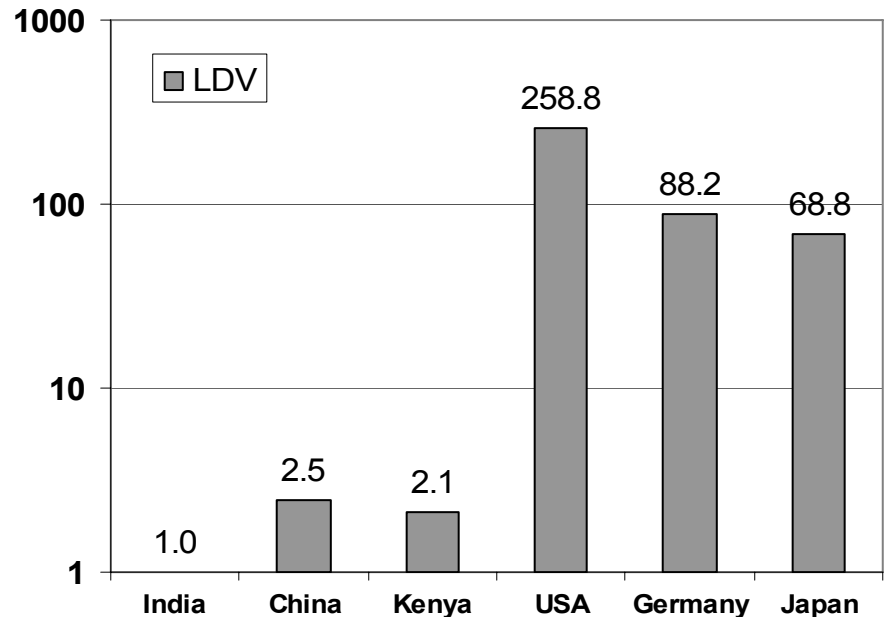
Heavy duty trucks >7.5 t

## 2. India in the global context

CO<sub>2</sub> emissions (road)  
by world regions, y2000



Comparison of per capita CO<sub>2</sub> emissions  
by LDV, y2000, India=1

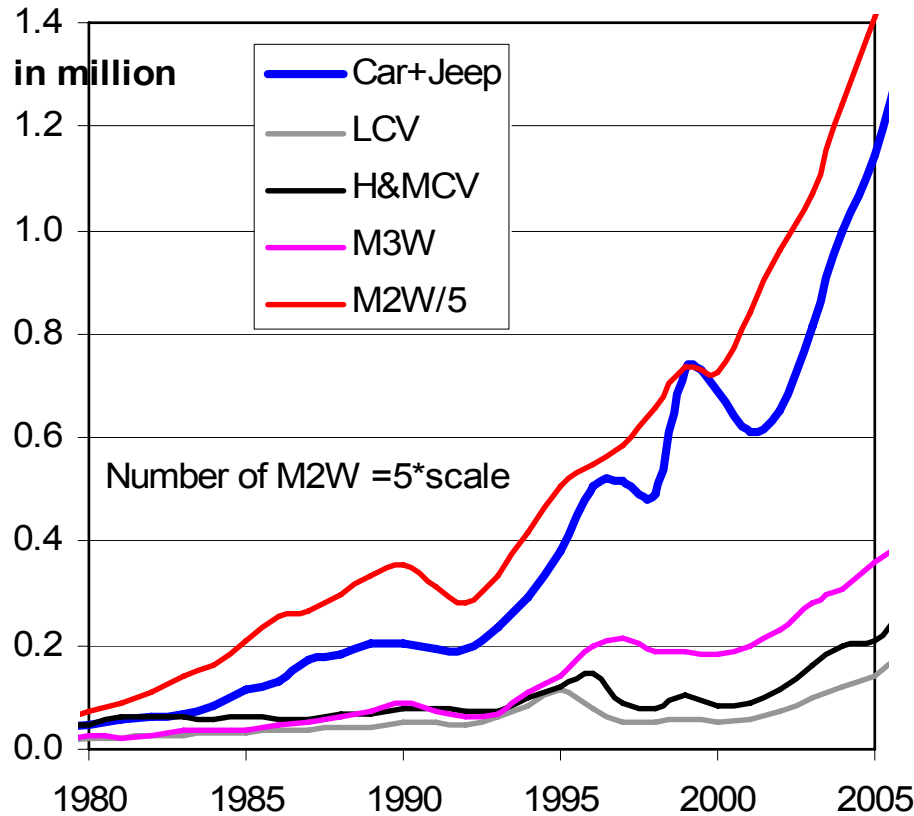


- y2000 already old for India and China
- Fuel consumption (road, year 2000) : 2.3% of global total

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

### 3. Stock development in India

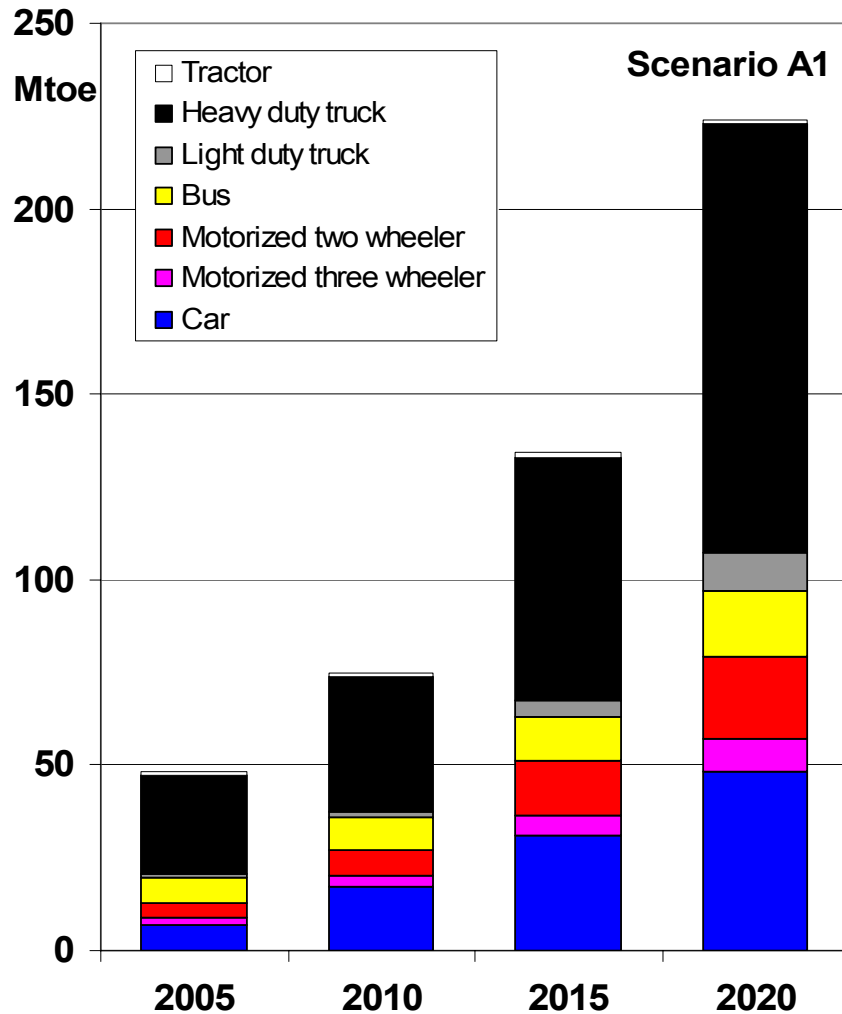
➔ Two and half decades of rapid growth of vehicle sales



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

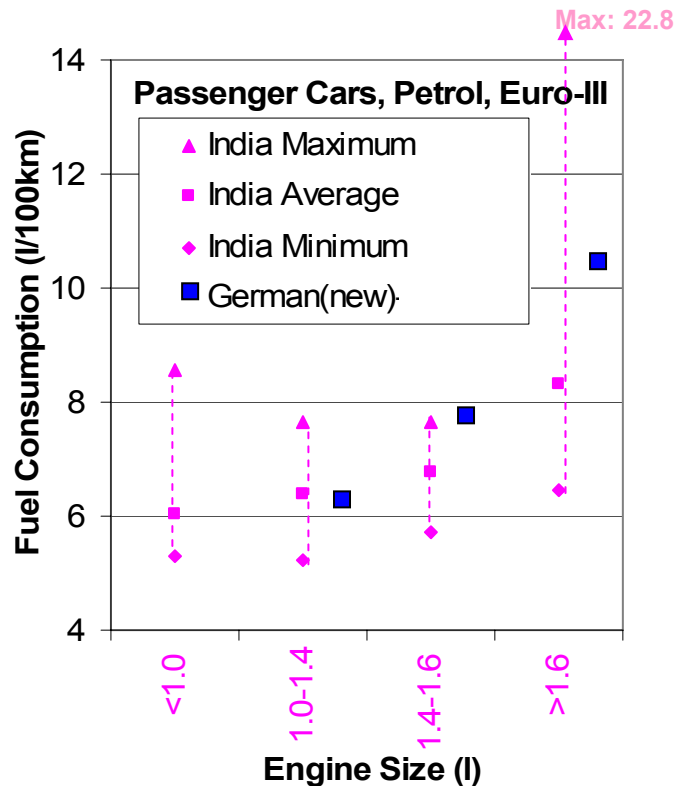
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- **Definition:**  
Fuel consumption rate = fuel consumed / vehicle kilometres travelled (i.e. l/100km)
- **Estimation of fuel efficiencies**
  - Lab (regulation) cycle vs. real world
  - Point/ single vehicle measurement vs aggregate stock estimate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

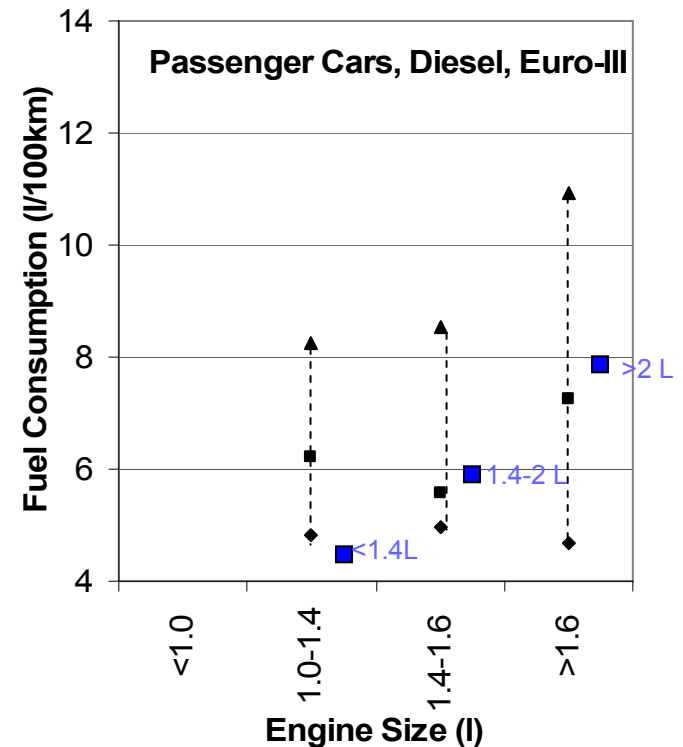
## 5.2 Fuel efficiencies of light duty vehicles: New vehicles

### 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

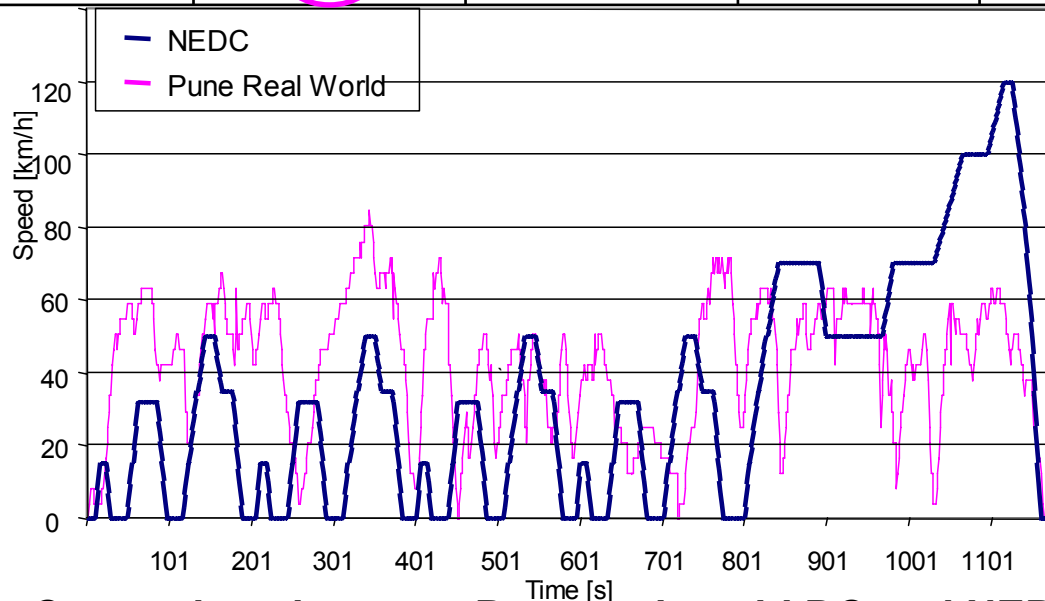


## 5.2 Fuel efficiencies of light duty vehicles: Real world measurements

### 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!!**

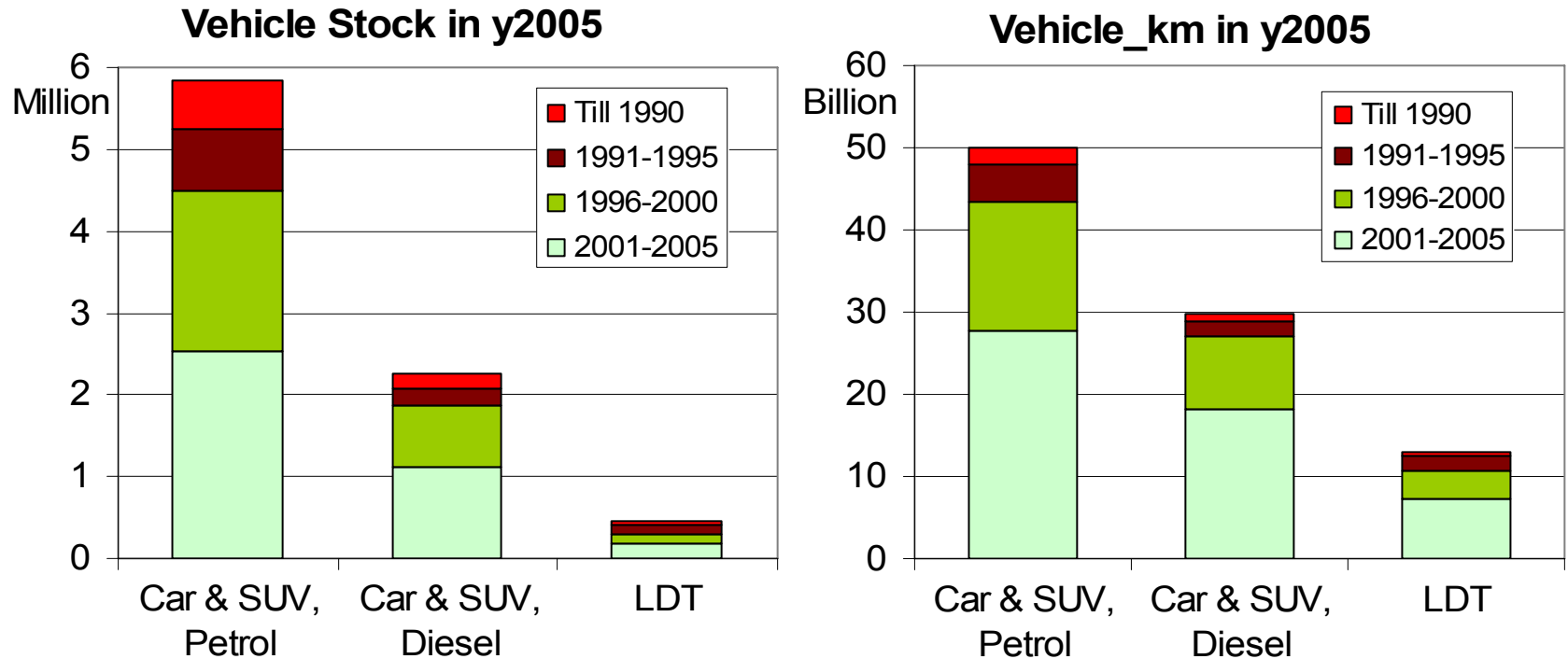
Driving Cycles	Acc <sub>avg</sub> (m/s <sup>2</sup> )	%time in Acc	%time in Acc < 1 m/s <sup>2</sup>	%time in Acc > 1 m/s <sup>2</sup>
ECE-15	0.65	21.6	21.6	0
ECE-15+EUDC	0.54	18.3	18.3	0
Pune (CIRT)	<b>1.85</b>	14.4	7.3	<b>7.1</b>



Source:  
CIRT Pune, Sep. 2007

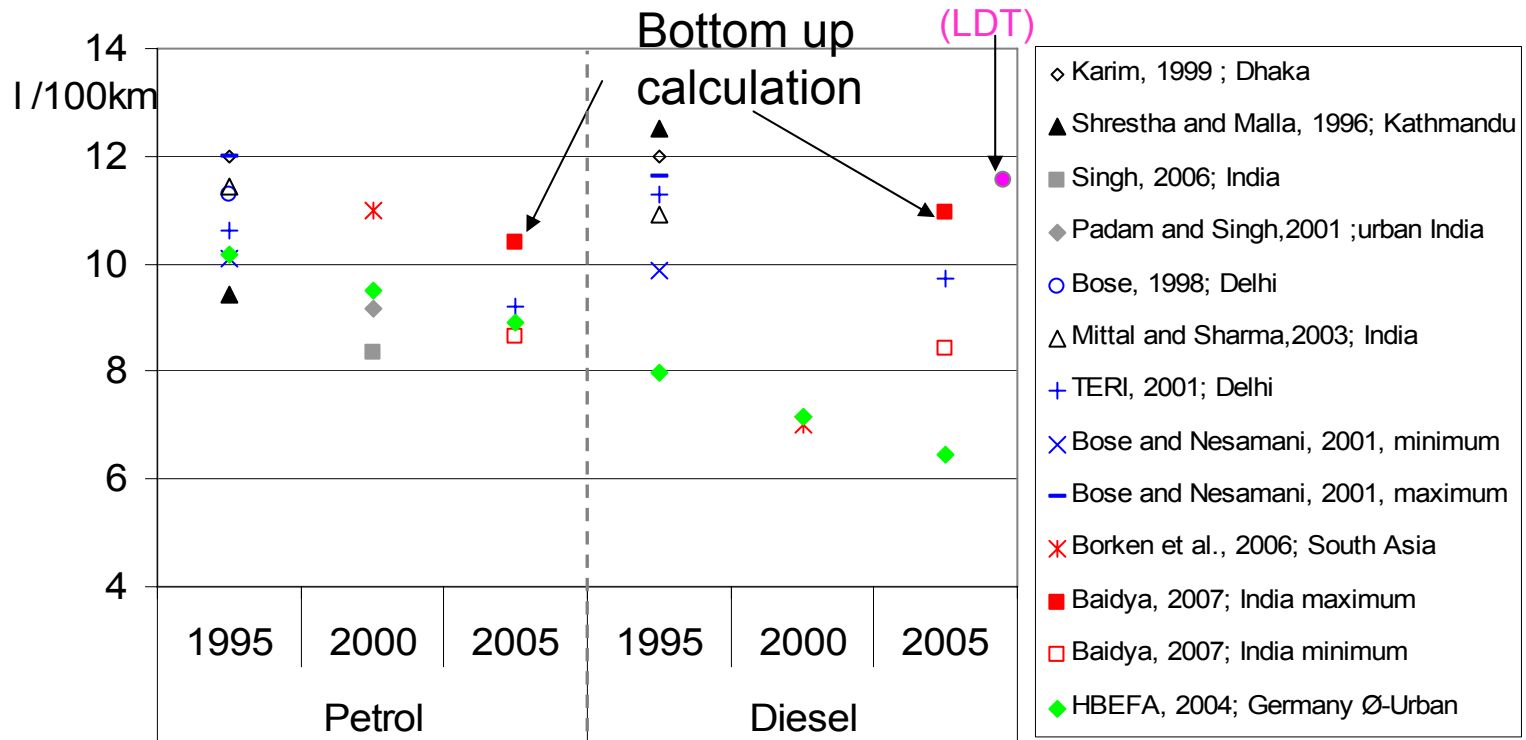
### Comparison between Pune real world DC and NEDC

## 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  $\leq 4$  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

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### 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

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- **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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