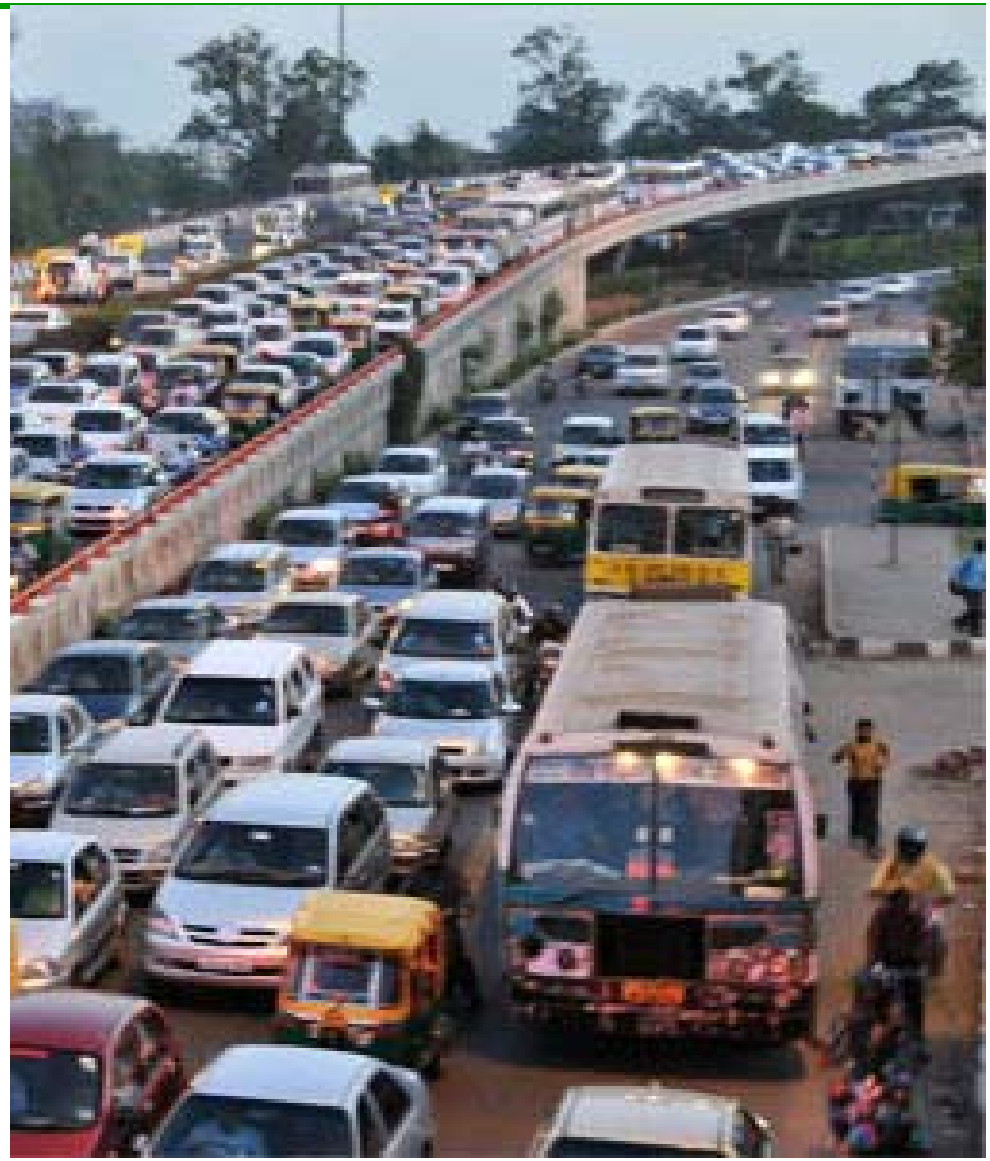
Vehicles: Taming emissions, fuel guzzling and warming

-- Centre for Science and Environment

Workshop Series on
Transport and Climate

New Delhi, July 24 - 25, 2013



The energy challenge

- India's Integrated Energy Policy of 2006:
  - If India needs to sustain 8-10% economic growth rate over next 25 years to meet human development goals, primary energy supply must increase by 3-4times from 2003-4 levels.
  - Ministry of Petroleum and Natural Gas's new vision -- reduce crude oil imports by 50% by 2020, 75% by 2025 and achieve energy independence by 2030.
  - To achieve this expand energy resource base, seek new energy sources, and make energy use more efficient.

-- This target is a challenge -- International Energy Agency (IEA) says about 94 per cent — nearly the entire requirement of India will have to be imported by 2030.

Transport energy challenge…….

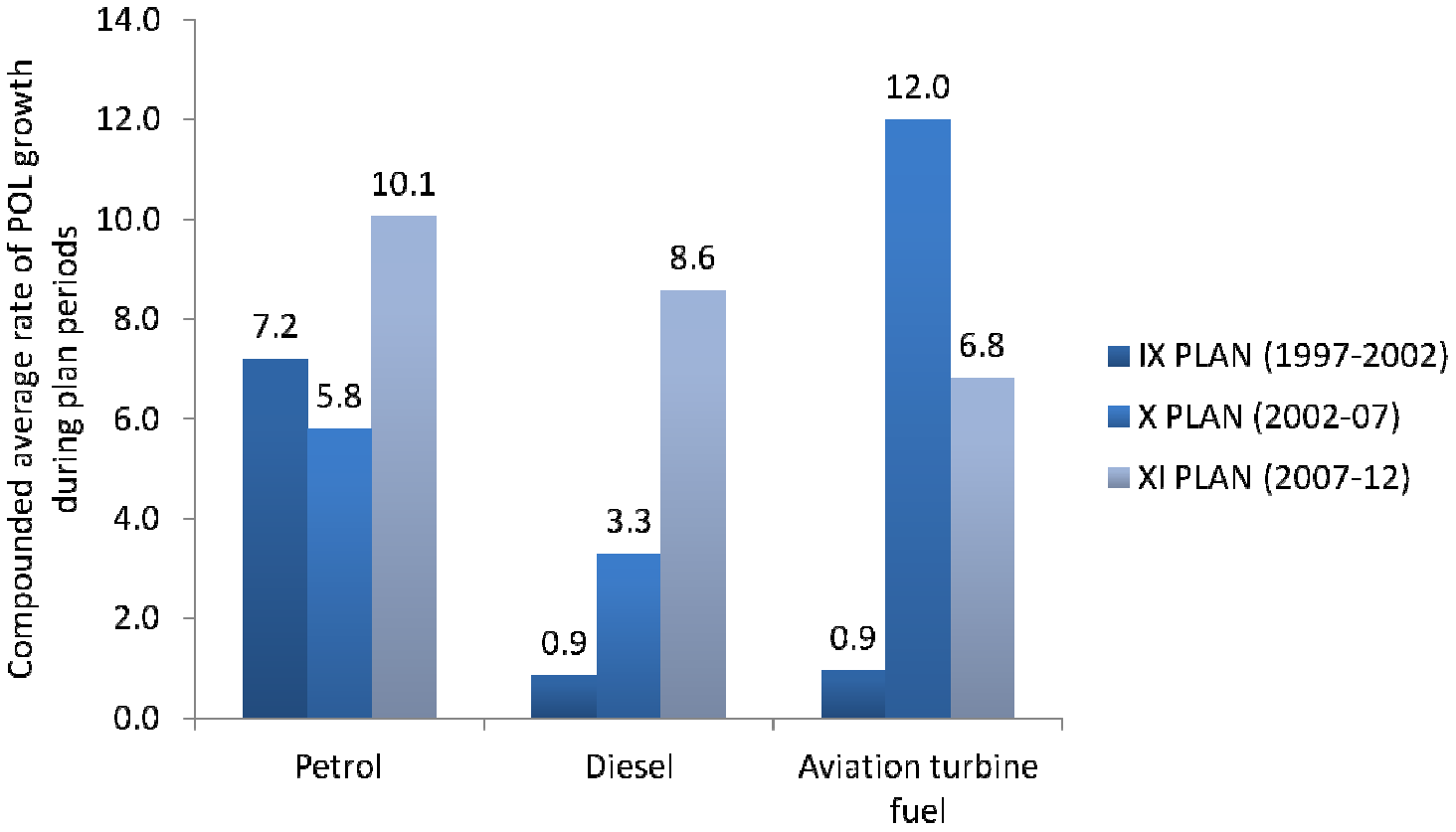
- Transport sector uses up more than 40 per cent of the total oil and oil products

- As much as 98 per cent of the total petrol stock is used up by vehicles; Nearly 62 per cent of India's diesel fuel used by vehicles.

- Explosive increase in number of vehicles -- The total registered vehicles have grown at a rate of 9.9% per annum between 2001 and 2011.

Transport fuel: Bullish

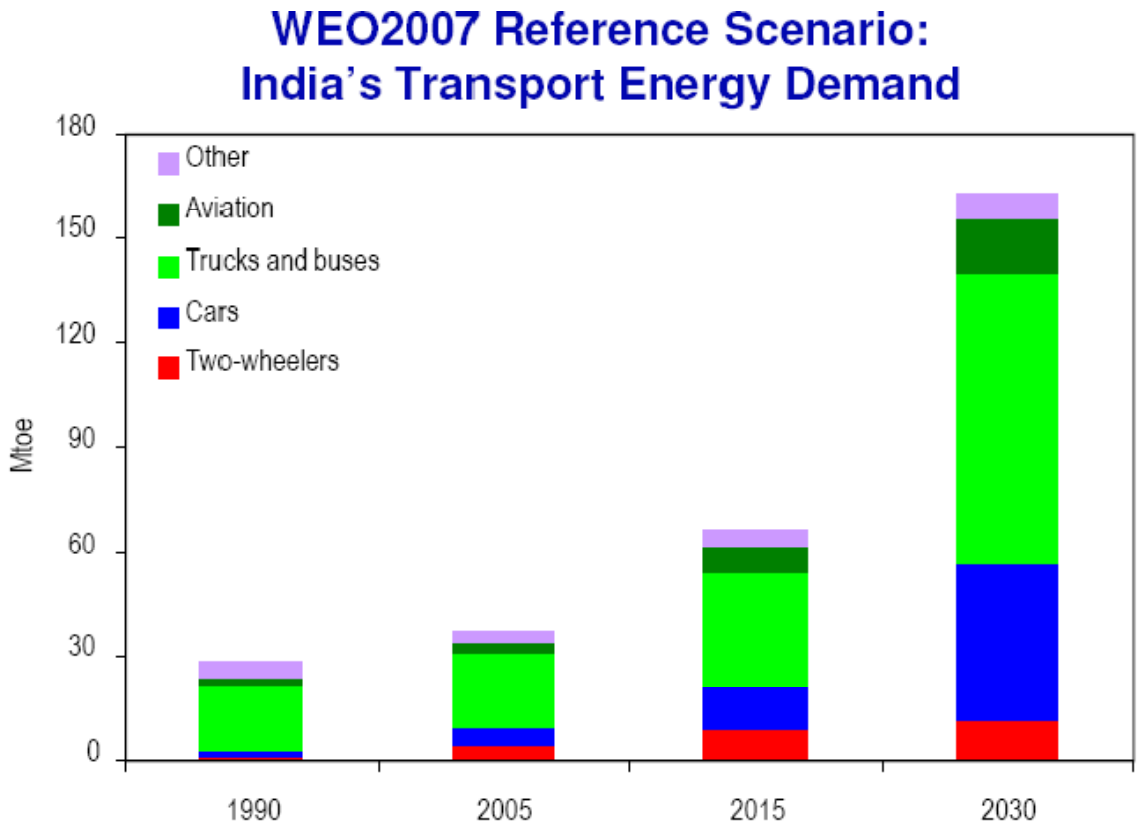
Petrol and diesel consumption have continued to grow. Only aviation fuel has dipped because of economic down turn



Source: Based on PPAC data

Cars, trucks and buses will drive the future oil demand…..

Trend in fuel consumption by different modes of transport in India



Transport demand – mostly oil – grows rapidly as car ownership increases in line with rising incomes

Source IEA

Worries…….

Transport energy demand has grown at 1.2 times the GDP growth rate.

Fuel consumption by vehicles in 2035 could be six times that of the 2005 level. (ADB). Personal vehicles will be one of the primary drivers

Car travel consumes nearly twice as energy on average as average urban bus travel

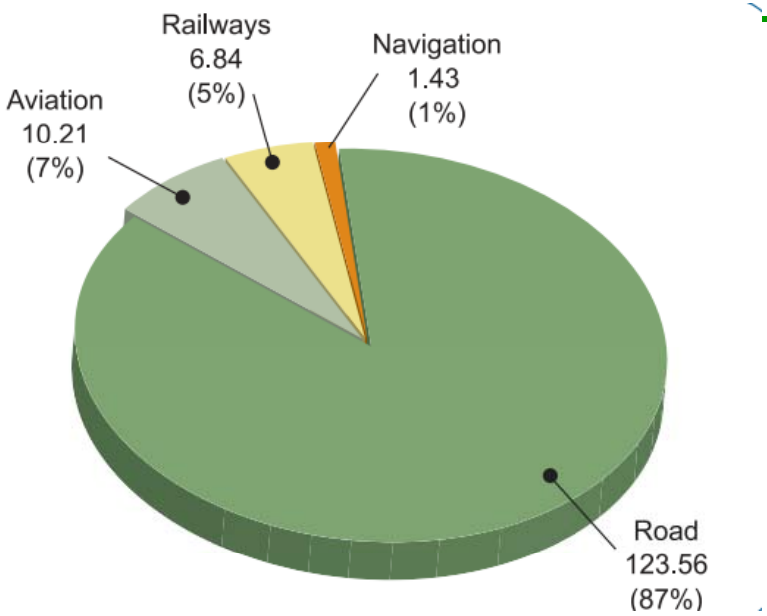
By 2030-31 on an average Indians will travel thrice as many kilometers as they traveled during 2000-01.

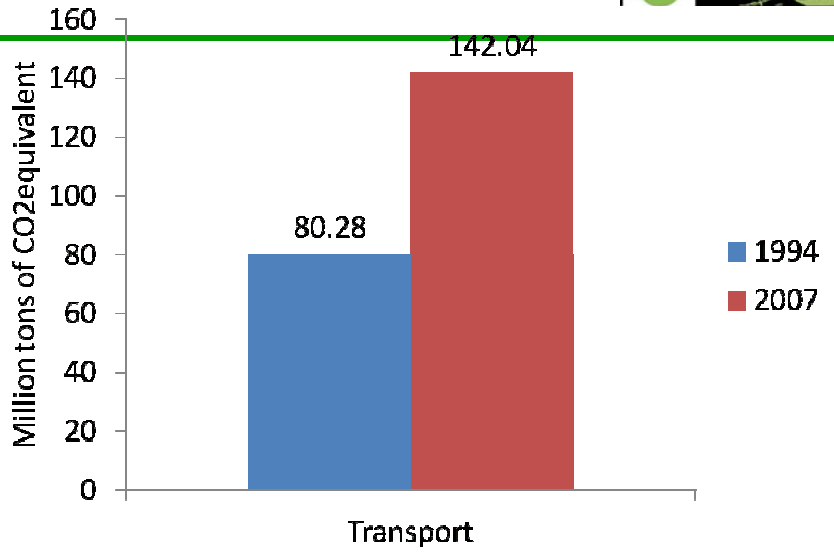
Shift of freight from railways to trucks will also add to the energy stress: (Railway share less than 30%)

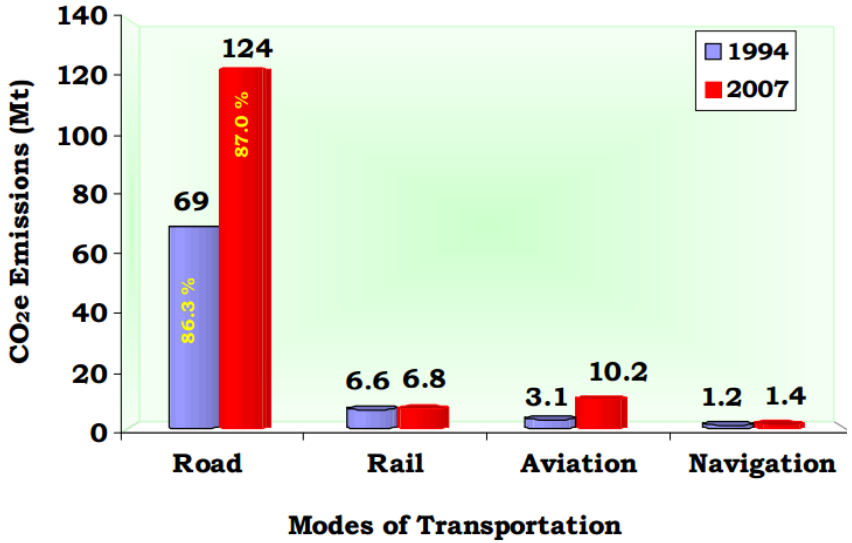
Warming impacts

India CO2e emissions from transport

GHG emissions in 1994 and 2007 in million tons of CO2 eq







- Road transport: 87% of total transport sector emissions

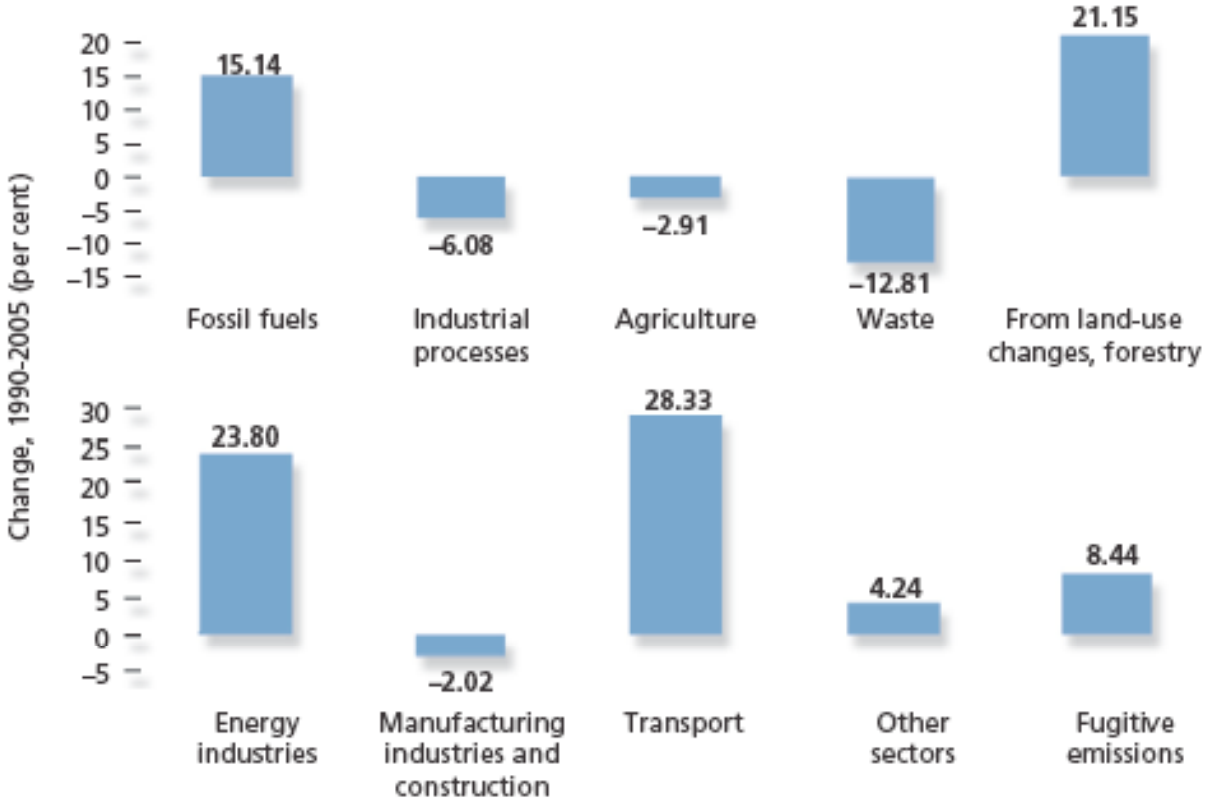
- Transportation sector is the 4th largest emitter of GHG emissions in India

Source: http://www.moef.nic.in/downloads/public-information/EXECUTIVE%20SUMMARY-PS+HRP.pdf

Source: http://www.moef.nic.in/downloads/others/Anil%20Singh.pdf

Globally transport has remained the most difficult sector for climate mitigation

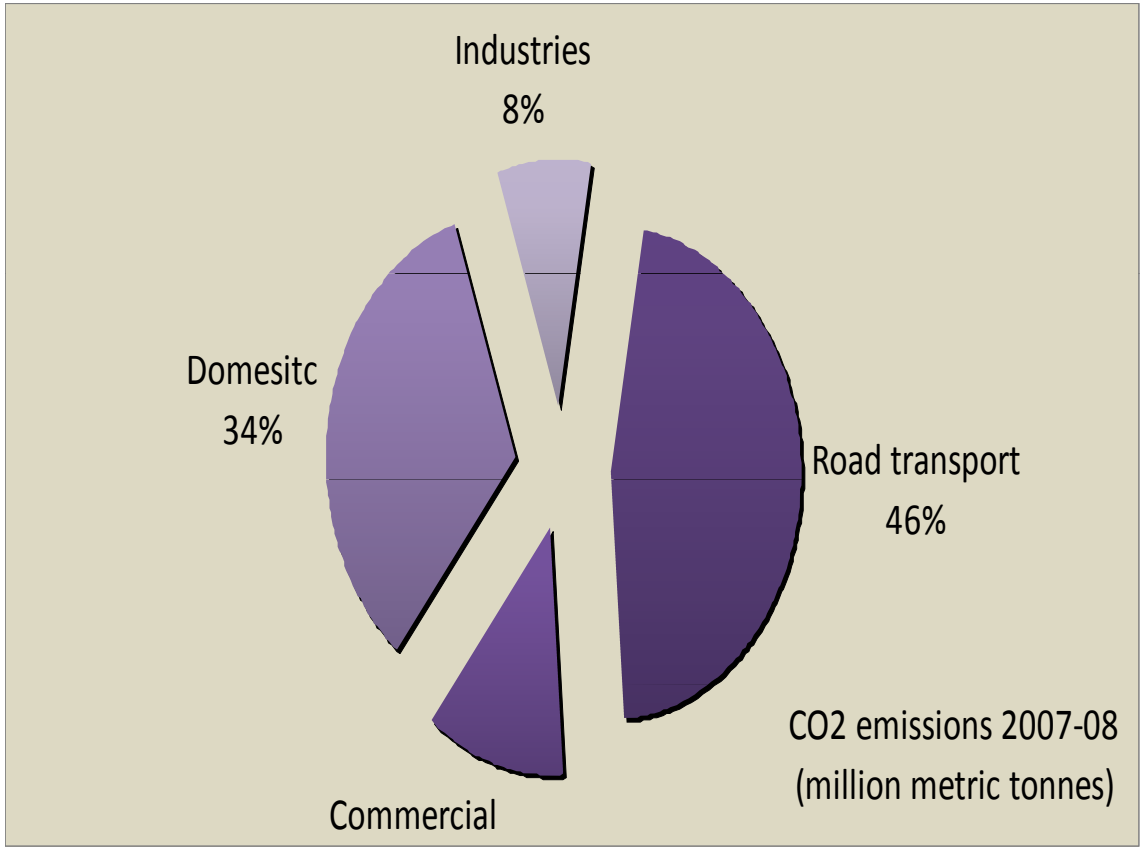
Sectoral change in CO_2 emissions; fossil fuel break-up



Note: Figures for Annex I countries in UN Framework Convention on Climate Change excluding ex-Soviet bloc countries
Source: UN Framework Convention on Climate Change, 2007

Transport sector emissions rising.

Cities are energy guzzlers: Delhi



Delhi government estimates:

-- Close to half of CO2 from transport

-- Other studies show CO2 emissions estimated to increase by 526% from 1990 levels to 2030

Source: CLIMATE CHANGE AGENDA FOR DELHI 2009-12, Energy Efficiency & Renewable Energy management Centre, Department of Environment, Govt. of Delhi (http://www.nicra-icar.in/nicrarevised/images/State%20Action%20Plan/States-SAPCC-delhi.pdf)

Other side of the story……..

……..Emerging science on warming impact of black carbon, a part of killer particles, …….

Multiple risk – from ill health to…….

February 2013:

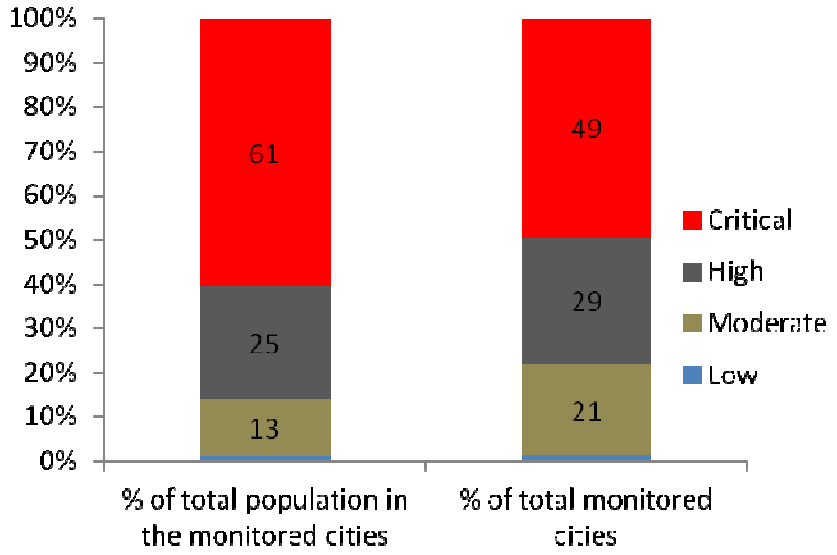
Global Burden of Disease findings for India: 620,000 premature deaths a year.

More than 18 million healthy life years lost due to air pollution. Air pollution triggers stroke, cardiovascular and respiratory diseases, cancer…..

Air pollution is the 5th largest killer in India

50% of cities monitored are critically polluted for PM10

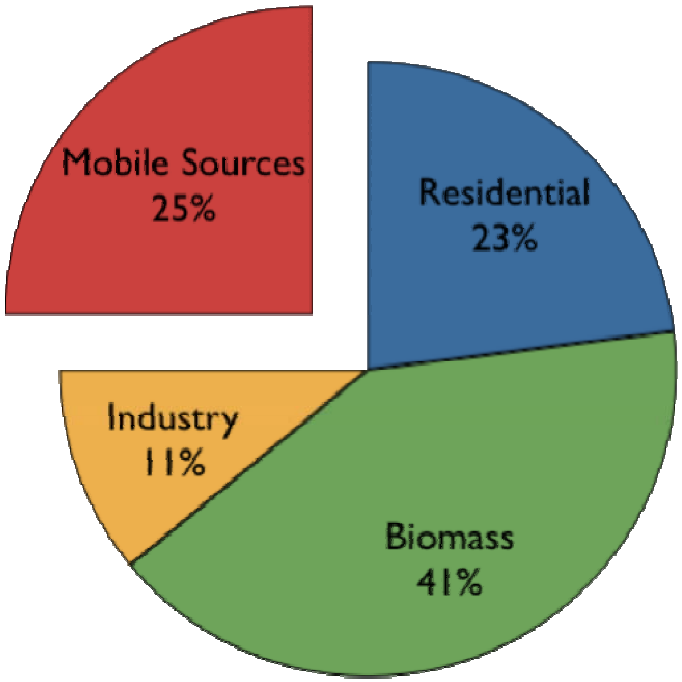
…… But 60% of people in monitored cities live in areas with critical PM10 levels



….. Warming
Link between local air pollution and warming….

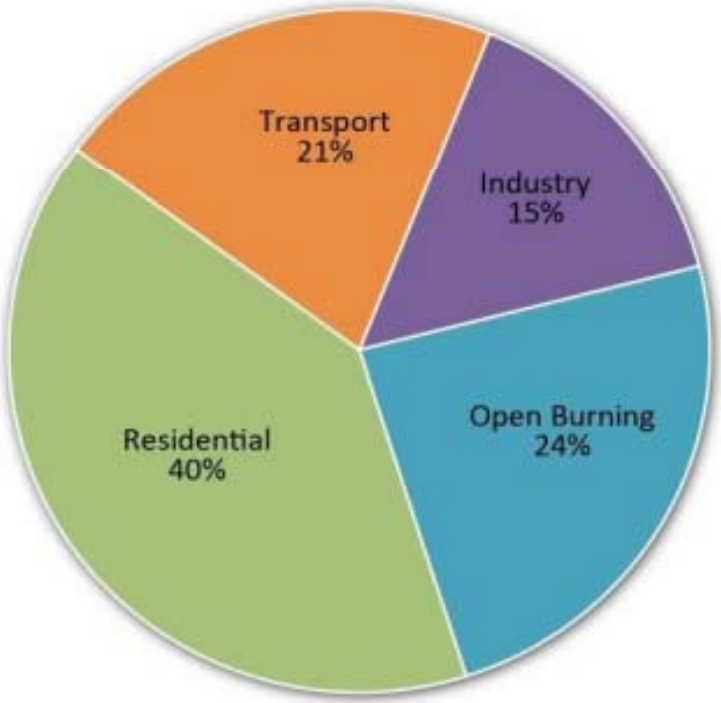
- **Local pollution can enhance the warming effects….**
    - **Black carbon** is a powerful climate forcer – absorbs slight and converts that energy to heat…
    - HC + NOx lead to regional ozone and background hemispheric ozon
    - CO becomes CO2 but consumes OH radicals along the way increasing CH4
- **Warming also enhance local public health impacts** …Eg, each increase of 1 degree Celsius caused by carbon dioxide, can enhance PM and ozone build up. This can lead to thousands of additional deaths and many more illness. (Mark Jacobson 2008)

Vehicles are responsible for ~25% of global black carbon emissions



Source: Bond et al., GBC 2007 + van der Werf, 2006 + updates for IPCC AR5

UNEP: Sectoral emissions of BC in India. In India transport is responsible for 21%



http://www.unep.org/ccac/Portals/24183/docs/BlackCarbonSAsiaFinalReport5.22.12.pdf

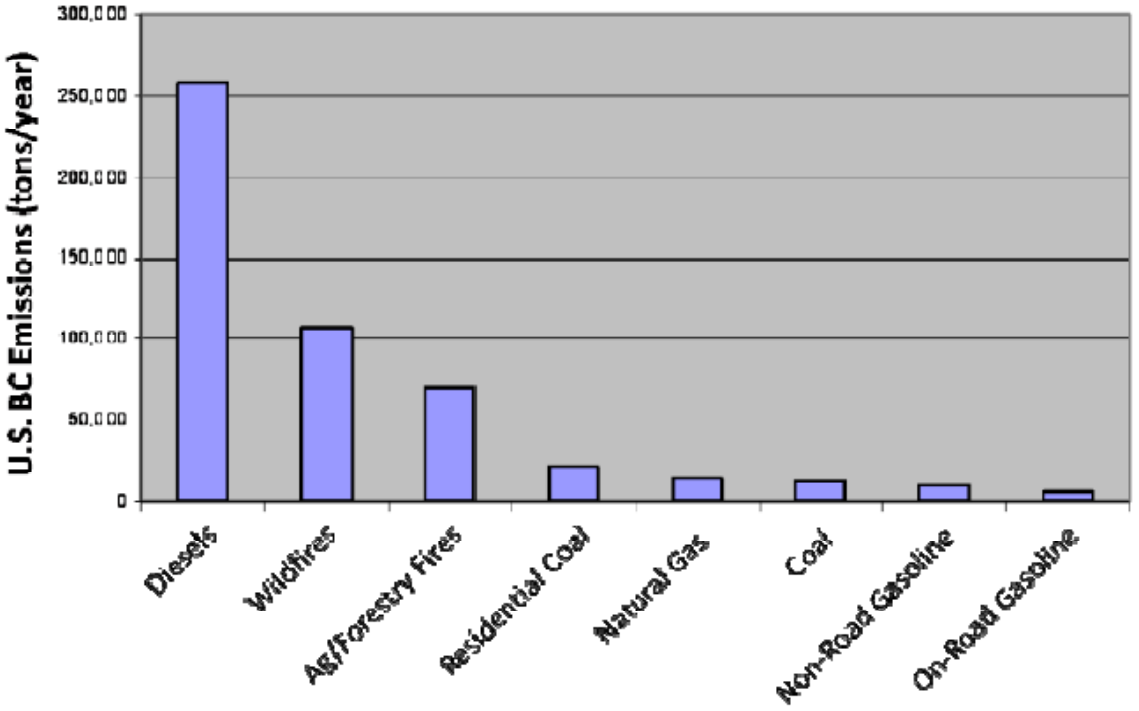
Need technology roadmap that improves both emissions and efficiency

Global action….

Globally, diesel related black carbon regulations are getting stronger.

Eg… Black carbon regulations for diesel in California, Europe, China etc, .

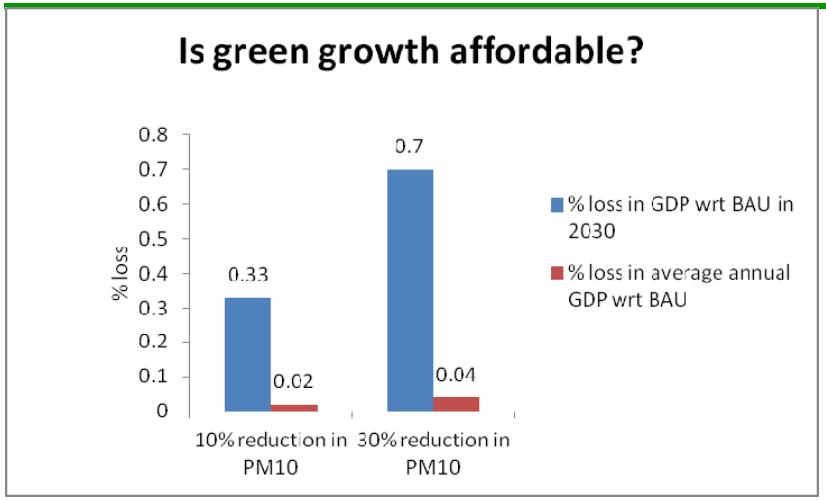
Even in the US -- biggest black carbon challenge is diesel

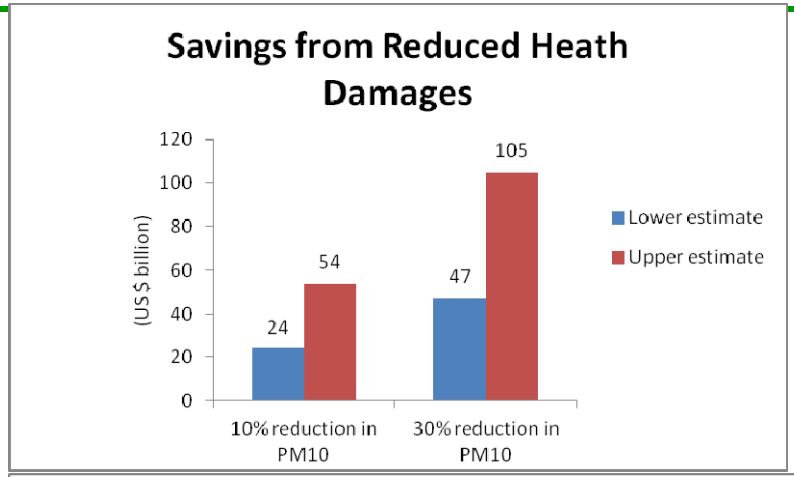


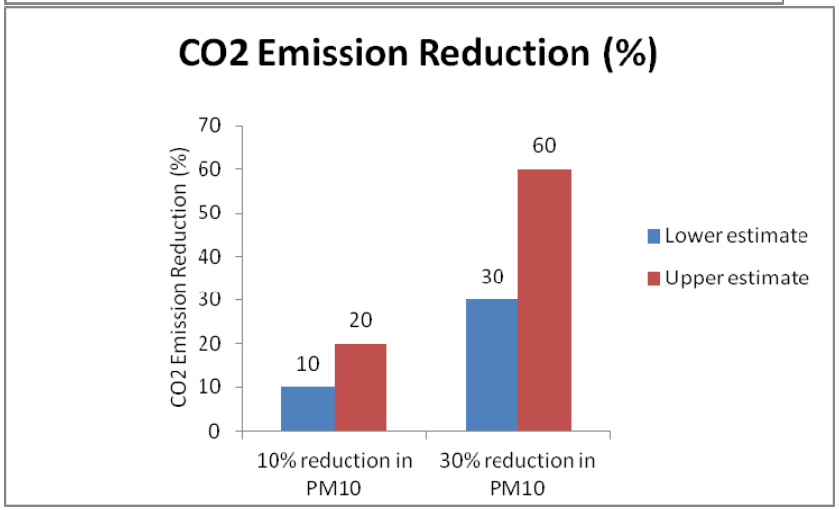
Sarofim 2009/Pew

Need co-benefit framework to reduce multiple risks

Cost of mitigation is off set by health benefits and reduced heat trapping CO2







•World Bank study (July, 2013):

- Outdoor air pollution is 29% of the total environmental damages
- PM10 mitigation will cost less than 1% of GDP
- Annual savings from health benefits can be more than USD 100 billion
- CO2 emissions can be reduced by upto 60%

Source: Based on (Diagnostic Assessment of Select Environmental Challenges in India A World Bank 2013)

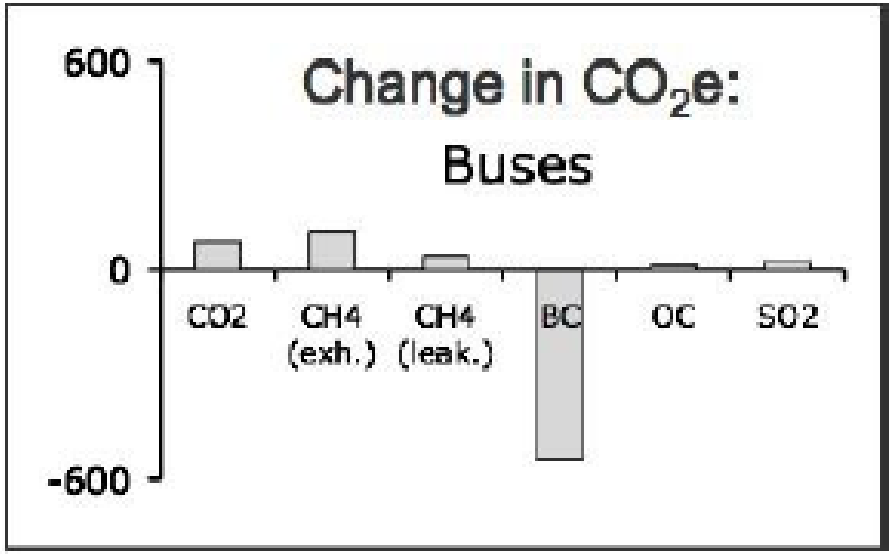
….Removing BC gives positive climate benefit
Example from Delhi

Delhi CNG programme

New study shows that in comparison with the warming potential of black carbon emissions from the older diesel fleet, CNG has been less warming…..

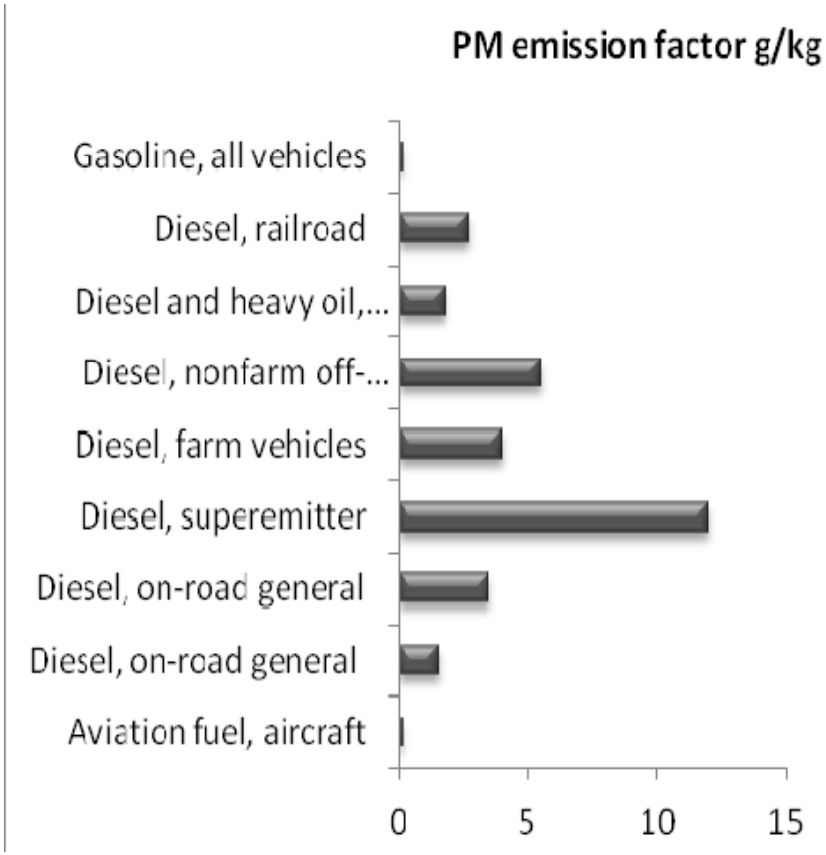
-- When black carbon from diesel is not considered estimated CO2 (e) increase due to switch

-- When black carbon is taken into account -- switch is carbon neutral
Upto 30% reduction in CO2 (e)

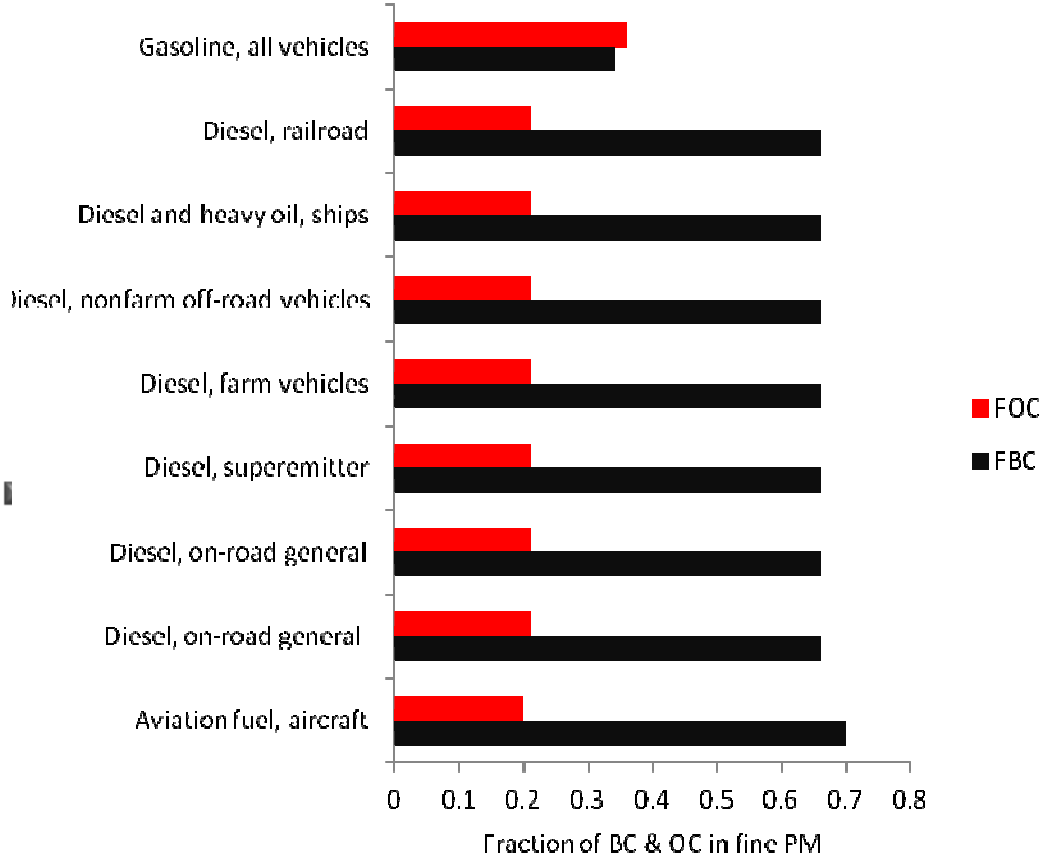


Source: Conor Reynolds and M Kandlikar, British Columbia 2008

Challenge of black carbon emissions from vehicles



Black carbon fraction is high in all diesel uses



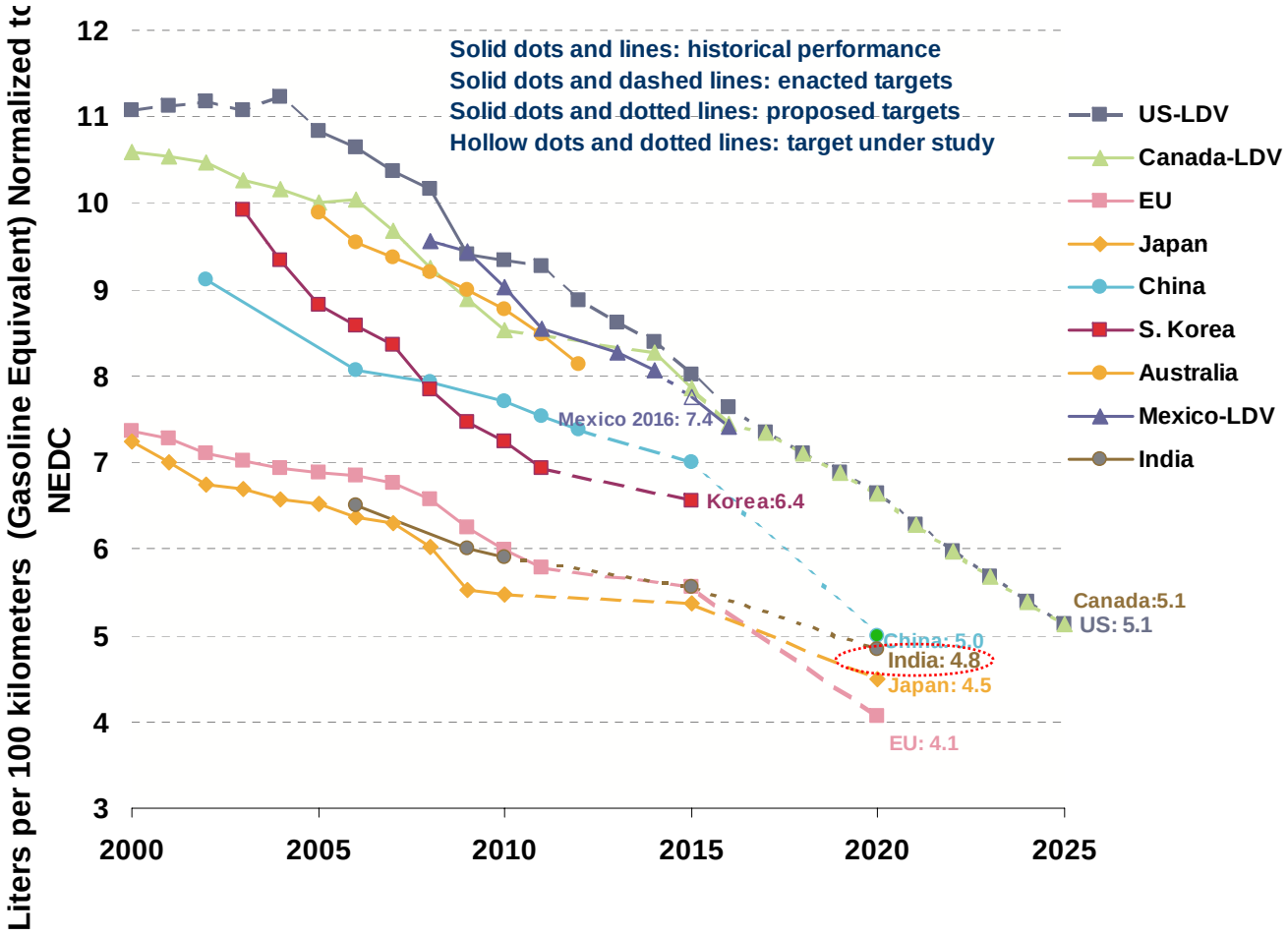
•Tami C. Bond et al 2004, JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 109, D14203, doi:10.1029/2003JD003697, 2004

Efficiency and emissions challenge….

Cars, bus, two-wheelers, trucks……

Cars……

India is the only vehicle producing country without fuel economy standards….



Source: ICCT 2009

The trajectory of fuel economy standard proposal in India

-- **2010**: The actual fleet wide sales weighted average fuel economy – 6 litres/100 km or 141 gCO2/km

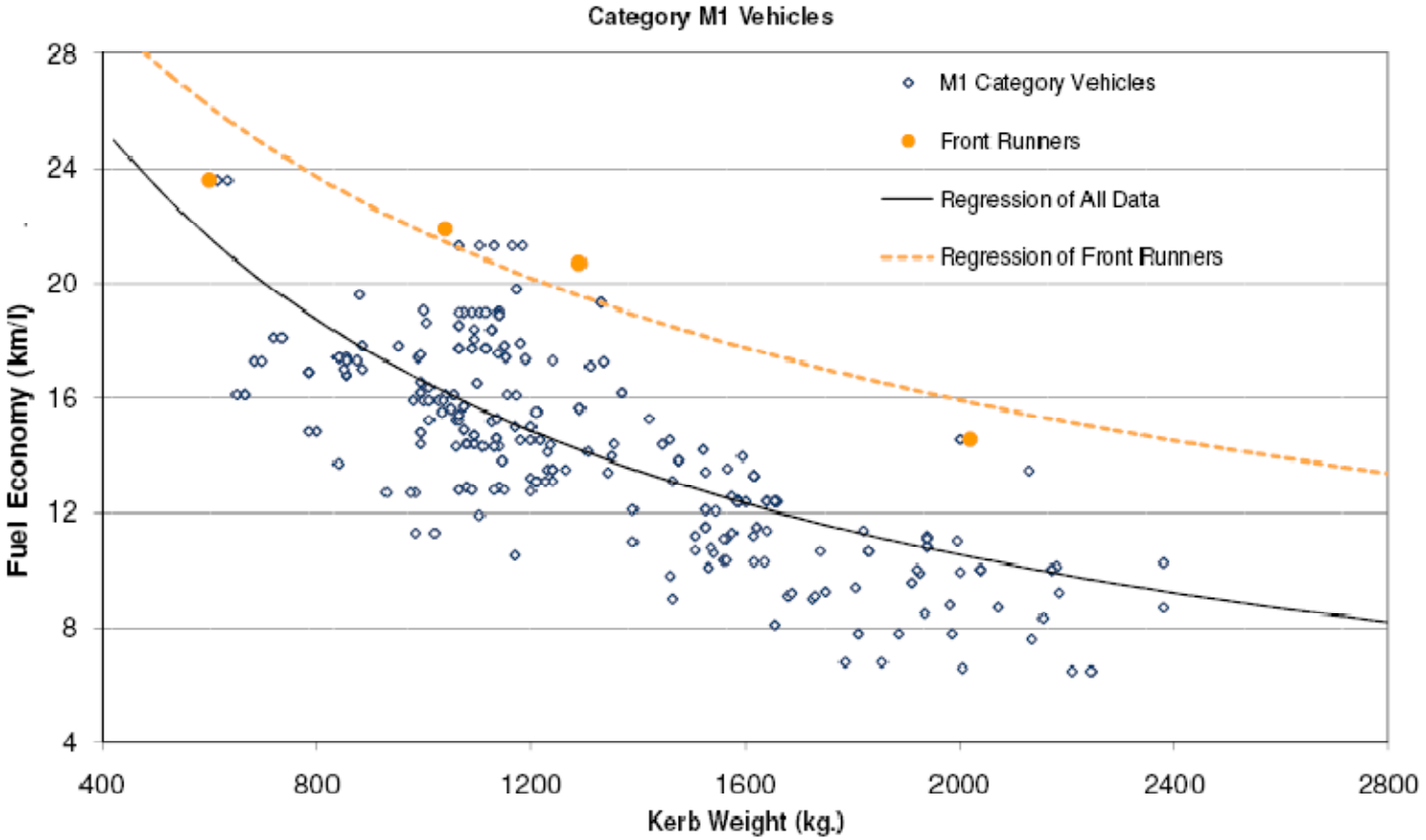
-- **The original proposed standards of BEE** -- 5.6 litres/100 km 123 gm/km by 2020. -- This slow rate of improvement allows a margin for increase in average weight of the car fleet, and worsen energy guzzling.

-- **Improved proposal:** After public consultation proposal was improved to 113 gm/km by 2020

-- Could have been better and more effective: If the natural rate of improvement is protected and further improved -- at 2.5% till 2015 and 3% thereafter – the target can be tighter – 104 gCO2/km (4.4 litres/100 km) country can get real fuel saving benefits.

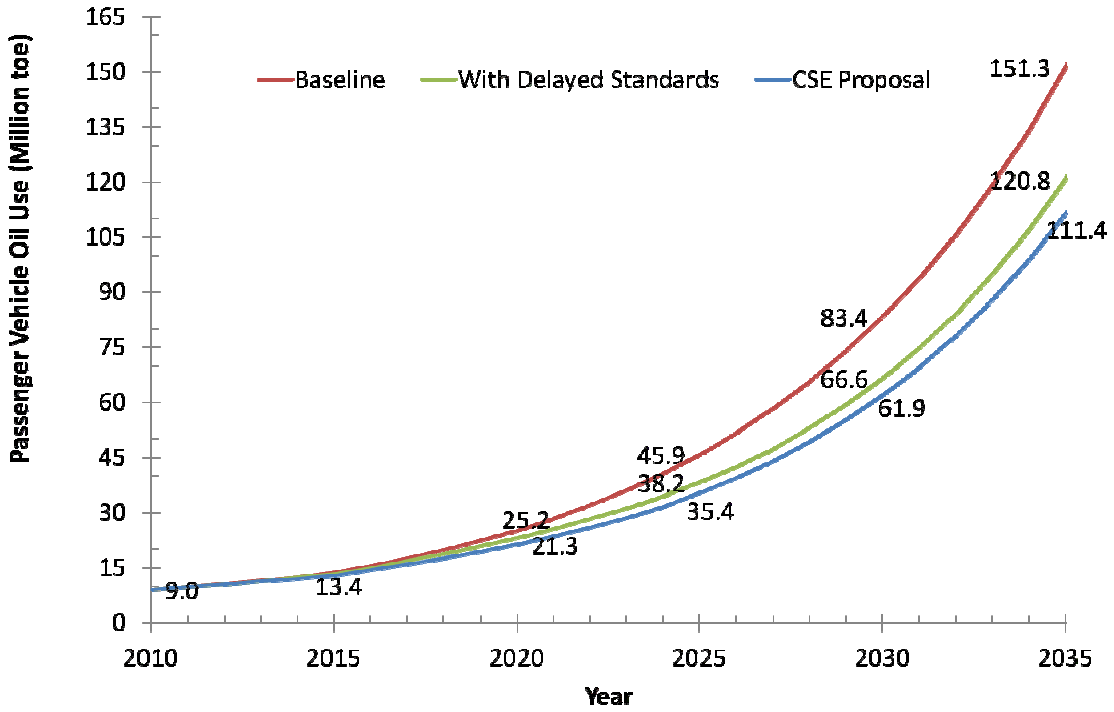
-- New point of negotiation – delay timeline of implementation. This can compromise fuel savings

Potential in the Indian market…Need effective standards to realise the potential



Cost of delay

Projected oil consumption in passenger vehicles in different scenarios



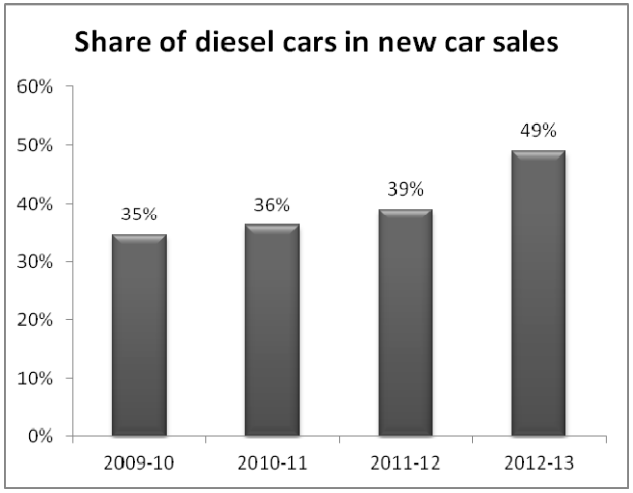
Source: based on ICCT method

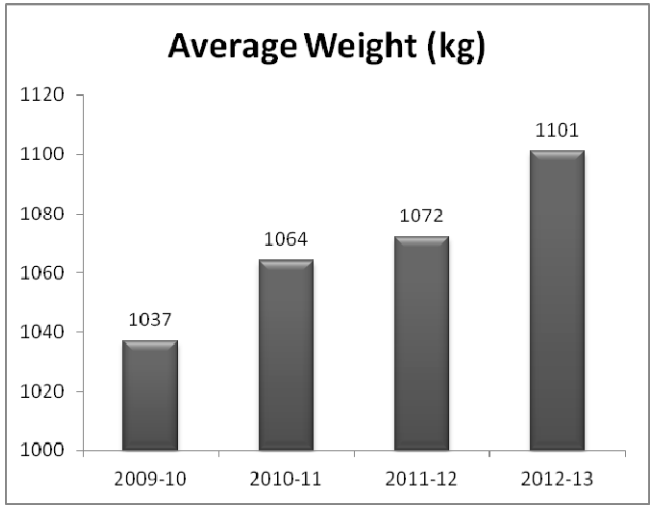
Cumulative savings between 2010 and 2030

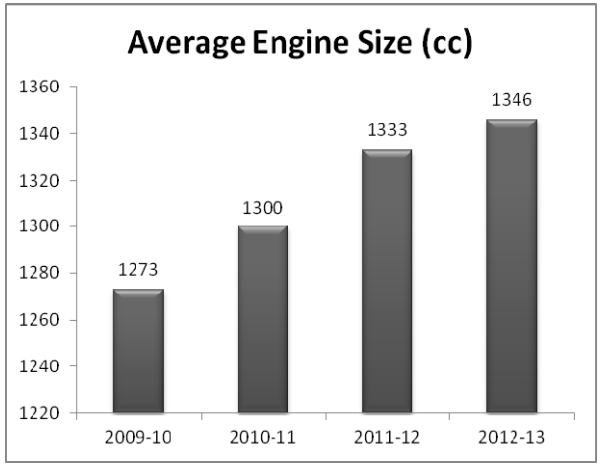
- Between 2010-2030 cumulative oil savings from delayed implementation of the proposed standards can only be 96 mtoe
- If tighter to protect natural rate of improvement the savings would have been 134 million toe – 1.3 times more
- -- This is 15 times higher than the oil consumed by 13.3 million passenger cars in 2010-11
- The energy cost will increase with more delay

In the meantime …..
Average weight of car fleet increasing….
locking up enormous energy and carbon

- Average weight and engine size during 2009-10 and 2012-13 has increased by 6%.
- On an average every year, the weight and size of new vehicles is increasing at a rate of 2%
- This threatens fleet-wide fuel economy



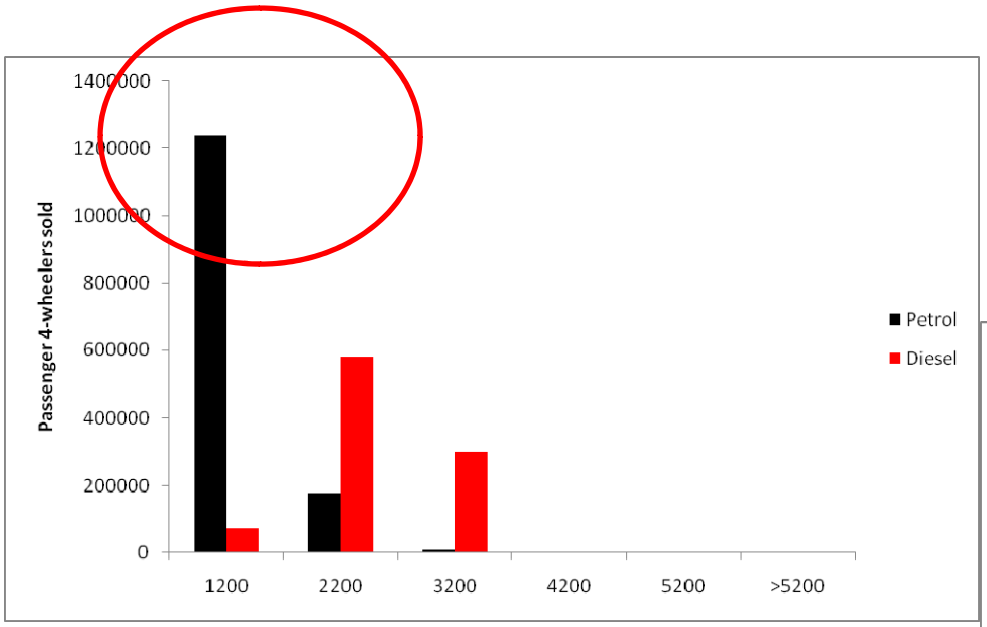


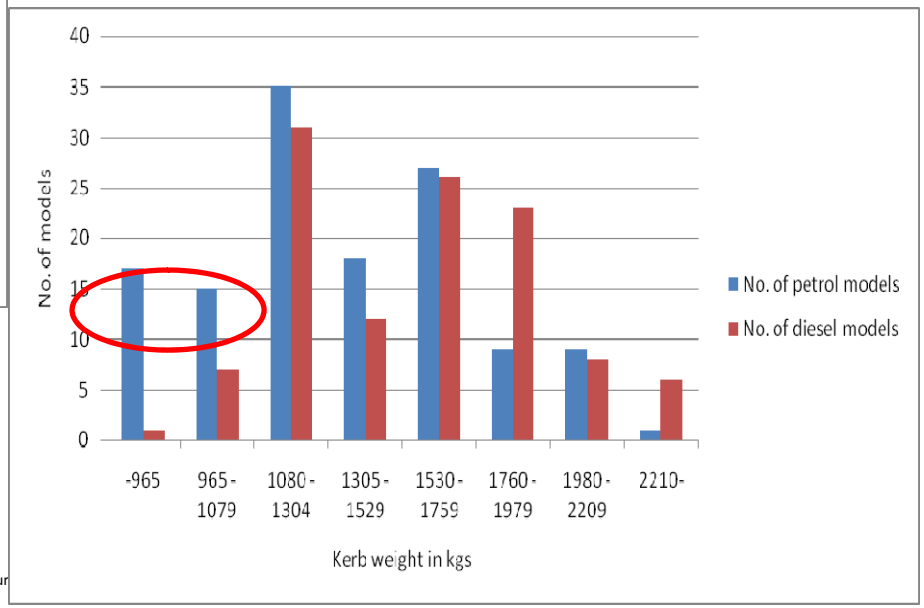


Energy insecure
Diesel is pushing market towards bigger cars that guzzle more fuel……

2011-12: Petrol car sales higher in small car segment -- 87% of petrol cars are below 1200 cc.

More than 40% of the diesel cars are above 1500 cc





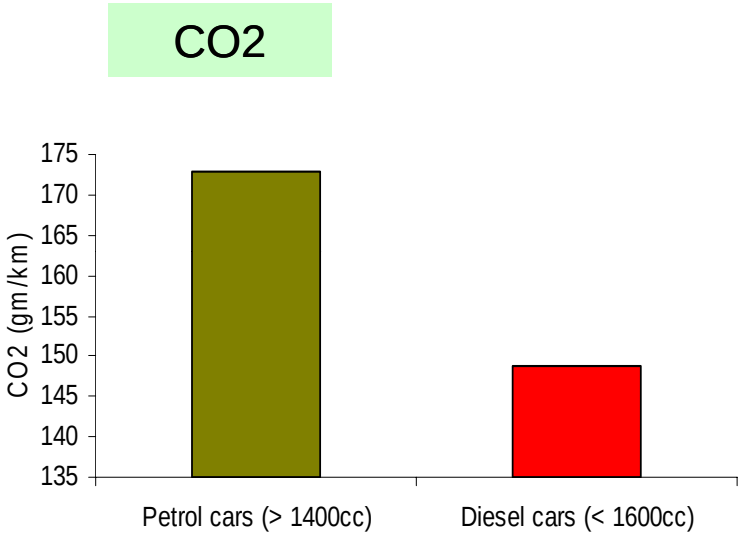
Sour

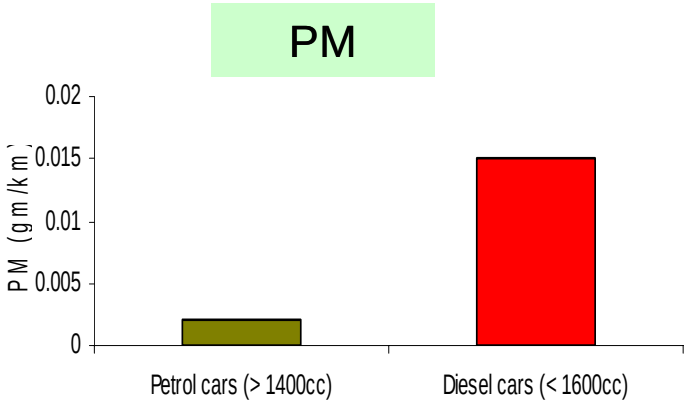
Why diesel makes us climate insecure?

Rebound Effect: Diesel fuel has higher carbon content than petrol. If more diesel is burnt encouraged by cheaper prices and more driving, more heat-trapping CO2 will escape.

Black carbon emissions from diesel vehicles are several times more heat trapping than CO2. Even under Euro IV particle standards, diesel vehicles may still warm the climate for well over the next 100 years (Jacobson's assessment)

CO2 emissions from the upstream diesel refining process will increase: European Commission has found lifetime pollution costs of Euro IV compliant diesel car is much higher than petrol cars.

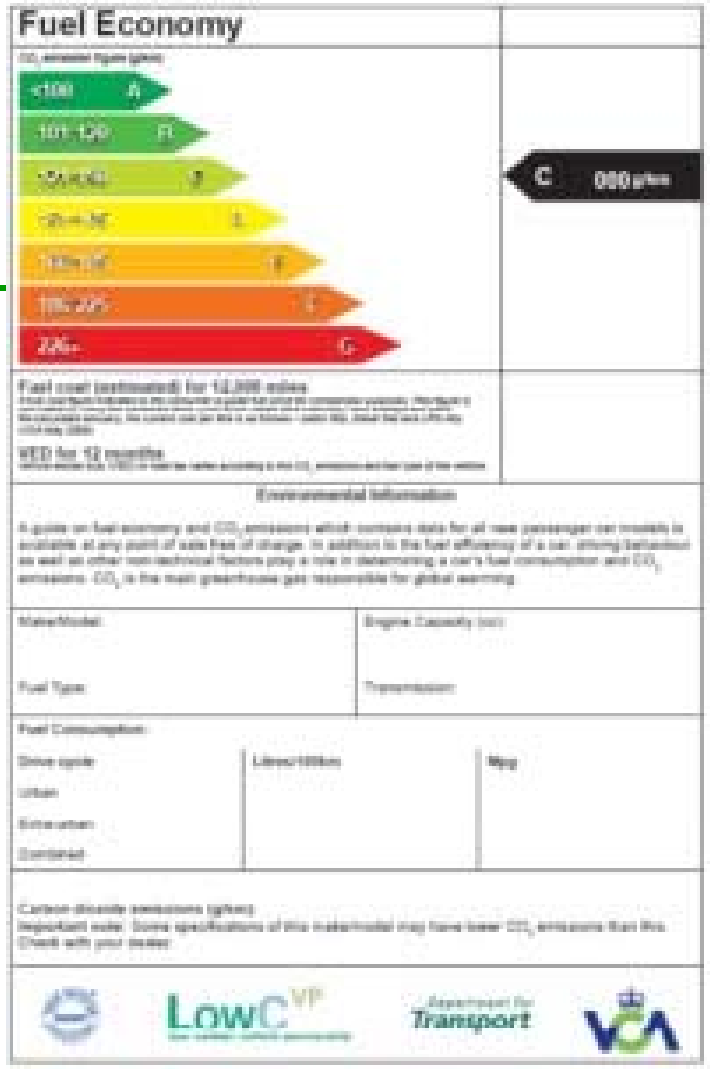




Implement fuel economy standards to improve technical efficiency of vehicles. Need transparent enforcement strategy

Need consumer information

- Display posters in car showrooms
- Fuel economy labelling
- Publish fuel consumption and CO2 emissions guide
- Include fuel consumption and CO2 emissions data in advertising, brochures etc.



Need tax policies

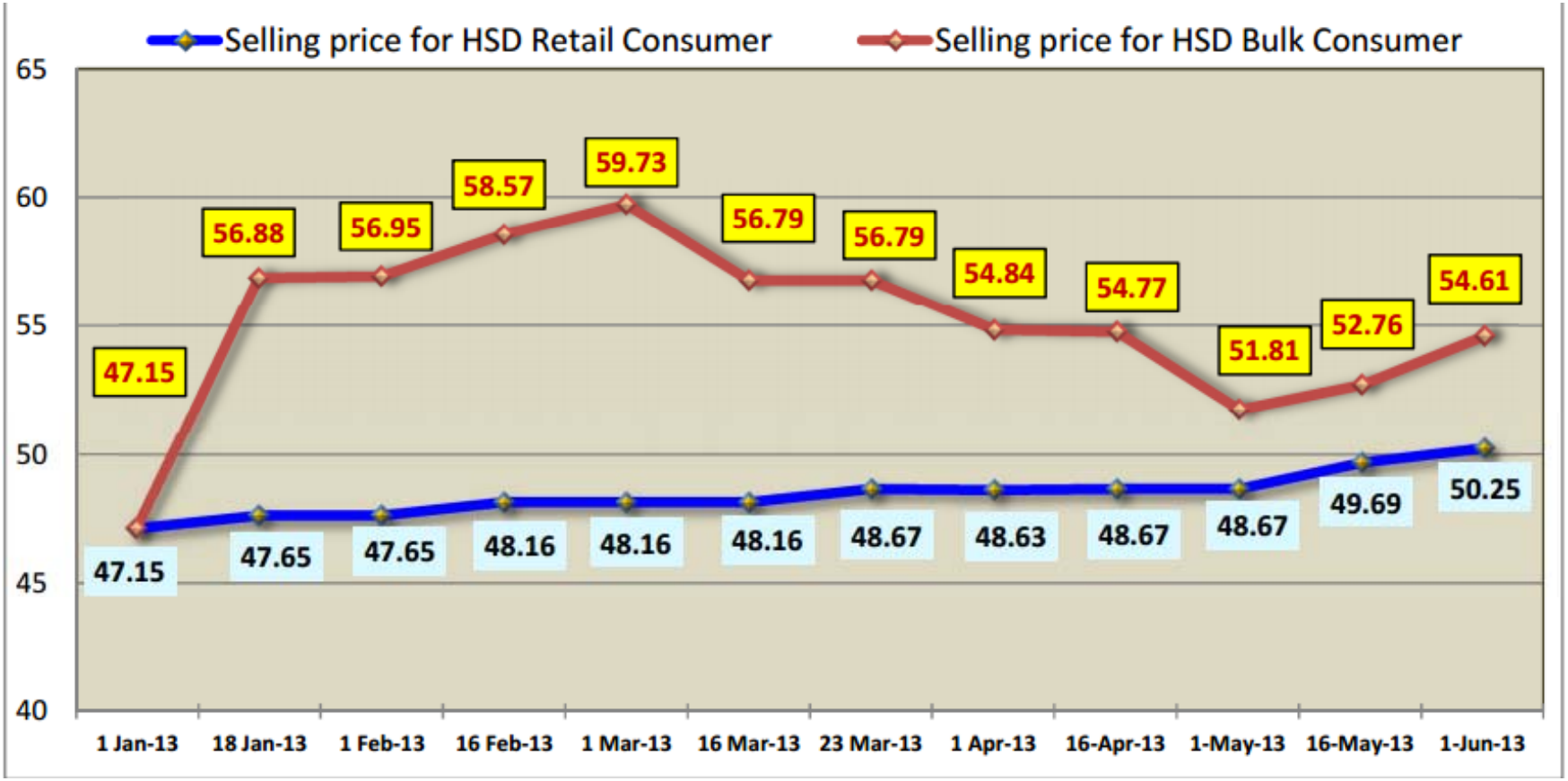
-- The US: Gas guzzler tax

-- Canada: National Fee-bate program by fuel consumption for cars, minivans, SUVs and light trucks

- **Japan**: Engine size based annual vehicle tax
- **European Commission** proposed car registration taxes and annual circulation tax to be totally or partially CO2 based
- **UK**, the Vehicle Excise Duty (VED) is an annual road tax based on CO2 emissions.
- **The Netherlands** -- tax break based on the energy bands etc

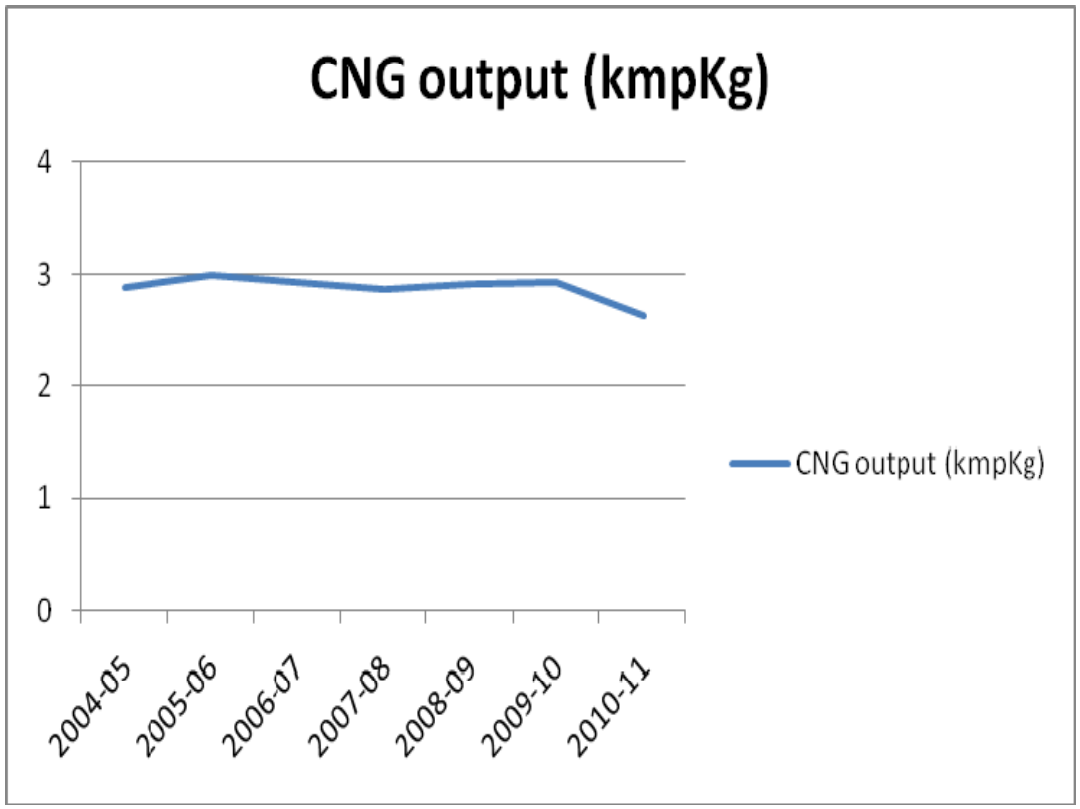
Bus.....

Diesel deregulation: Fuel cost increasing for buses



Source: http://ppac.org.in/writereaddata/Report_IPR.pdf

Drastic drop in fleet wide fuel economy of DTC buses

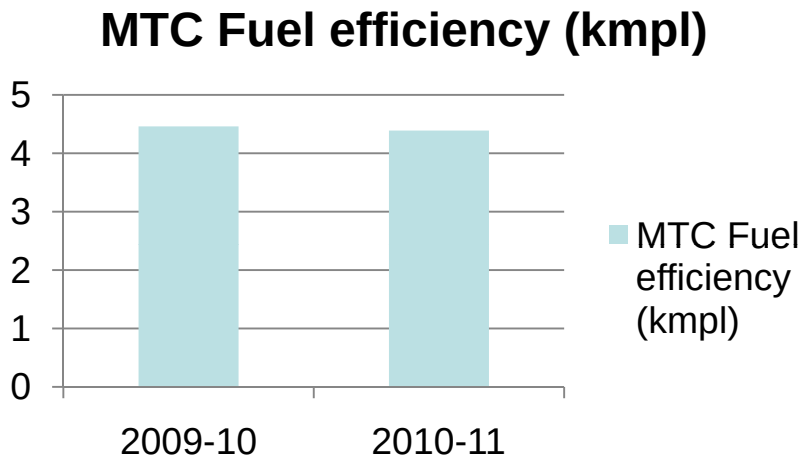


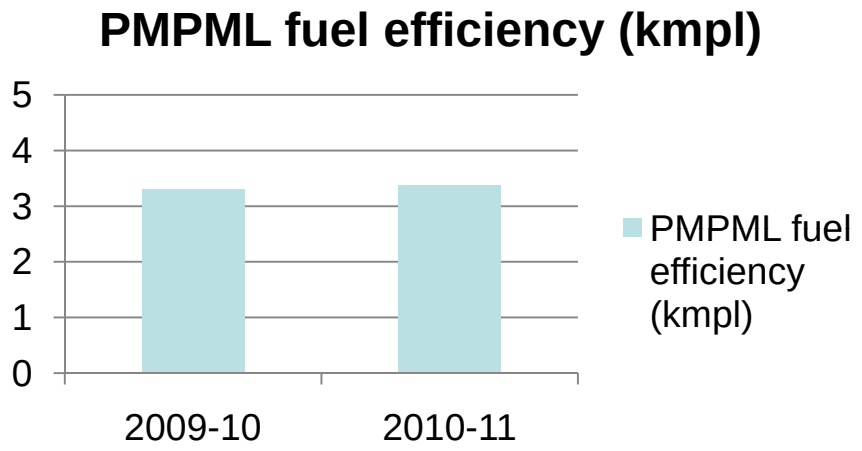
2005-06: Fuel economy of the fleet improved by +3.82%
2006-07: Declined by - 2.35%
2007-08: Declined by - 1.71%
2008-9: Improved by +1.3%
2009-10: improved by +0.69%

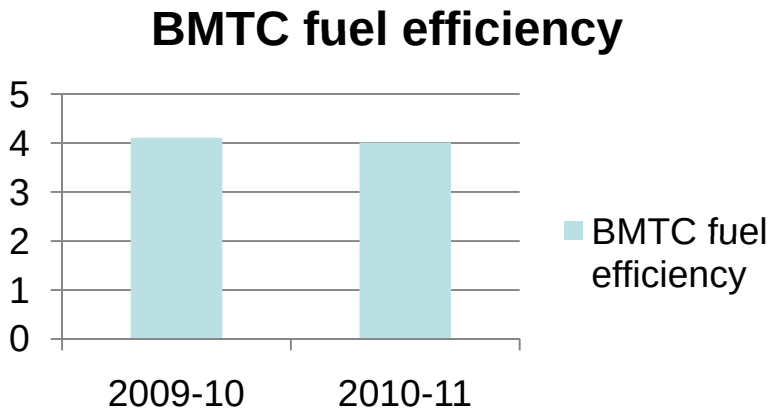
2010-11: Drastic decline of - 10.24%

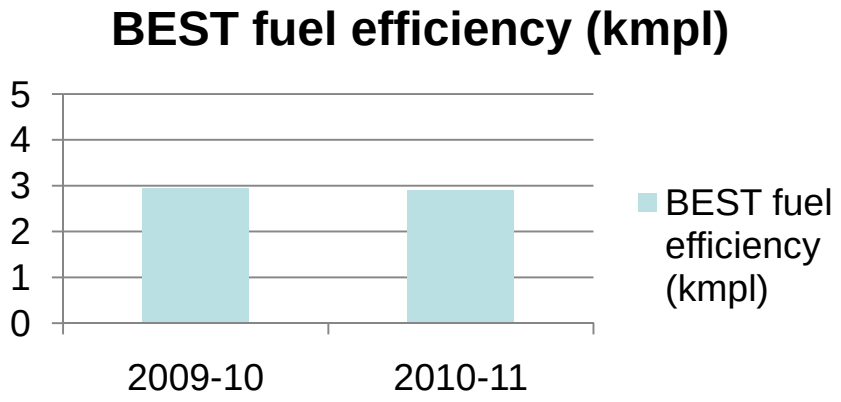
-- Coincides with the roll out of big buses
-- There is no fuel economy standard for buses
-- There is no strategy to reduce or cushion fuel costs of public transport

Other bus corporations: Fuel economy stagnating or declining









Fuel economy of buses worsening: BMTC

Fuel economy performance of the bus fleet in Bangalore

Figure: HSD KMPL

Leyland and Tata BS-I vehicles

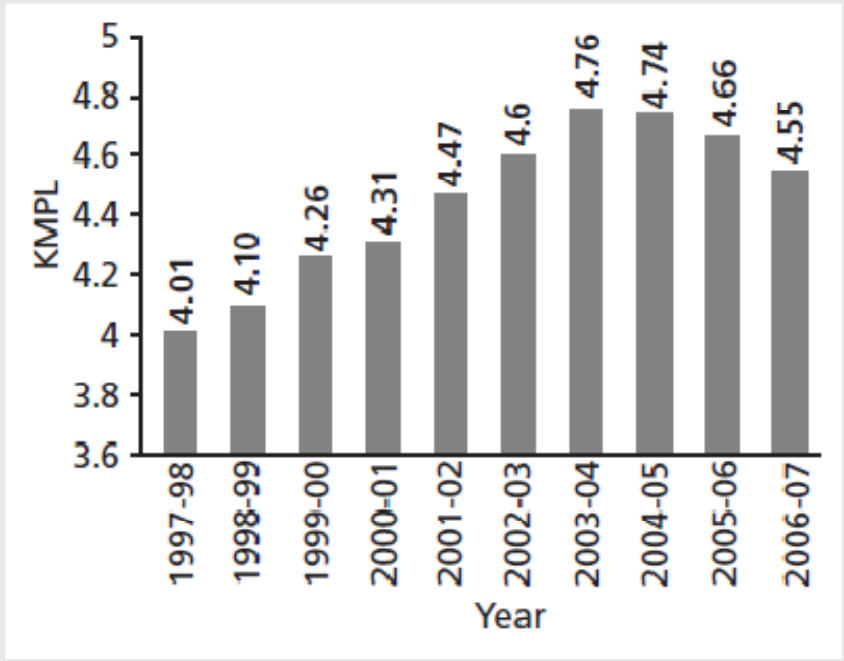
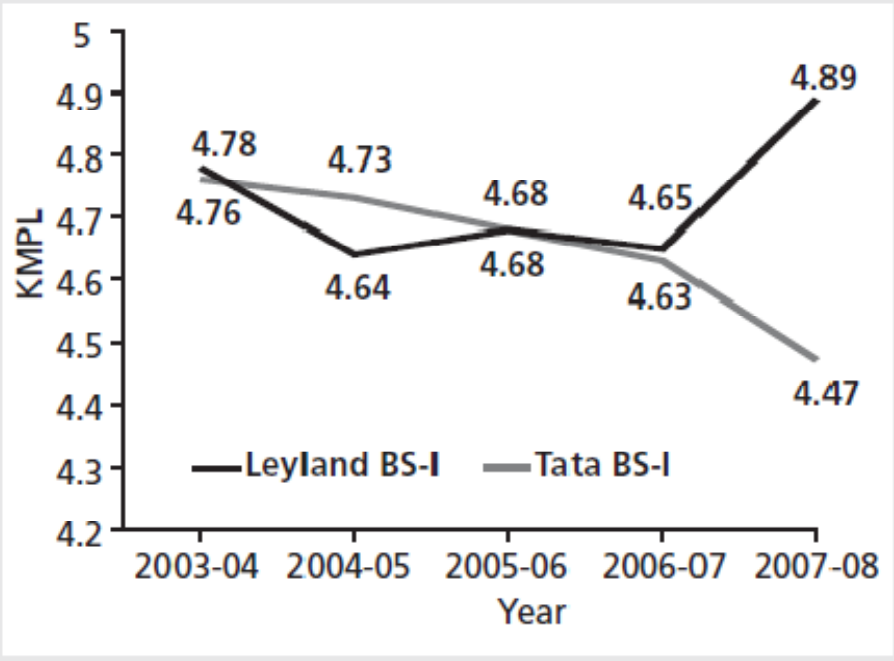
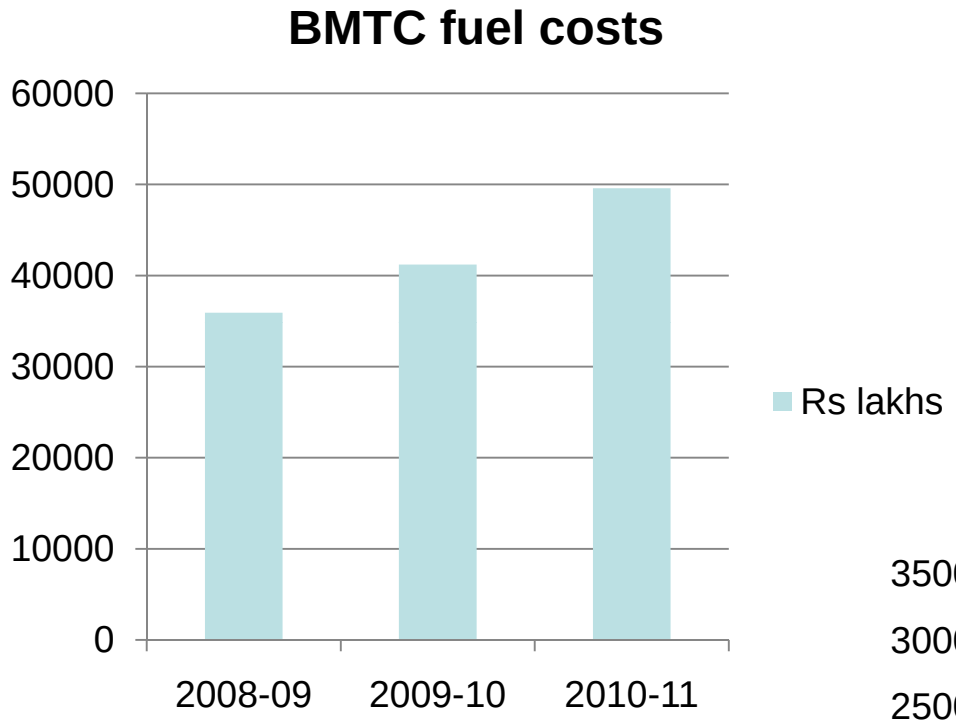
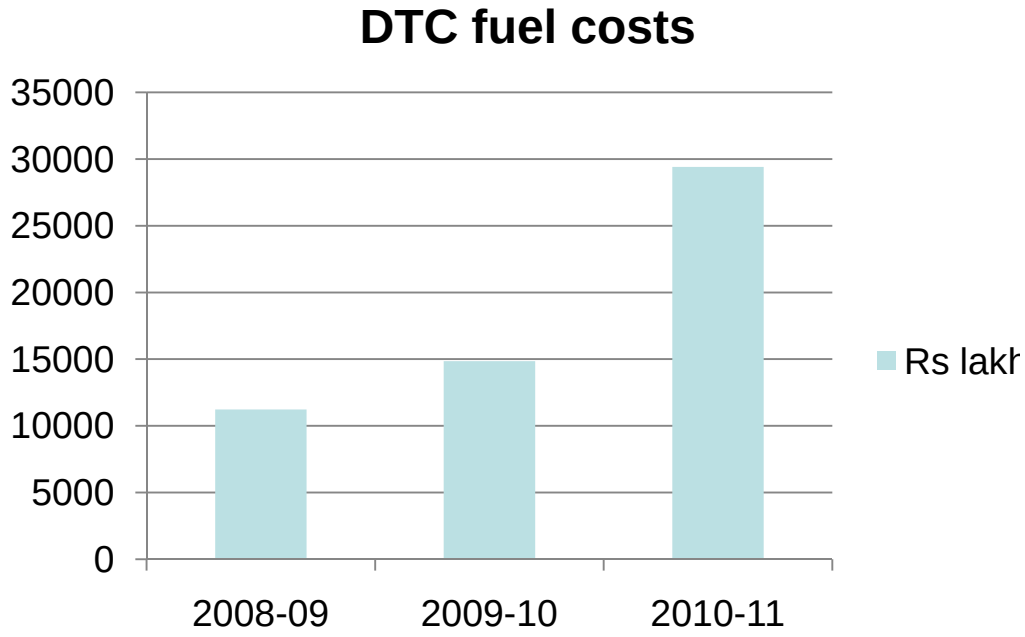


Figure: KMPL comparison of



…. At enormous cost





Improve operational efficiency

Need improved bus operations to cut operational fuel losses:

- Idling, frequent acceleration and deceleration on congested roads can also affect fuel efficiency.

- CAI Asia-BMTC study: by reducing idling by 10 minutes BMTC can save 100 litres per bus or Rs 3 crore annually.

- Also with the help of improved drivers training, and maintenance a savings of Rs 23 crore annually is possible.

Need road map for buses to maximise emissions and efficiency gains

Challenges:

Reduce toxic emissions – newer approaches to emissions control in buses evolving ……..

- Bangalore – Euro IV diesel buses with SCR systems to cut NOx
- Particulate traps must be introduced to cut PM
- CNG buses to enter new genre of technology

- **Need fuel economy standards and** regulatory capacity for designing of standards and test procedures etc

Need plans for operational efficiency

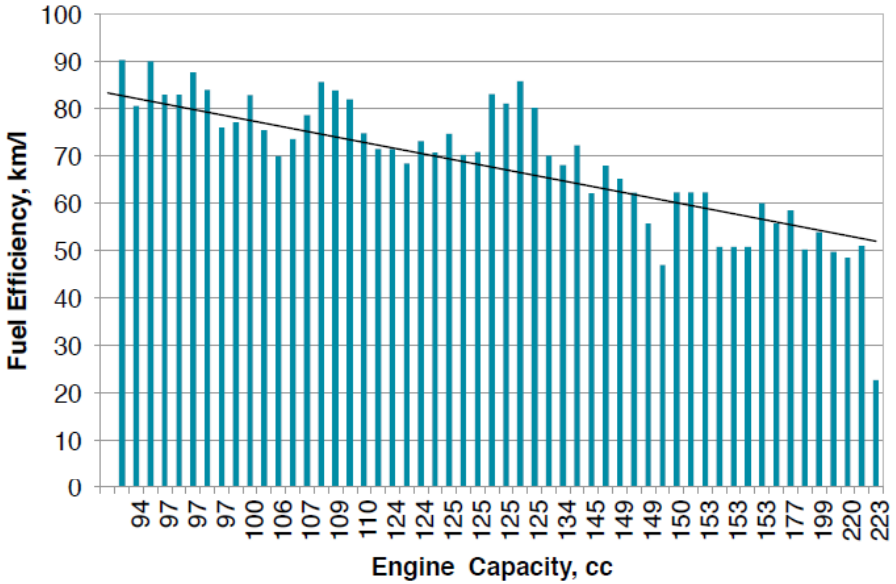
Two wheelers dilemma

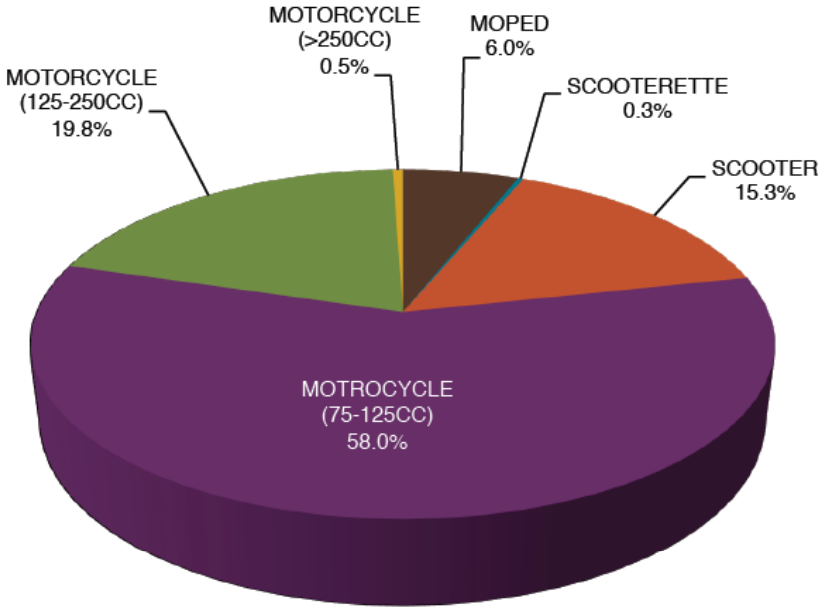
……. Smallest carbon footprint but polluting

Motorcycle India fuel economy

•Vehicles lower than110 cc have superior fuel efficiency
•Fleet wide fuel economy will decline if market shift towards bigger engines

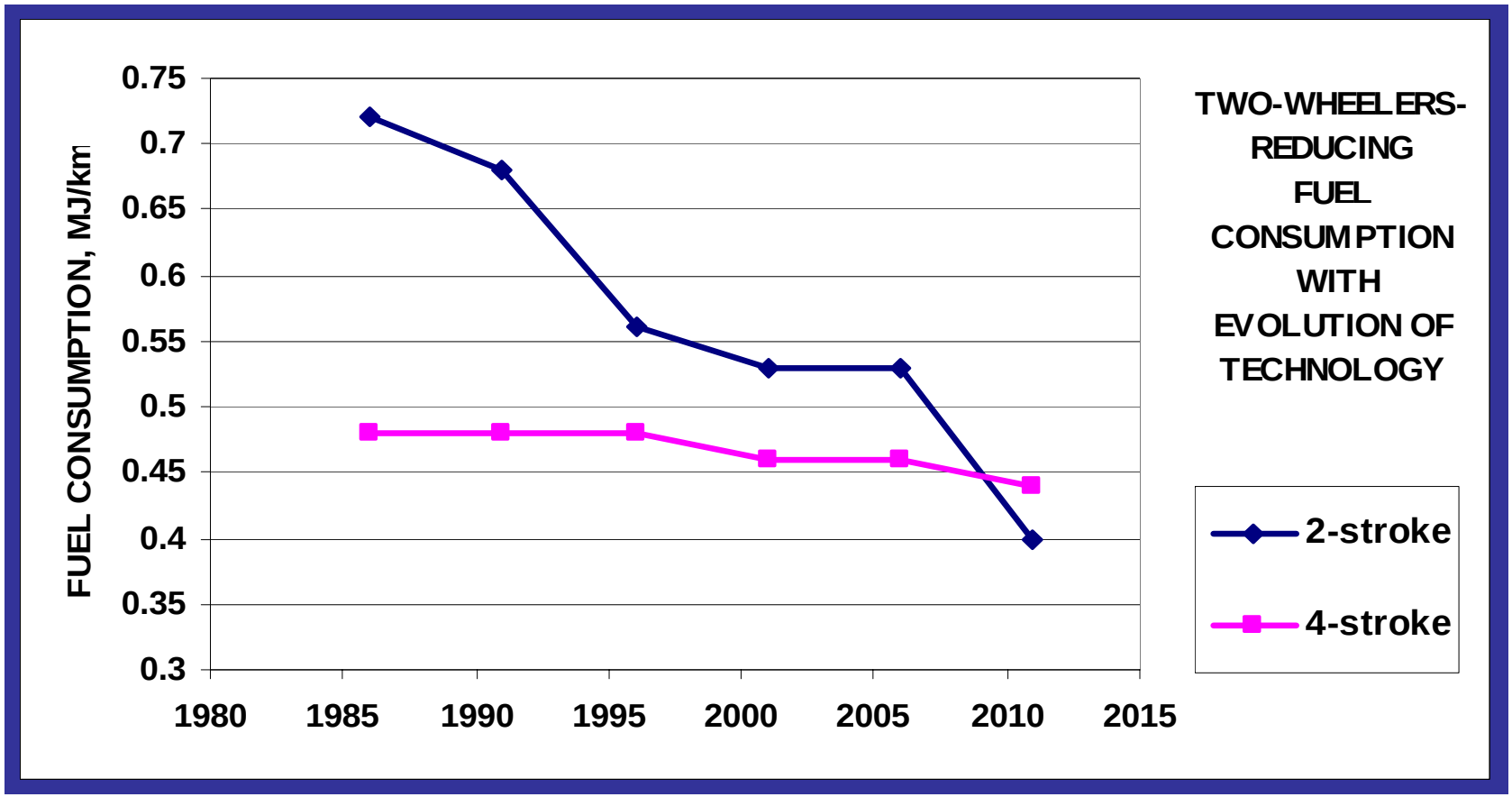
Market Shares of different categories of Two-Wheelers during 2009-2010
Motorcycles (75 to 125cc) dominate at 60%





Source: Narayan V. Iyer, August, 2012, A Technical Assessment of Emissions and Fuel Consumption Reduction Potential from Two and Three Wheelers in India Prepared for the International Council on Clean Tranportation (ICCT)

Significant reduction in Fuel Consumption of 2-Wheelers – impact of Improved ICE Technologies



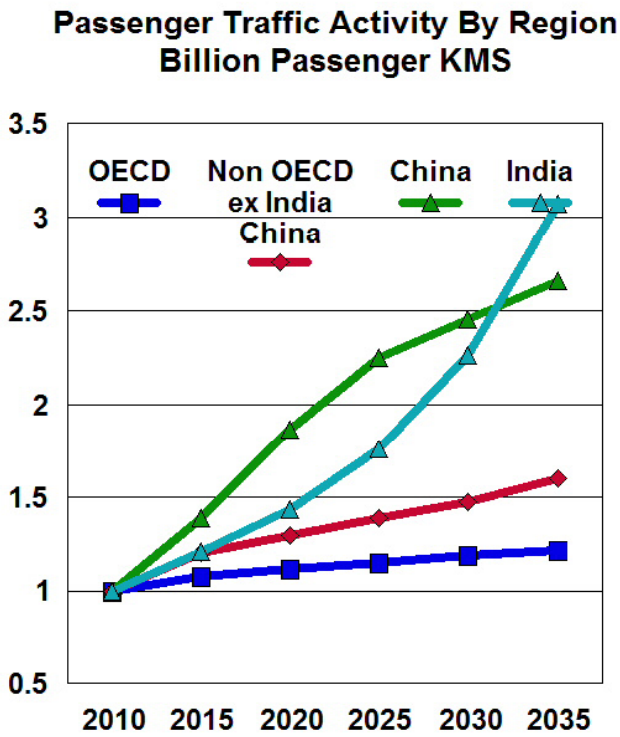
N V Iyer, 2006

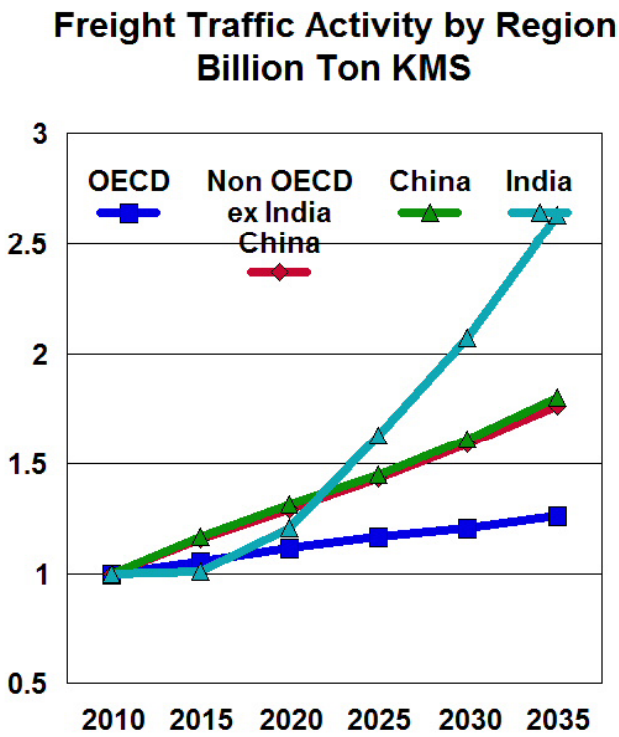
Two-wheeler dilemma – extremely fuel efficient but still more polluting than cars

The big solution is not possible if strategies for all transportation modes are not integrated and planned……

High growth expected in India

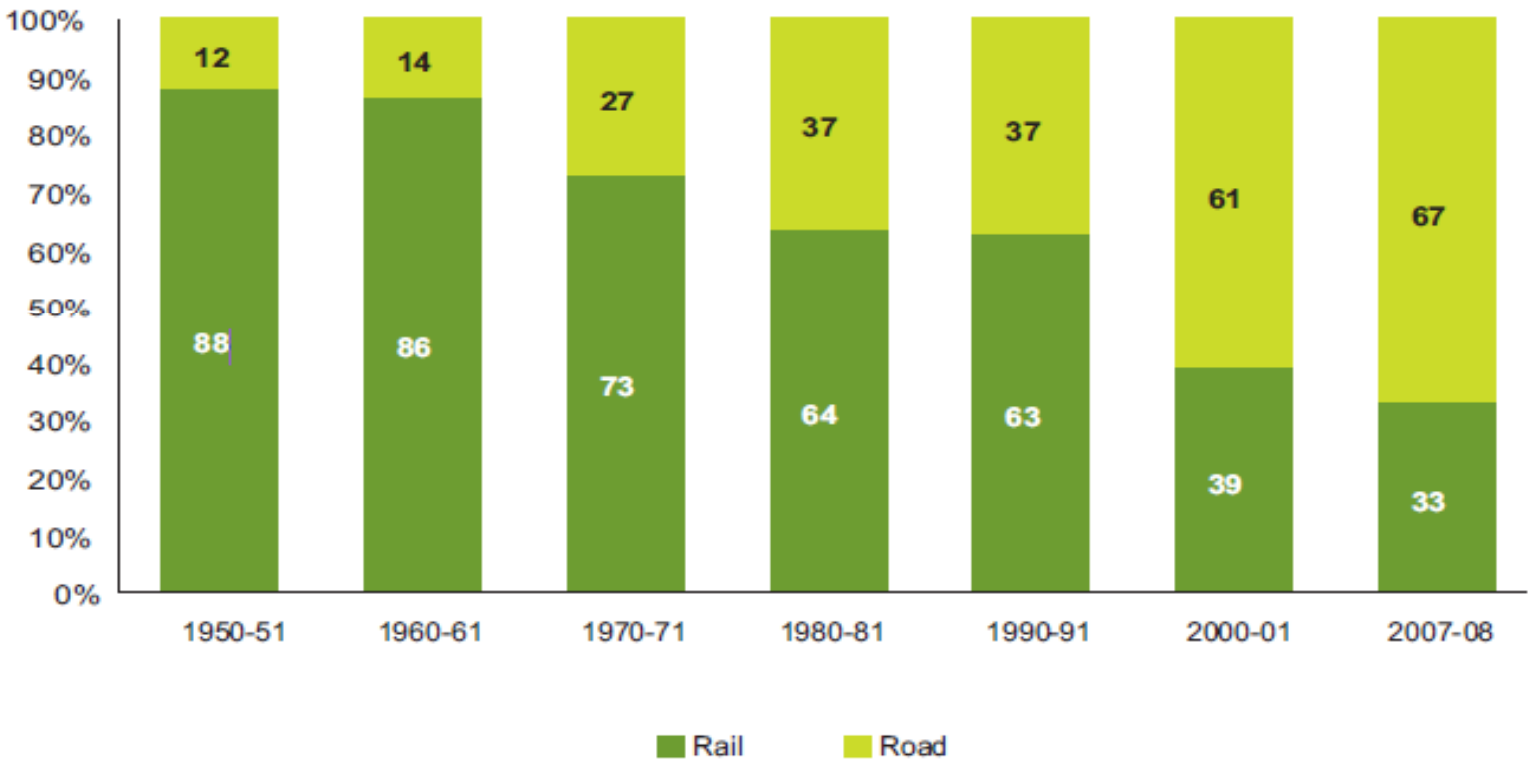
Forecast Passenger and Freight Growth
Normalized to 2010





Source: IEA Data

Erosion of railway freight



• Relative share of rail in total freight traffic declined from 86.2% in 1960-61 to 63.5% in 1980-81 and to less than 30% today.

•In India, the transportation energy demand could grow even faster than anticipated, if all of the new highway projects currently under consideration are completed.

Diesel truck consumes 3.1 times more fuel than rail on diesel (per net tonne km)

Modes of freight	**Specific fuel consumption** In liter/ net tonne kilometer (NTKM)	**Assumptions**
1. With dedicated freight corridor Rail (electric)	0.008 liter/ NTKM	Assuming 30% improvement in fuel economy
2. Without dedicated freight corridor		
Diesel truck (20T)	0.0143 litre/NTKM	Assuming average mileage of 3.5 km/litre
Rail (Diesel)	0.0045 L/NTKM	Computed from Annual Statistics (2009-10) of Ministry of Railways
Rail (electric)	0.011 kwh/NTKM	Computed from Annual Statistics (2009-10) of Ministry of Railways

Source: Promoting low carbon transport in India – Infrastructure for low carbon transport in India: A case study of Delhi-Mumbai dedicated freight corridor, UNEP 2012

Need technological and operational interventions to improve truck fuel efficiency

- **Action on truck:**

The following is part of the official discussion (MORTH). Need road map and implementation strategy:

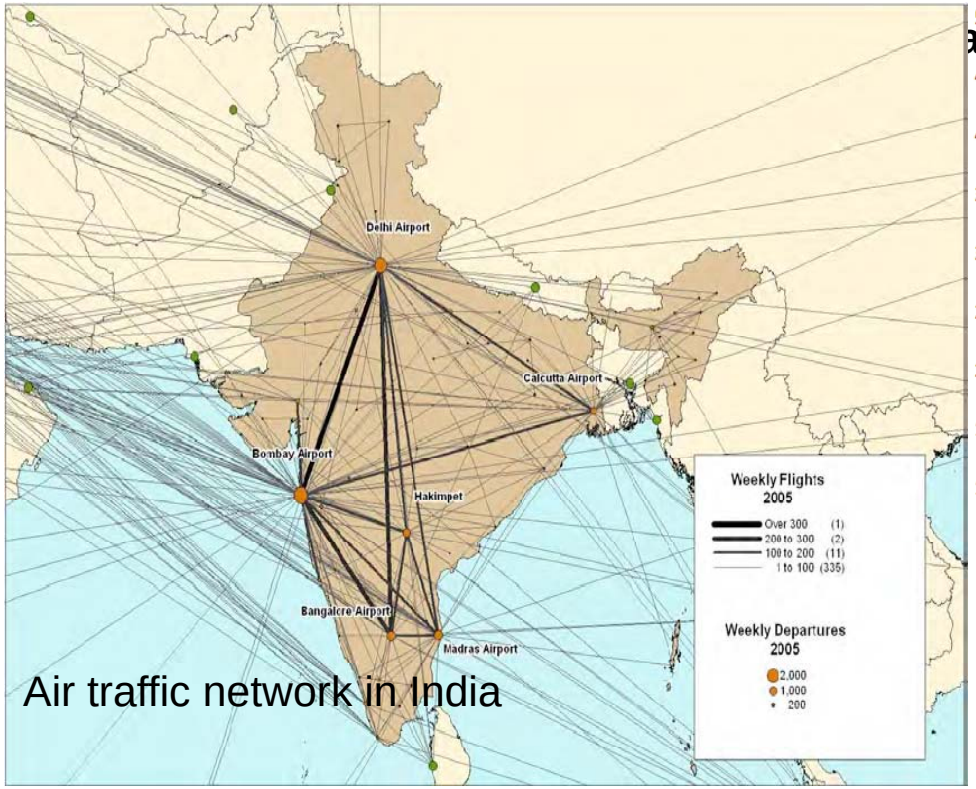
- Need standards to drive emissions control technologies
- Tire and wheel technologies and equipment
- Aerodynamics technologies and equipment
- Vehicle activity and driving pattern improvement
- Enhanced maintenance
- Idling control through technologies and behavior
- Fuel, oil and lubricant improvement
- Oil by-pass filtration system
- Fleet and engine modernization

Need strategies to increase rail modal share for freight and passenger traffic

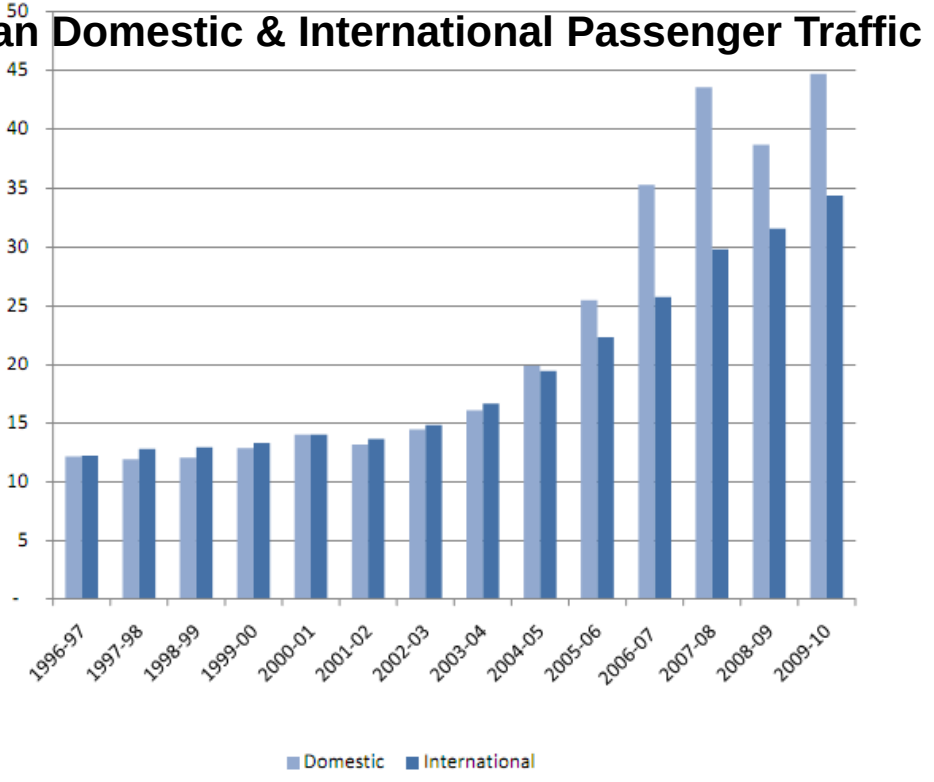
Aviation traffic: Explosive…….

Indian civil aviation sector: Phenomenal growth rate of about 40% annually (2008-09 – 2009-10). Now only 1 % of the population a year boards plane……

High passenger occupancy, younger fleets of the Indian private airlines assures more efficient operations. But need roadmap now.. At the early stages of growth



Air traffic network in India



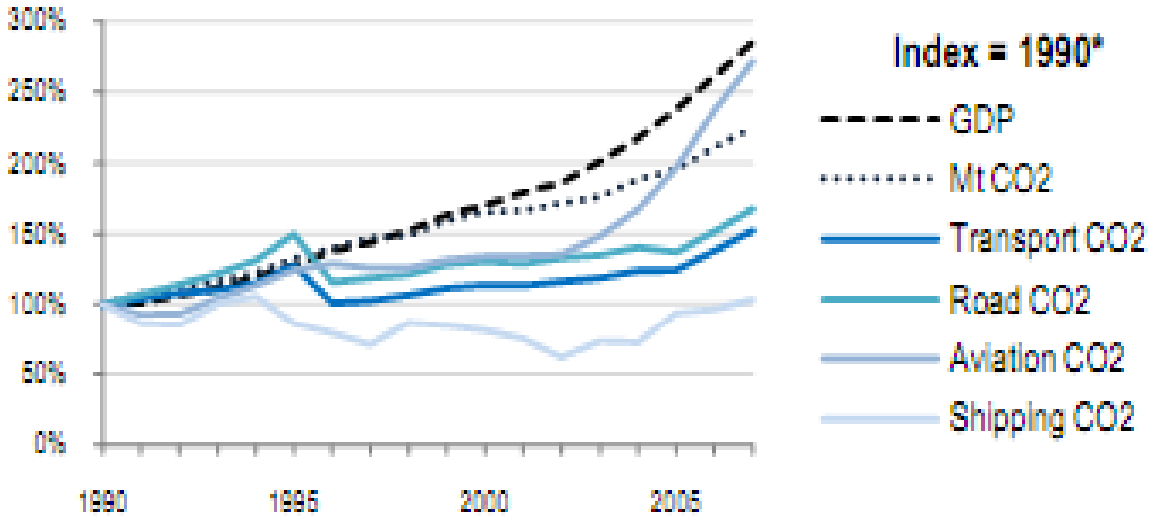
High energy and climate impact……..

High fuel consumption -- Globally domestic and international operations **account for 38% and 62% of global fuel consumption** (ICAO 2010). In India, consumption of Aviation Turbine Fuel up by about 40%

Official greenhouse gas emission inventory for India 2007: Transportation emissions -- 87.3% from road activities, 7.3% from aviation, 4.3% from railways and 1.1% from marine navigation. **Emissions from aviation have more than trebled since 1994** (INCCA 201)

The IEA (2010) estimated an exceptional increase in emissions of 165.7% between 1990 and 2008, compared to the world average of 76.1%.

CO2 emission trends in Indian transportation from 1990-2007



Nascent policy discussion in India

- Aviation Environmental Unit" (AEU) Initiative of the DGCA

- **Better operational procedures under discussion**
  - Minimum usage of auxiliary power unit, reduced flap takeoff and landings, idle reverse on landing, proper flight planning system, adhering to proper maintenance of aircraft, weight reductions in the form of reducing the weight of cabin equipment, catering services, avoiding carrying extra fuel on board, etc.
  - IATA estimates that within India, a streamlined air traffic management system can cut airlines' fuel bills and thus emissions by more than 50%.
- **Integrated approach**:
  - technology and operational practices;
  - Modification in Climb, cruise and descent cycle
  - additional aspects of business strategies and models
  - demand management,
  - air transport management, airport management,etc.
  - "Route Dispersion Guidelines" to minimise planes operating on routes with a low load factor.

Waterways – The advantage ……..

More efficient carriage: A barge can carry cargo equivalent of 15 rail wagons or 60 truckloads worth of goods (NCAER 2006).

Cheaper -- The operating cost per tonne kilometre in waterways is Rs 0.53 as against Rs 1.32 in railways and Rs 2.75 in roadways. ((NTPDC 2012).

More fuel efficient: a litre of diesel would carry 105 tonnes over a kilometre through waterways, 85 tonnes through railways and 24 tonnes through roadways.

Less emissions: An IWT vessel emits less than 50% of carbon a lorry emits, (NTDPC 2012). The Indian Network on Climate Change Assessment (INCCA) estimates - inland navigation caused one per cent of total transport GHG emissions in 2007 . -- No estimate for local pollution from Inland water transport.

Advantage nullified ……..

Poor navigability -- Fewer days of navigability limits the transportation potential of the river, -- At Allahabad, navigability of the Ganga restricted to 140 days for large vessels with the least available depth of 1.5 metres.

-- Most of the barges on national waterways have a capacity of 750 tonnes due to less navigable depth.

Need revival plan

-- IWAI plans revival of Inland Vessel Building Subsidy Scheme,. The vessel fleet to be augmented

-- Budget for technological upgradation. Centre to facilitate inland water transport operators to obtain loans

-- River training and conservancy, including dredging.

-- IWAI to develop new irrigation-cum-navigation canals like Yamuna canal and delta canals of Mahanadi, Godavari and Krishna.

Way forward…..

Need integrated strategy to fulfill the vision of energy independence, and meet the co-benefits of lower GHG emissions and public health protection

Set time bound target for energy savings, GHG reduction and clean emissions

- **Immediately implement the proposed fuel economy standards for cars by 2020**
- **Prepare roadmap for fuel economy standards for bus, trucks and two-wheelers**
- **Introduce consumer information system and labeling programme**
- **Implement advanced vehicle technology programme (hybrids and electric) along with strong fuel efficiency programme for all vehicle segments**
- **Auto fuel policy to ensure that emissions and efficiency improve together:** Prevent trade-off between efficiency and emissions. Eg, maximise emissions and efficiency gains of diesel vehicles
- **Need integrated multi modal planning for freight and passenger movement – Shift to more fuel efficient freight modes**. Improve modal share of railways and waterways.
- **Introduce fuel efficiency based taxation**

Thank You