

**Pricing and infrastructure costing for  
supply & distribution of ULSD & CNG in  
the transport sector in Mumbai**

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...TERI study

**ADB Project - RETA5937**

“Action Plans for Reducing Vehicle Emissions”

Dr. Ranjan Kumar Bose

Senior Fellow, TERI, New Delhi, India



**Objectives**

- Define the air pollution problem at present in Mumbai and the likely trend in pollution;
- Estimate the demand for CNG and ULSD as road transport fuels over a 10-year timeframe (2000-10) and identify supply sources;
- Analyze the resultant emissions loading of CO, HC, NO<sub>x</sub> and PM under alternative scenarios which are based on increased penetration of CNG and ULSD;
- Determine the cost of supplying the two fuels up to the retail outlets;
- Analyze the price build up of the fuels;
- Identify arrangements for supply of CNG in a safe and speedy manner;
- Suggest measures to prevent adulteration of ULSD in the city.



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## **Methodological framework**

- Review international experience to determine potential emissions reductions from CNG and ULSD
- Use of LEAP framework to project the fuel demand and resultant emissions of CO, HC, NO<sub>x</sub> and PM under alternative scenarios till 2010
- Costing of CNG and ULSD supply
  - CNG: Domestic as well as import route
  - ULSD: Import route

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## **Methodological issues**

- Absence of credible data on emissions factors of in-use vehicles by fuel/vehicle category
- Inadequate data on number of vehicles (& VKT) in actual use by fuel/vehicle category
- Commercial availability of technology?
- Costs of emission control technologies?

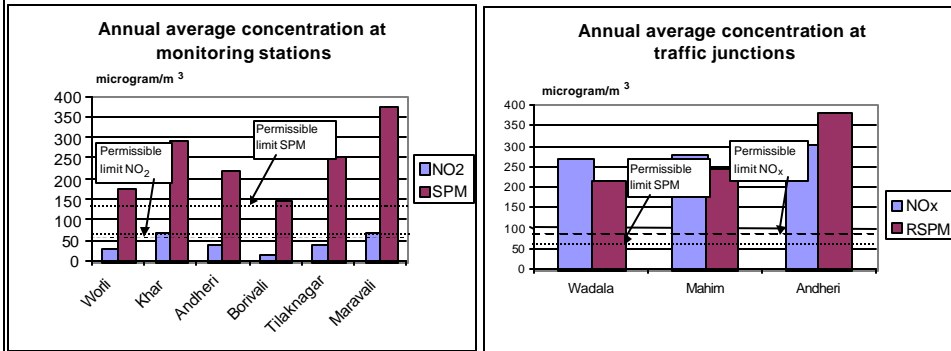
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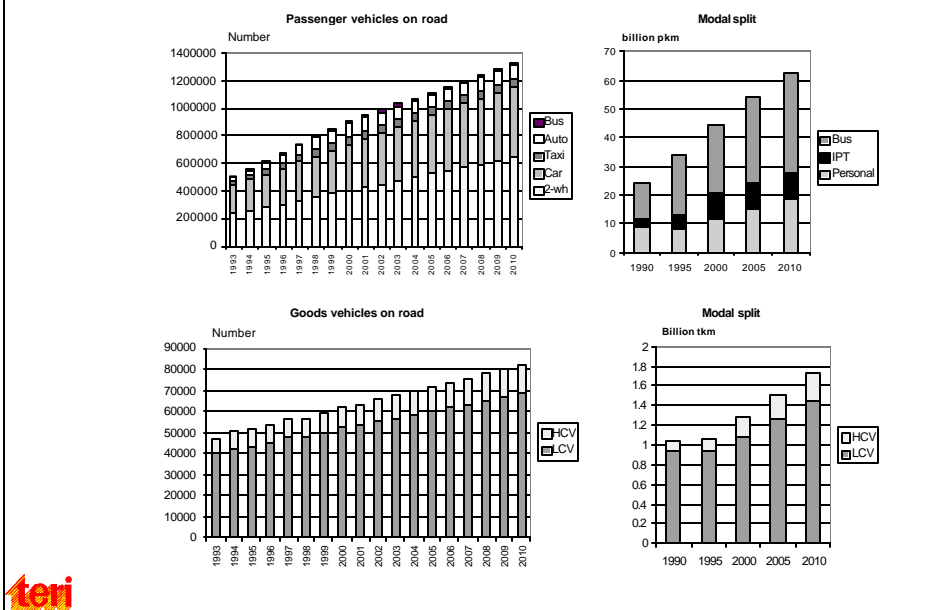
**Critical pollutants & their ambient levels in 2000-01 indicate serious health concerns**



Source: Environment Status of Brihanmumbai, 2000-01, Municipal Corporation of Greater Mumbai

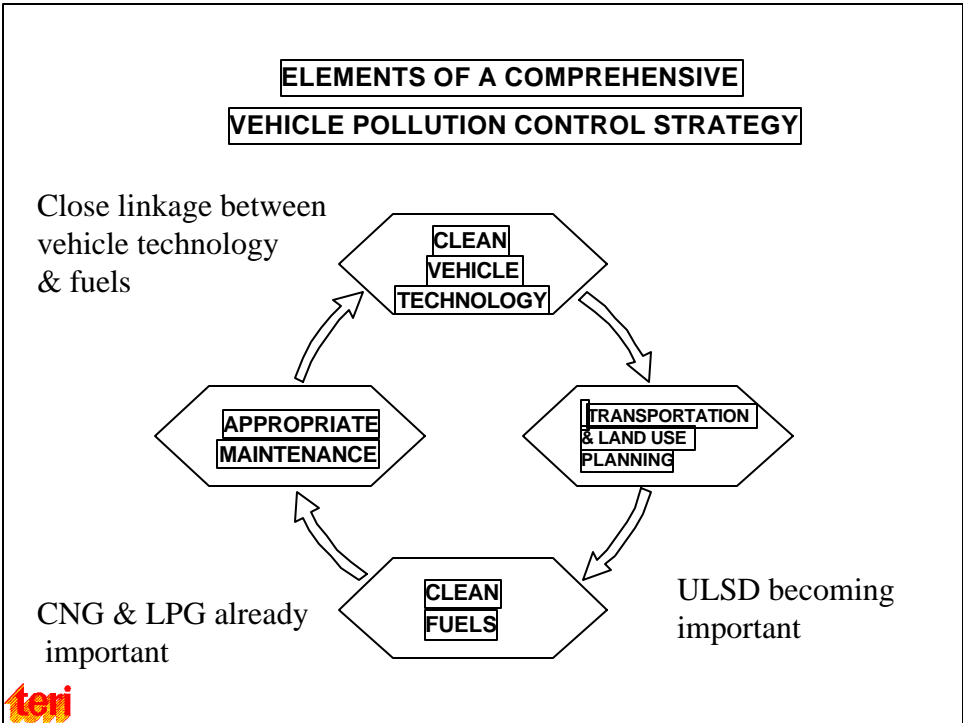
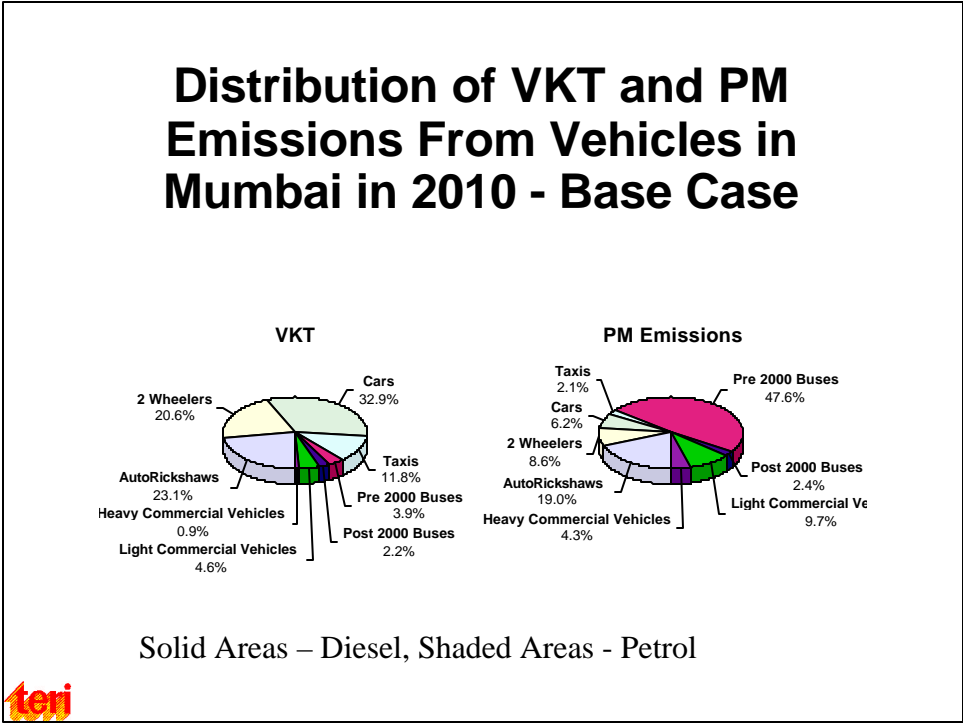


**No. of passenger and goods vehicles in use & modal split indicate that the problem may get worse**



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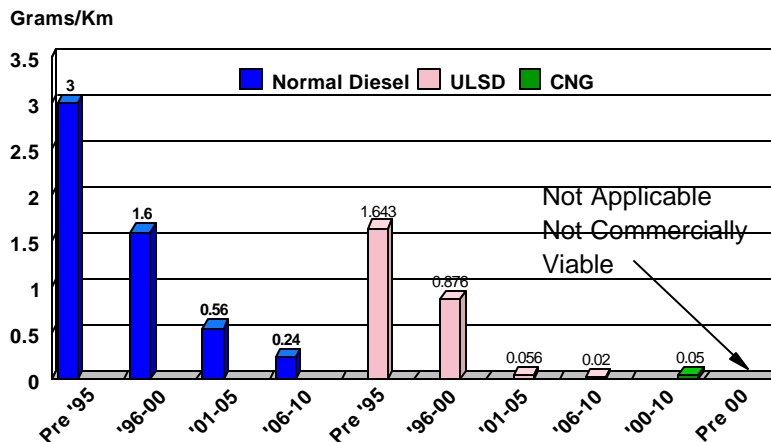
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### Critical emissions assumptions

- Neither CNG or ULSD suitable for 2-wheelers
- CNG not commercially viable for pre-Euro II buses or for light or heavy trucks
- ULSD & PM filter feasible for all Euro II diesel light trucks and buses
- ULSD & DOC feasible for all pre-Euro II diesel vehicles and for Euro II heavy trucks
- CNG use in new cars, taxis, buses & autos will gradually increase in base case



### Assumed PM Emissions Factors For Buses



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## **Baseline scenario**

The following factors would change as per current trends, during the period 1993 to 2000:

- growth of in use motor vehicles
- penetration of improved technologies conforming to progressively stringent emission standards (Euro norms)
- penetration of CNG
- improvement in fuel efficiency
- CO, HC, PM coming down slowly, NO<sub>x</sub> stable

However, the occupancy/load factor and the effective distance moved per vehicle is assumed to remain constant from 1990 to 2010

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## **Two potential future cases**

### **Assumed in both cases**

- All pre-2000 diesel vehicles operate on ULSD & DOC
- All pre-2000 CNG/petrol vehicles continue to run on CNG/Petrol
- All new cars to run on petrol/CNG with 3-way catalyst and (if diesel) ULSD with PM filters

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### Other assumptions

#### CNG Case

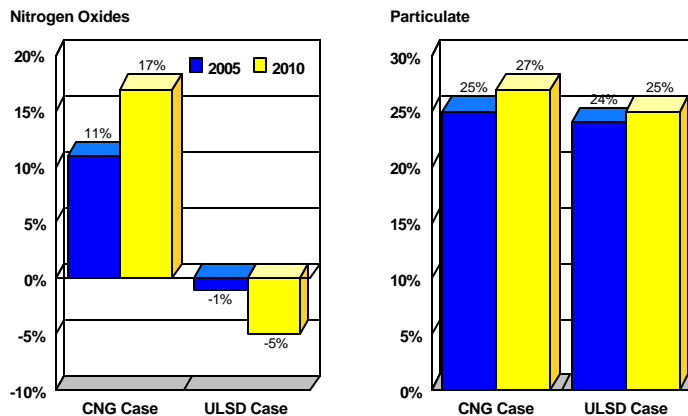
- All new (post-2000) buses, taxis & autorickshaws to run on CNG with 3-way catalyst
- All new LCV & HCV operate on ULSD with DOC

#### ULSD Case

- All new (post-2000) buses, taxis and LCVs will operate on ULSD & PM filter
- All new autorickshaws operate on CNG/petrol with 3-way Catalyst
- All HCVs to operate on ULSD with DOC



### Emissions Reductions Relative To The Base Case



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### Cost of CNG supply (2010) - Import

	Dubai Crude Price, \$ / bbl	25
	JCC CIF, \$ / bbl	26.67
1	LNG CIF Japan, \$ / MMBTU	4.51
2	LNG CIF Dahej, \$ / MMBTU	3.93
3	Regasification and Storage Cost, \$ / MMBTU	0.40
4	Pipeline Transmission Fixed Cost, \$ / MMBTU*	0.20
5	Pipeline Transmission Operating Cost, \$ / MMBTU*	0.18
6	CIF Pipeline Tariff, \$ / MMBTU (4+5)	0.38
7.1	Natural Gas at City Gate Station, \$ / MMBTU (2+3+6)	4.71
7.2	Natural Gas at City Gate Station, Rs/kg	10.03
8	Annualized Capital Cost, Rs/kg	2.72
9	Cost of Distribution plus transportation Cost, Rs/kg	2.00
10	Dealers Commission, Rs/kg	1.20
11	Cost of supplying CNG, Rs/kg (7.2+8+9+10)	15.95
	* For LNG Ex Dabhol Rs/kg	15.69



### Cost of CNG supply (2010) - Domestic

	Dubai Crude Price FOB, \$ / bbl	25
1	Fuel Oil Price FOB Arabian Gulf, \$ / ton	136.37
2	Fuel Oil Freight Cost (AG to Mumbai), \$ / ton	6.50
3	Insurance, ocean loss, wharfage, \$/ton	0.43
4	Fuel Oil CIF Price, \$ / ton (1+2+3)	143.30
5	Terminal Charges (storage & port handling), \$ / ton	4.21
6	Natural Gas, \$ / ton [(4+5)x1.15]	169.64
7.1	Natural Gas at City Gate Station, \$ / MMBTU	3.79
7.2	Natural Gas at City Gate Station, Rs/Kg	8.06
8	Annualized Capital Investment, Rs/kg	2.72
9	Cost of Distribution plus transportation Cost, Rs/kg	2.00
10	Dealers Commission, Rs/kg	1.20
11	Sales Price Rs/kg (6.2+7+8+9)	13.98



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### Cost of ULSD supply

	Crude Price, \$ / bbl	25
1	FOB Price HSD \$ / bbl	27.88
2	Premium LSD over HSD \$ / bbl	0.40
3	Premium ULSD over LSD, \$ / bbl	3.51
4	Freight Cost to Mumbai port, \$ / bbl	1.40
5	CIF Price ULSD, \$ / bbl (1+2+3+4)	33.20
5	CIF Price Rs/kl	9914.43
6	Terminal charges, Rs/kl	175.00
7	RPO charge, Rs/kl	83.98
8	Dealers Commission, Rs/kl	277.00
9	Cost of supplying ULSD at retail outlet Rs/l	10.45
10	Cost of supplying ULSD at retail outlet Rs/l*	11.50



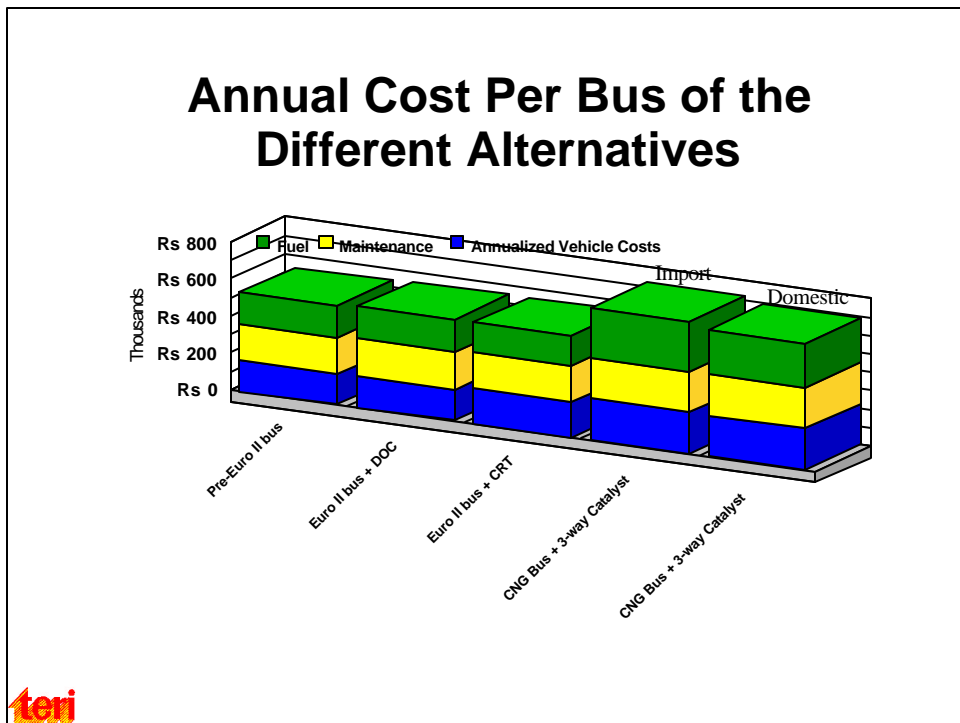
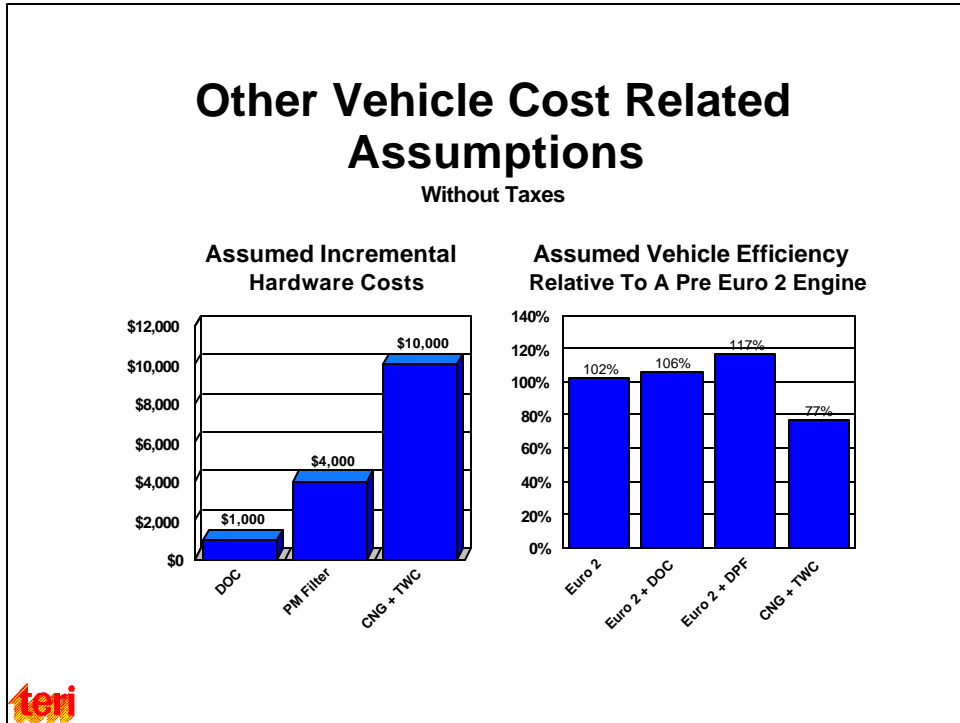
### Summary of costs

Dubai Crude Price, \$/bbl	Unit	22	25	28
ULSD	Rs/litre	9.44	10.45	11.46
CNG thru import ex Dahej	Rs/kg	15.23	15.95	16.67
CNG thru indigenous	Rs/kg	13.04	13.98	14.91
ULSD bus	Rs/km	2.32	2.57	2.82
CNG bus (Import)	Rs/km	3.59	3.76	3.93
CNG bus (Domestic)	Rs/km	3.62	3.88	4.14



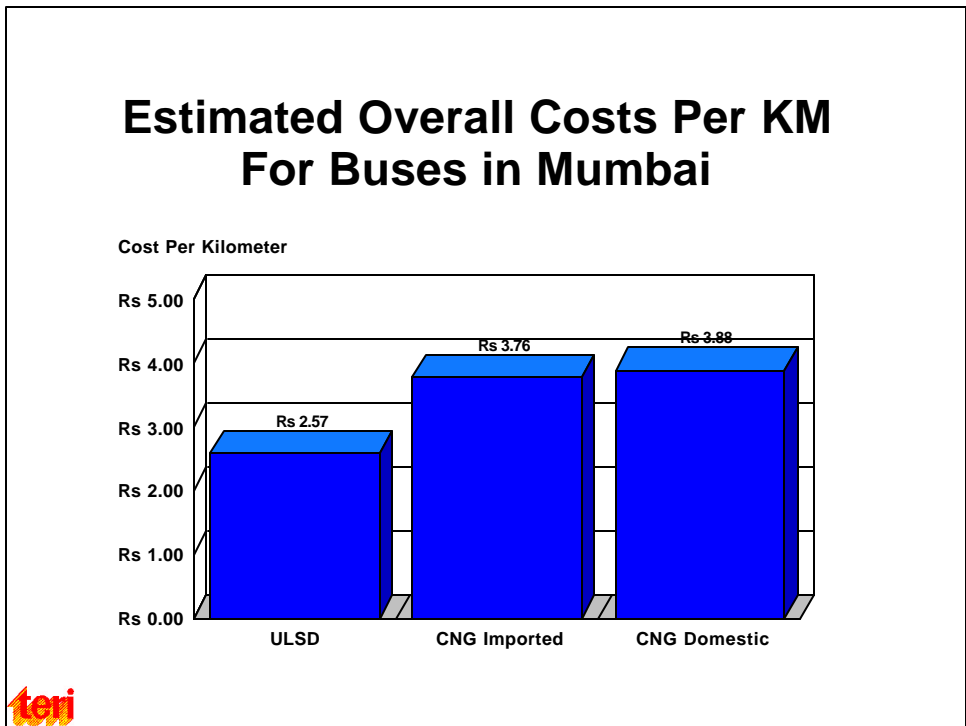
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### PM abatement cost of alternative technologies and fuels for a Mumbai bus

Bus type	Fuel type	Cost (US \$/tonne)	
		Without tax	With tax
Euro II diesel bus + DOC	50 ppm S diesel	6,758	6,801
Euro II diesel bus + CRT	50 ppm S diesel	3,123	350
CNG bus + 3-way catalyst	CNG - LNG route	39,473	10,200
CNG bus + 3-way catalyst	CNG - domestic	33,026	10,200

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## Conclusions for Mumbai

- Both CNG and ULSD have the potential to substantially reduce PM emissions from vehicles
- CNG can also reduce NOx Whereas ULSD Has No Impact
- While less environmentally important in Mumbai, small improvements in CO and reactive HC result from both fuels
- ULSD expected to be cheaper than CNG
- Based on the local fuel costs and the assumptions regarding hardware costs and fuel efficiency gains, abatement costs will be lower for ULSD Than For CNG
- Creation of additional infrastructure for CNG difficult because of space constraints



## Challenges and risks with each fuel

### ULSD

- Fuel adulteration must be prevented or benefits will disappear
- Appropriate post-combustion ECD must be carefully matched with vehicle operating characteristics
- Good maintenance practices critical to ensure efficient functioning of ECDs
- Fuel not currently produced or sold in quantity in India and while it could be imported, currently no such regulation mandating its use has been adopted.

### CNG

- Need for adequate additional infrastructure facilities to ensure speedy dispensation
- Performance and reliability of converted heavy duty diesel vehicles not established
- Safety must receive greater attention
- CNG not available across the country



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**Recommendations for future work**

- Better, more reliable emissions factors for all categories of vehicles/fuels are needed
- Carefully controlled demonstration projects in the region with both ULSD and CNG would be very helpful
  - Emissions data
  - Cost data
- Common methodologies for assessing fuels alternatives need to be developed

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Thank you!

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