UNESCAP - UNHABITAT

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Emerging Technologies

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- Vehicle Technology and Market Scenario
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- Vehicle Technology and Environment
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- Comparative Statement – Fuel Technology
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- Challenges with Adopting Technologies
- Summary

Urban Transport and Environment

- Air pollution is a major environmental health problem affecting people worldwide
- Traffic is predominant source of air pollution
- Cities manage environment regulations by planning, policies and vehicle technologies
- To regulate CO2 emissions and local pollution, alternate vehicle technology is key.

Vehicle Technology and Market Scenario

Market Availability

Wide range of alternative fuels & technologies are available in market

- **Fuel technology for Buses**
  - Standard Diesel
  - Ultra Low Sulphur Diesel (ULSD),
  - Compressed Natural Gas (CNG),
  - Liquefied Petroleum Gas (LPG),
  - Biofuel (bio-methane/bio-diesel) ,
  - Electricity
  - Hydrogen Fuel Cell
- **Engine Technology**
  - Internal Combustion Engine (various EURO stages)
  - Hybrid

Vehicle Technology and Market Scenario

Market Development

- Diesel has established market in bus vehicle
- Needs to compete with other fuel alternatives innovated R&D on engine / propulsion technology with lower emissions
- CNG over past few decades has established its market
- Initial infrastructure for refueling & maintenance was created
- Some safety concerns are on potential fire risk exists with CNG
- Hybrid vehicle are growing in market in Mexico and Brazil

Vehicle Technology Choice

Factors influencing fuel and vehicle technology type choice

- Policy support, Tax incentives, Funding
- Life Cycle Cost
- Availability of fuel and refueling infrastructure
- Maintenance facilities – Infrastructure and technical expertise
- Scope of replacement
- Priority to air pollution or green house emissions

Vehicle Technology and Environment

Emission Type	Local Pollutant	GHG pollutant	Regulating Regions
CO	Y		US, Europe, Brazil, India, Mexico
CO_2	Y	Y	US
NOx	Y	Y	US, Europe, Brazil, India, Mexico
Total HC			Europe, Brazil, India
Non-Methane HC	Y		US, Mexico
PM	Y		US, Europe, Brazil, India, Mexico
CH_4		Y	Europe
SO_2	Y		US, Europe, Brazil, India, Mexico

Emission norm followed in various region

Country	2012 ppm	Future Target	Location
Brazil	50	10	Major cities
	500	50	Metro Area
	1800	500	Nationwide
Mexico	15	15	Metro Area
	500	50	Nationwide
India	50		Major cities
	350		Metro Area
	500		Nationwide
US	15		Nationwide
Europe	10		Nationwide

Paper: Exhaust emission of Transit Bus - Embarq

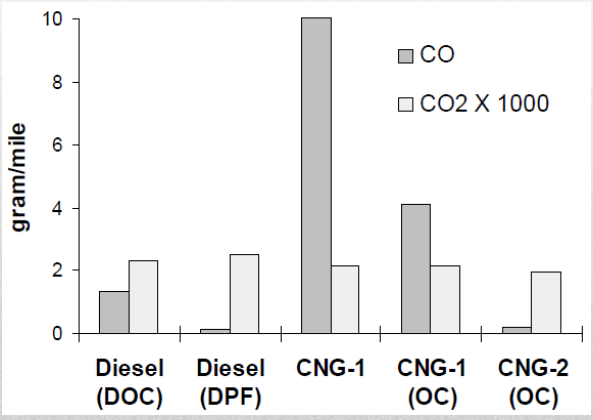
Brazil 2013 & UNEP 2012a, 2012b, 2012c

Vehicle Technology and Environment

Eq. CO2 and CO Emission during life cycle cost of **std diesel and CNG** – buses.

Most CO_2 emissions (GHG) are related to vehicle operation while CO emission is result of material production in life cycle cost.

CNG produces more CO in operations

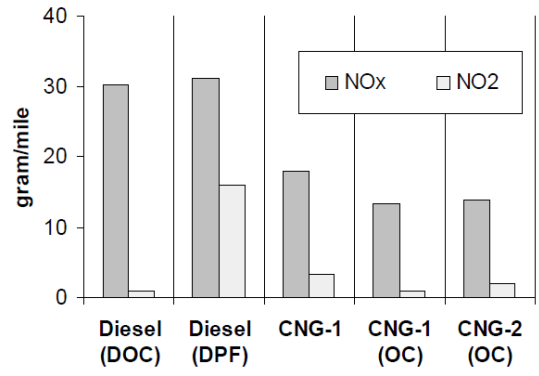


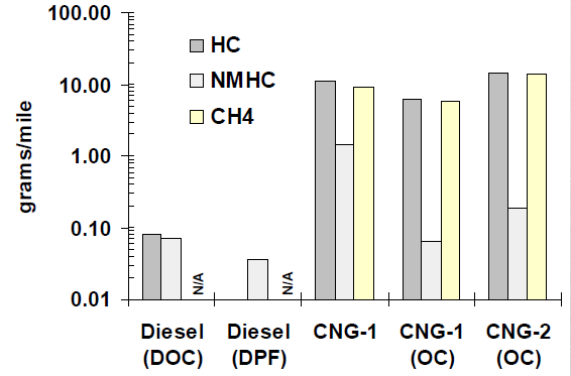
CNG and Diesel Transit Bus Emissions in Review - by California Environmental Protection Agency; Air Resource Board

Vehicle Technology and Environment

Eq. NOx and SOx Emission during life cycle cost of **std diesel** and CNG - heavy vehicle.

Diesel produces NOx more than CNG during vehicle operation while higher HC and methane emission is produced in CNG





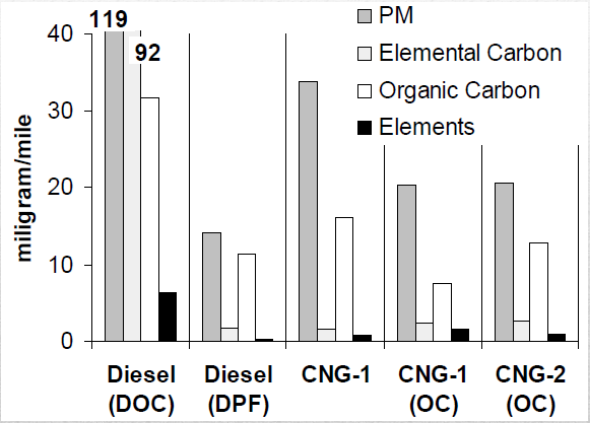
CNG and Diesel Transit Bus Emissions in Review - by California Environmental Protection Agency; Air resource Board

Vehicle Technology and Environment

Eq. PM Emission during life cycle cost of **std diesel and CNG** - heavy vehicle.

PM content are most emitted in vehicle assembly and material production

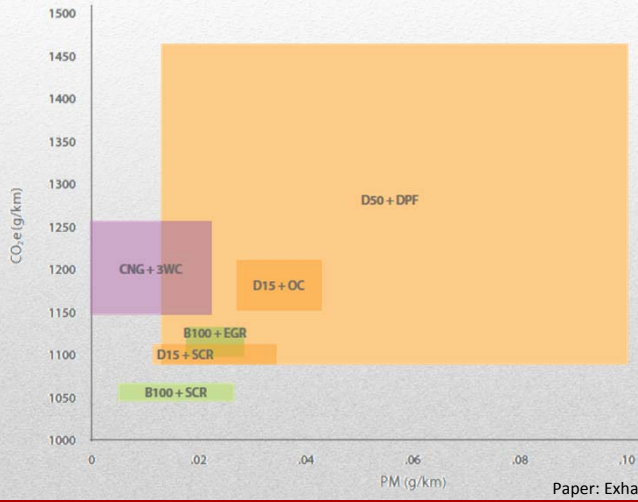
PM emission is high for diesel but with new technologies it is regulated than CNG.



CNG and Diesel Transit Bus Emissions in Review - by California Environmental Protection Agency; Air resource Board

Vehicle Technology and Environment

PM emission vs GHG emission

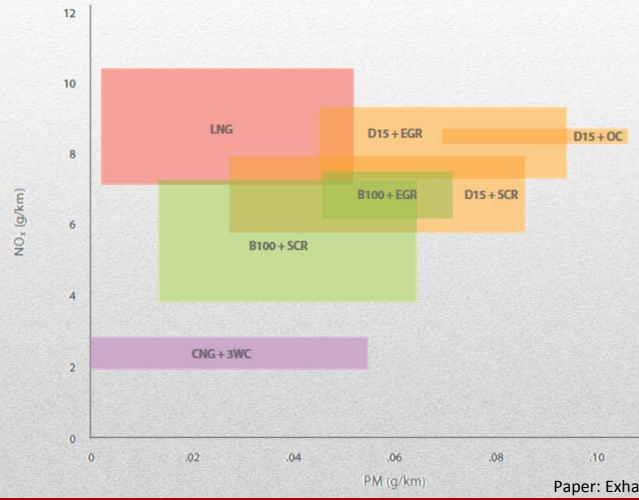


Diesel technologies are available with lower GHG emission than CNG and comparable PM emission

Paper: Exhaust emission of Transit Bus - Embarq

Vehicle Technology and Environment

PM emission vs NOx emission



Bio-diesel benefits over PM as well as NOx over standard diesel technologies whereas CNG better NOx emission

Paper: Exhaust emission of Transit Bus - Embarq

Vehicle Technology and Environment

Regulation norms have been developed for diesel engine technology

- Local pollutant regulations are existing two decades.
- Remarkable research in reducing pollutants seen in past decade
- Regulations of GHG emission are recent considerations

Emission norms for bus

Stage	Year	CO	HC	NOx	PM
		g/kwh			
Euro – 1	1992	8.1	1.98	14.40	0.648
Euro – 2	1998	7.2	1.98	12.60	0.270
Euro – 3	2000	3.8	1.19	9.00	0.180
Euro – 4	2005	2.7	0.83	6.30	0.036
Euro – 5	2008	2.7	0.83	3.60	0.036
Euro – 6	2013	2.7	0.23	0.72	0.018

Source: Lindqvist 2012.

Fuel Energy Content

Diesel remains as most preferred fuel by urban local authorities / operators as it has high energy density; i.e. more mileage.

Bio-diesel also has high energy content

Energy content in fuel

Fuel Type	Energy content	Fuel efficiency
Diesel	128,000 – 130,000 BTU	3.2 mile/DGE
Bio-diesel	117,000 – 120,000 BTU	3.3 mile/DGE
CNG	33,000 – 44,000 BTU	2.7 mile/DGE
LNG	≈ 73,500 BTU	2.7 mile/DGE
Hydrogen	≈ 6,500 – 16,000 BTU	2.7 mile/DGE

Source: Department of Energy 2012 & TCRP 2011

BTU – British Thermal Unit; DGE – Diesel Gallon Equivalant

Comparative Statement – Fuel Technology

Comparison of Fuel Technology - 1

Diesel	CNG	Bio-methane / Biogas	Bio-diesel / FAME
Non-renewable	Non-renewable	Renewable fuel	Renewable fuel
		Fuel price depends on production cycle and supply chain	Fuel price depends on production cycle and supply chain
		Production volume is relatively smaller to input	
Established market & relevant infrastructure	Established market & relevant infrastructure	Technology similar to CNG; makeover in market easier	

Extract from Clean Buses – Experiences with Fuel and Technology Options: by- clean fleets - 2014

Centre of Excellence in Urban Transport, CEPT University

Comparative Statement – Fuel Technology

Comparison of Fuel Technology - 1

Diesel	CNG	Bio-methane / Biogas	Bio-diesel / FAME
	Major saving in PM and NOx emission compared to diesel	Significant savings on CO_2 emissions PM emission are	Significant savings on CO_2 emissions Significant savings