

# Vehicle Technology Improvements: Current and Future

Anup Bandivadekar

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# What has been accomplished as a result of Auto Fuel Policy of 2003, and what is ahead?

- Vehicle emission standards and fuel quality standards implemented more or less as per schedule
- Use of CNG and LPG has increased, especially in city buses and autorickshaws
- Comprehensive long term program for zero emission vehicles not in place
  - Partial efforts along the lines of National Hydrogen Energy Roadmap, and recently formulated National Mission on Electric Mobility
- Little progress on improving I&M program
  - 10 testing centers to be set up by ARAI by 2012
- Little rigorous testing of fuel quality supplied around the country
- Administered Pricing Mechanism for fuels not completely dismantled
- Source Apportionment Studies in Six Cities conducted

## 2-3 wheelers are more than 3/4<sup>th</sup> of the vehicle stock, and have a major impact on emissions

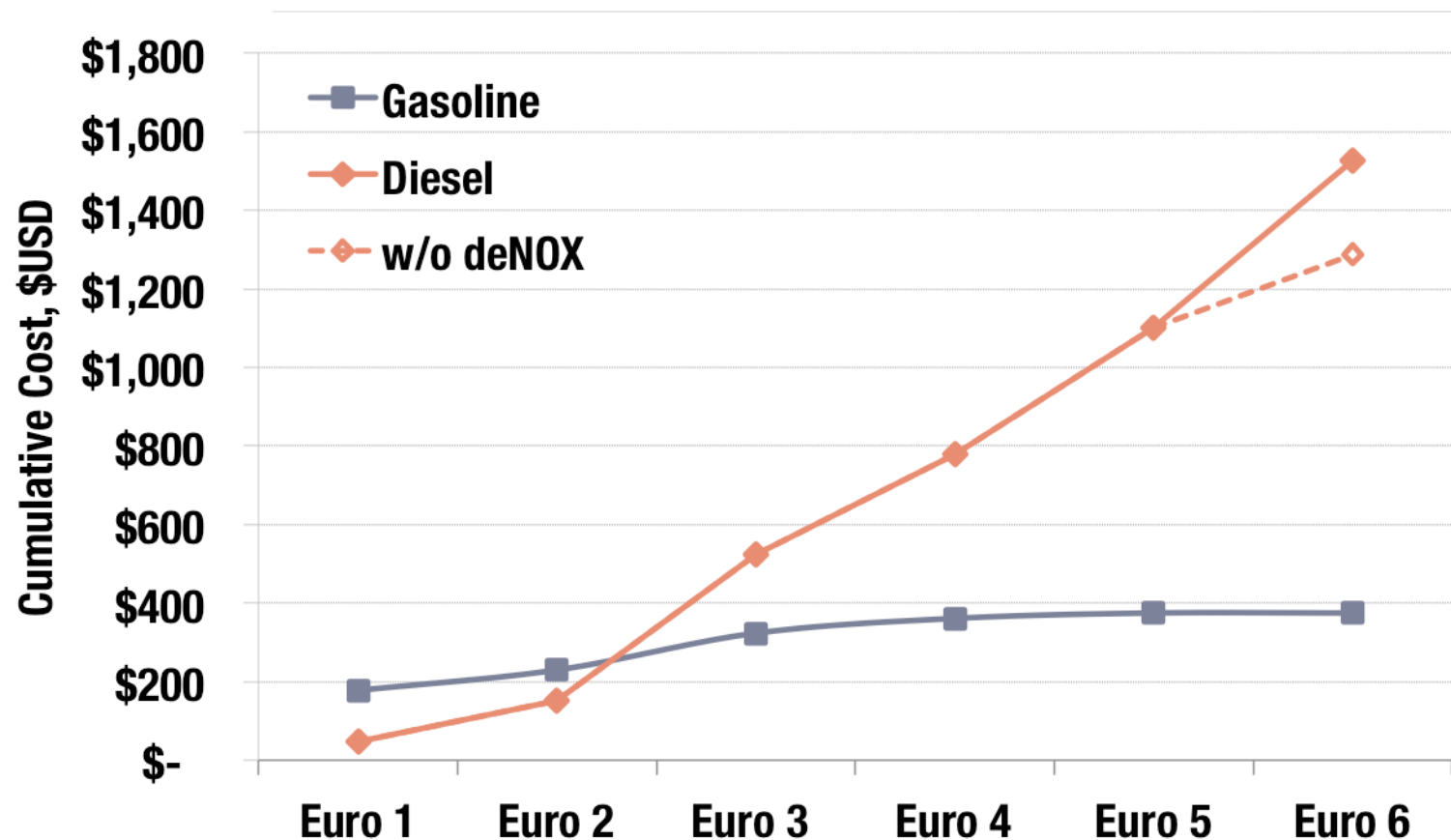
- Present Bharat III standards for motorcycles based in Indian Driving Cycle (IDC)
  - GTR2 draft released, not yet adopted.
  - WMTC use not mandatory until after 2015
- Combined HC+NO<sub>x</sub> limit in India as opposed to separate NO<sub>x</sub> limit
  - Lean operation in India reduces HC emissions and improved fuel economy
  - Limited use of fuel injection on motorcycles and three-wheelers so far
- No evaporative emission limits until 2015?
- By 2020, 2-3 wheeler emission standards in EU will match the nominal values of passenger-car Euro 5 limits.

## Light-duty passenger and commercial vehicles are growing at a robust rate

- While India follows Euro Path, not all elements of the program are harmonized with Euro
  - Indian test cycle uses EUDC for low-powered vehicles which limits top-speed to 90 km/h
    - While vehicles in India are have lower power than in EU, high speed operation becoming more common with highway and expressway expansion
  - M1 regulation applies to vehicles with 6 seats only instead of 9
- Evaporative emissions (mainly a problem of gasoline vehicles) can be controlled using on-board refueling vapor recovery (ORVR) systems
  - Evaporative emissions become more important as exhaust HC emissions decrease
  - Europe following stage II controls which may be a costlier option

# Most of the hard work already done for Bharat IV petrol vehicles, but challenges remain for Diesel vehicles

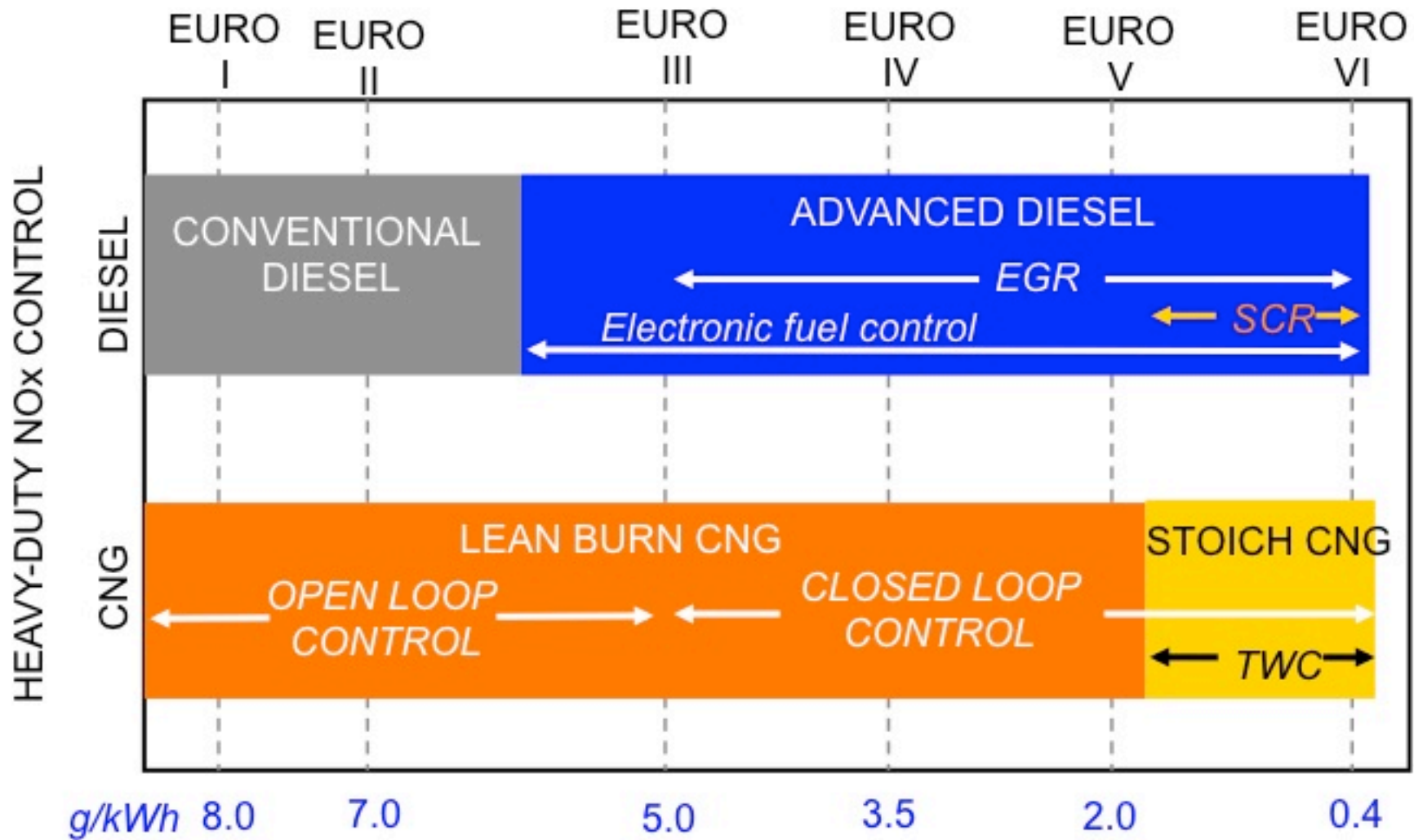
Once Bharat V/VI standards are adopted, diesels can realize their full potential in terms of reducing energy consumption and carbon emissions.



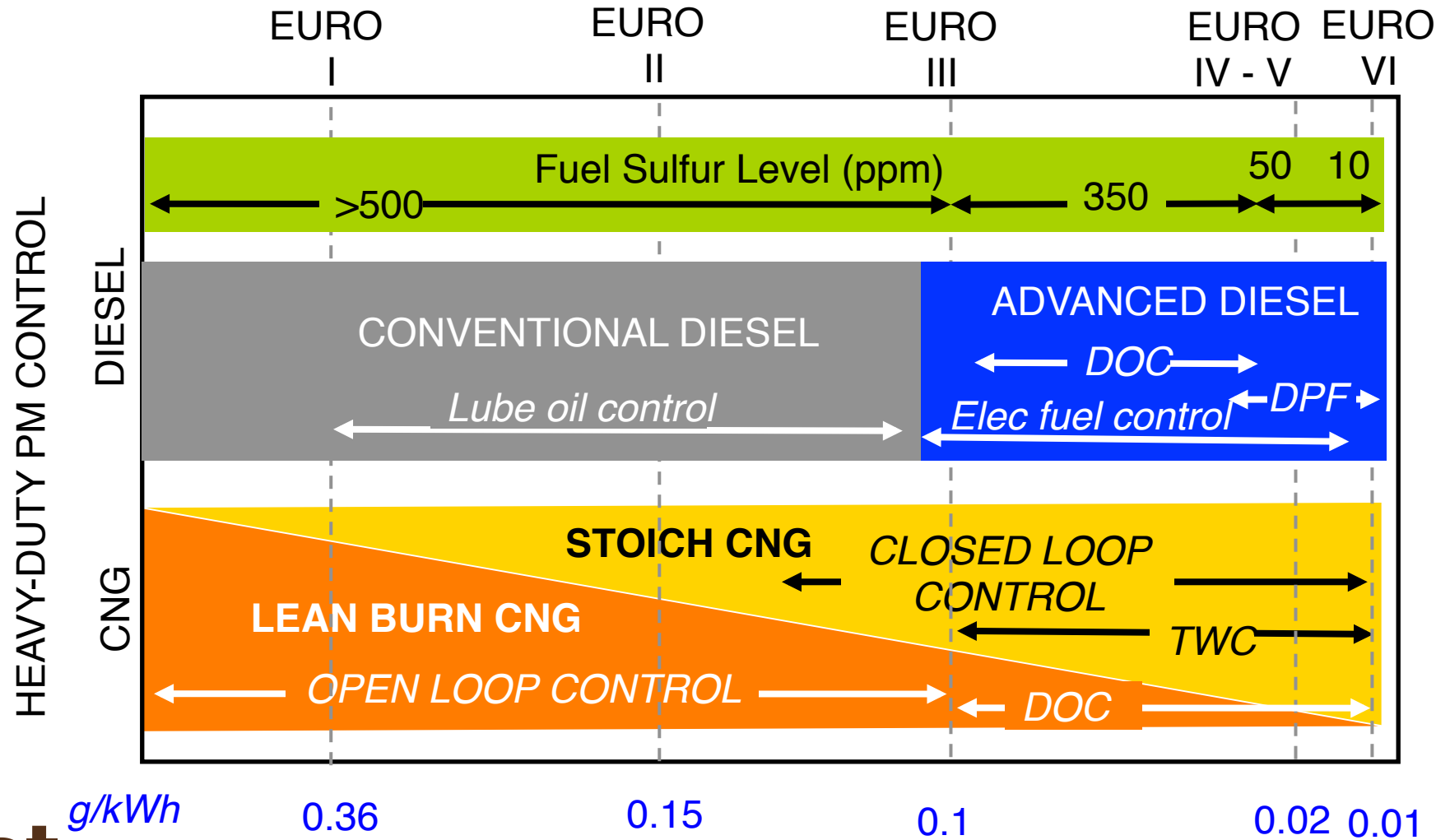
# One Country, One Fuel Quality, and One Regulation?

- Operation of wall-flow diesel particulate filters required for Bharat V needs <50ppm sulfur fuel countrywide (10ppm is ideal)
- Selective Catalytic Reduction (SCR) systems deployed for Bharat IV/V heavy-duty application can be most effective with zeolite catalysts, which may not work well with dual fuel sulfur
  - Vanadium catalysts may have better sulfur tolerance, but may face challenges in low-speed urban traffic
- Availability of <50 ppm sulfur fuel countrywide opens up the possibility of leapfrogging to Euro VI standards, although 10 ppm sulfur fuels needed countrywide eventually for optimal performance of after-treatment devices

# HD CNG and Diesel NOx Control Pathway



# HD CNG and Diesel PM Control Pathway





# Key Technologies to meet Euro V/VI equivalent Standards

Vehicle Category	Key Technologies to meet Euro V/VI equivalent standards
Gasoline 2/3 wheelers	Closed loop oxygen sensor and three way catalyst
Diesel 3-wheelers	Oxidation catalyst to reduce PM emissions
Gasoline Light-duty vehicles	Continued improvements in air-fuel management systems and three-way catalyst performance
Diesel Light-duty vehicles	High pressure fuel injection systems, Diesel Particulate Filters (DPFs), and Lean NOx Traps (LNTs) or SCR
Diesel Heavy-duty vehicles/equipment	Exhaust gas recirculation (EGR), selective catalytic reduction (SCR), and Diesel Particulate Filters (DPFs)

Fuel economy of many vehicles improved as newer engines were introduced to meet Bharat IV standards in 2010. Similar fuel economy benefits will be realized as well as engine technology improves in the future.

# Proposed LEV III Standards in California

- SULEV on path to be AVERAGE by 2022
  - 73% reduction from 2008 average!
- A more stringent combined NMOG+NOx standard for both light and medium duty vehicles for MY 2014-2022
- Increase the durability requirements for emission control systems from 120,000 to 150,000 miles
- PM emissions from 10 mg/mi to proposed 3-1 mg/mi
  - A particle number standard is also under consideration
- Near zero evaporative emission expected even on E10 vehicles

# Air Quality related goals in China's 12<sup>th</sup> Five Year Plan

- Vehicles
  - Establish a passenger vehicle fuel economy standard of 7 liters per 100 kilometers (33.6 miles per gallon)
  - Improve heavy-duty vehicle fuel economy 11 percent
  - Improve light-duty commercial vehicle fuel economy 15 percent
  - Establish vehicle pollution supervision centers in 31 provinces
  
- Air Quality
  - Reduce total emissions of sulfur dioxide by 8 percent and nitrogen oxides by 10 percent
  - Fully develop and implement the regional air quality management mechanism issued in 2010
  - Ensure that at least 230 cities meet the World Health Organization's Grade II air quality standards
  - Strengthen environmental enforcement

# China moving ahead with Euro V equivalent standards

- Light-duty vehicles (LDV):
  - China V standards proposed in March 2011; to be implemented from January 1, 2016
  - Beijing plans advanced implementation of China V in 2012
  - Proposed test cycle and emission limits same as Euro 5b, but no particulate number (PN) requirements yet
  - Draft OBD requirements same as Euro 5+, but do not include the requirements for in-use performance ratio and “access to vehicle OBD and vehicle repair and maintenance information”
- Heavy-duty diesel vehicles (HDDV):
  - Same test cycle and emissions limit as Euro V; less stringent durability requirements
  - Implementation likely to be delayed from the previously planned January 1, 2012
- Fuel quality also a challenge for China

# Roadmap for the next decade is missing

- Auto Fuel Policy of 2003 recommended revision every five years
  - Need to continue to treat vehicle and fuel as a system, fuel quality improvements critical for next phase of standards
- Long term roadmap needed quickly to give industry adequate lead-time
  - Technology already in the market, but on limited models in India

Anup Bandivadekar

International Council on Clean Transportation (ICCT)

1225 Eye St. NW

Suite 900

Washington D.C. 20005

anup “at” theicct.org