Reduction of particle emission from diesel vehicles (Public Transport and Freight) Alternatives for Mexico City

Sustainable Solutions for Powering Transit Buses

Jennifer Hodson

Marketing Director – Global Bus and Natural Gas

Mexico City

September 26th, 2016

Agenda

- Cummins in Public Transit Bus Market
- Solutions Portfolio
- A Portfolio Approach to Clean Propulsion

Cummins Bus Engine Business Facts

Smart Efficiency

97

Years of experience in the engine business

Transporting

2B+

passengers daily

Powering buses in Mexico since

1965

Smart Efficiency

Focus on Sustainability, Uptime & TCO

Engines shipped to over **140** countries

#1

Bus engine supplier in the world

Unparalleled Global Support Network

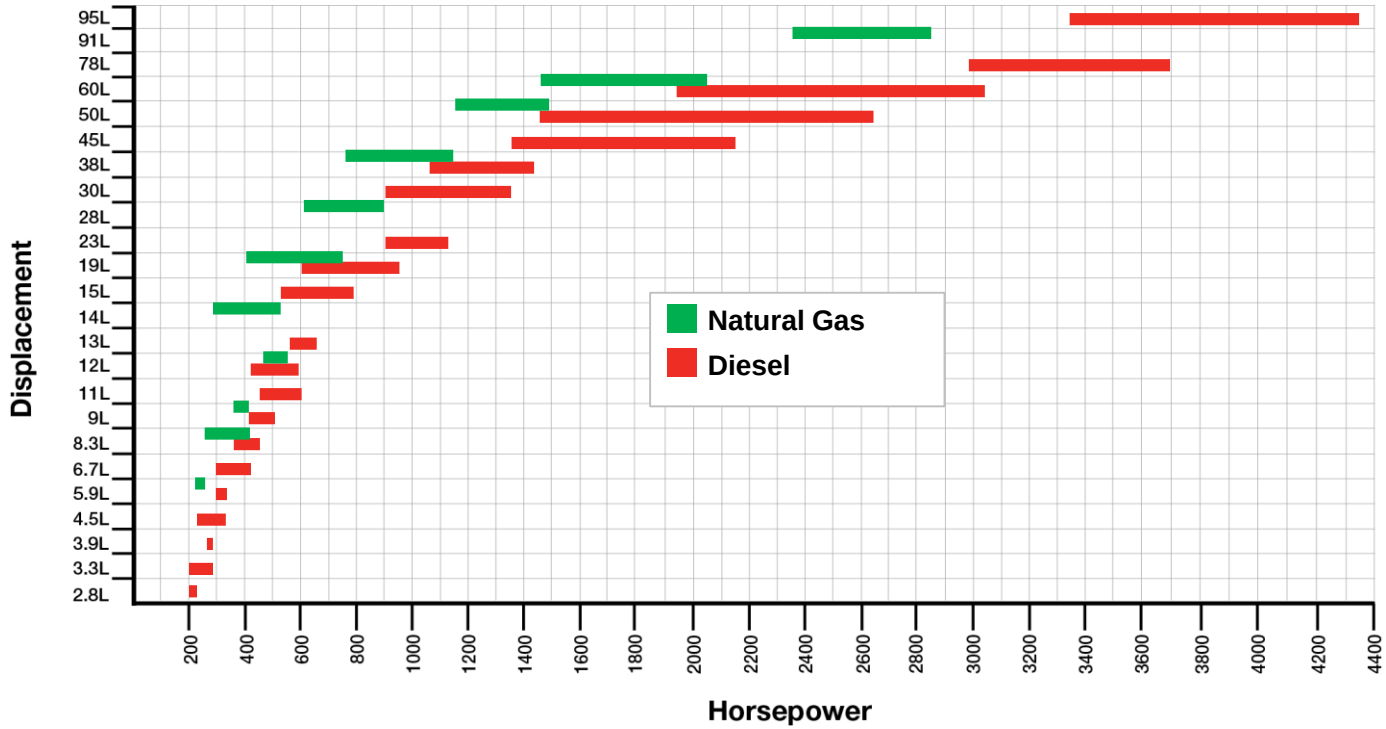
190+

countries

1/4

Of the world's bus needs served in 2015

Broad Product Range



Bus Market Megatrends

Smart Efficiency

Urbanization

Public transit solutions to combat urban clogging

Alt Energy

Sustainability has taken center-stage

Connectivity

Real Time Fleet and Route Management.

Export

Exports across regions by both developed and emerging market players

Cummins Global Transit Bus Initiative

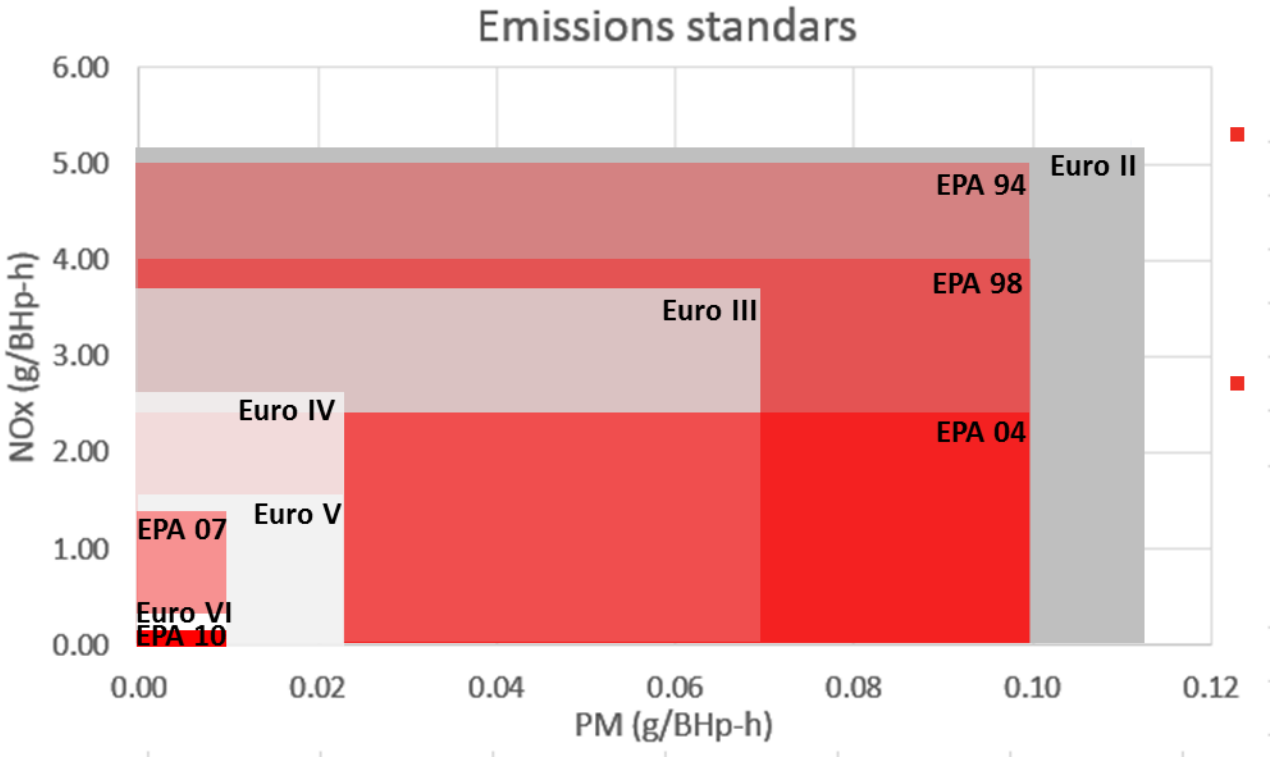
Environmental Sustainability

Lower Total Cost of Ownership

Improved Uptime

Focus is **close partnership with customers** to understand their business and **optimize** our products for their **specific applications and duty cycles.** Scope includes optimized calibrations, product tailoring with improved power and torque, mild-hybrid technologies, integrated powertrains and an expanded lineup of alternative-energy products.

Emission Standard Evolution



- Reduction of pollutants
  - Close to 99% reduction with more stringent emission standards
- EPA 2010 technology
  - Offers additional reduction of NOx compared to Euro VI

Diesel Start / Stop

- Optimized for Bus Duty Cycle
- Proven durability
  - Over 4M Start/Stop events accumulated
  - 680 Start/Stop units in service
- Proven reduction in fuel consumption and CO2 emissions
- 30-40% reduction in NOx emission
- Improved passenger and pedestrian comfort
- Flexible architecture to meet customer and operator needs
- Short payback period

Start/Stop Technology

Diesel Hybrid

- Mainstream product in NA and Europe
- Engine downsizing
  - B4.5 Euro 6 powering double decker bus
- Two systems
  - Engine is a back up for electric system
- Long route capability
- No infrastructure investment required

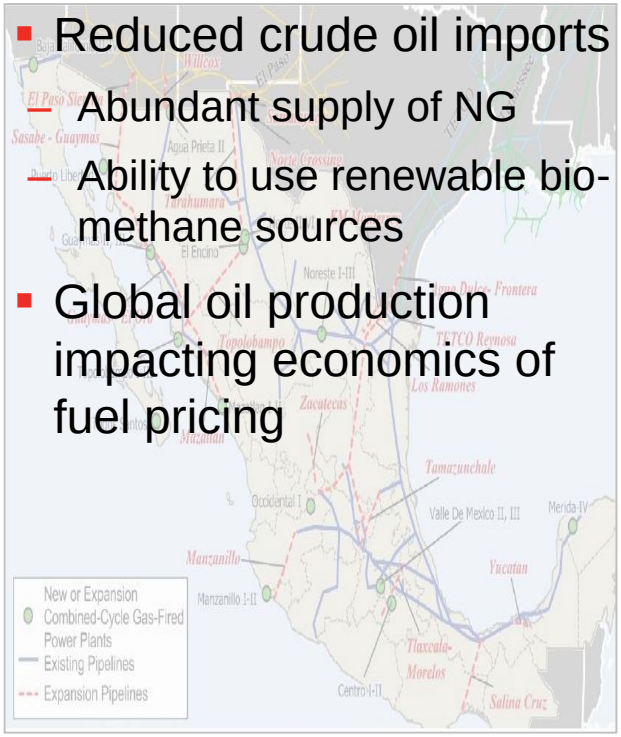
Natural Gas

Economics

- NG price less than diesel
  - However payback impacted
    - Fuel price differential
    - Fuel Usage
- NG vehicle premiums justified by fuel savings

Energy Policy

- Reduced crude oil imports
  - Abundant supply of NG
  - Ability to use renewable bio-methane sources
- Global oil production impacting economics of fuel pricing



Environment

- Adopting fleets increasing access to “green minded” customers, edge in niche markets
- Meets or exceeds GHG emission reductions

Near Zero Natural Gas

- Ability to meet Near Zero Emissions
  - ARB requires to certify at 0.02
    - Near Zero ISL G is certified to 0.01
  - 90% reduction from current EPA of 0.2 g/bhp-hr
- Low emission internal combustion technology
  - Competitive with electric, hybrids, and fuel cells
- Based on current ISL G architecture
- Maintenance free aftertreatment
  - 3-way catalyst

ISL G NEAR ZERO

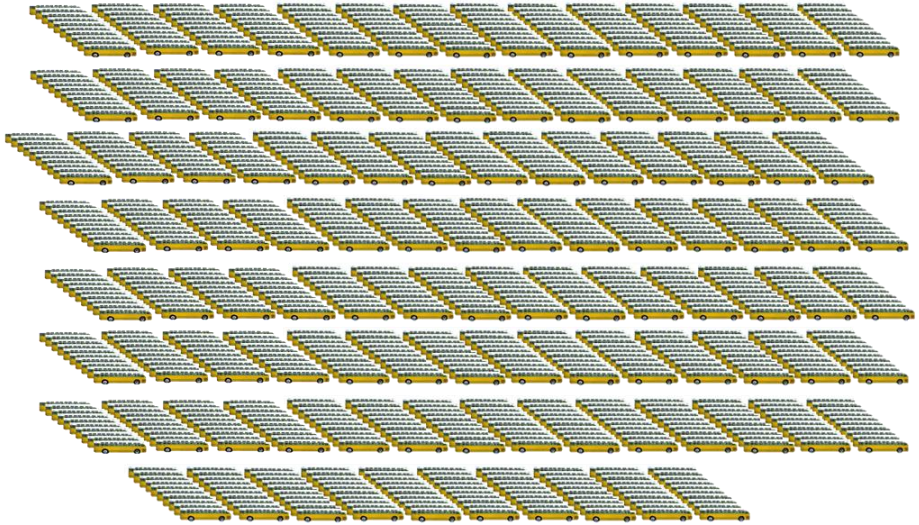
Near Zero Natural Gas

Smart Efficiency

Near Zero - How Much NOx is Reduced?

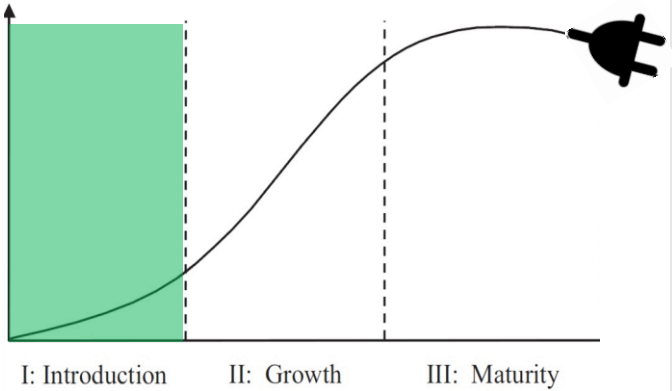
One 1985 engine emits the same NOx as **1080** ISL G Near Zero engines

=



Emissions year	NOx Standard g/bhp-hr.	Equivalent Number of Vehicles
Base = 1985	10.8	1
2010	0.2	54
2016	0.02	540
ISL G Near Zero	0.01	1080

Electrification



- Not the future, a reality today
- Wide-spread interest at transit authorities
  - Urban pollution is primary driver of interest
- Battery technology has developed but still relatively new
  - Electric buses are still highly reliant on government funding
- Must consider TCO in a different way
- Duty cycle/route analysis must be complete to determine impact on fleet

SmartChoice

A Portfolio Approach to Clean Propulsion

A Program of Smart Efficiency

SmartChoice

Smart Efficiency

What Do You Value Most In Your Solution? Choose Your Key Enablers.

Life of Bus	Clean Air	Low Maintenance	New Technology	In Route or Depot Ability
Lower Initial Investment	Emission Standards	Cummins	Connectivity	TCO
Mileage Range	Lower Nox	Uptime	Noise Pollution	Infrastructure

The Right Momentum