

Westport
INNOVATIONS INC.

Energy 2003

How do you see the future?





Powering the Planet - Protecting the Dream





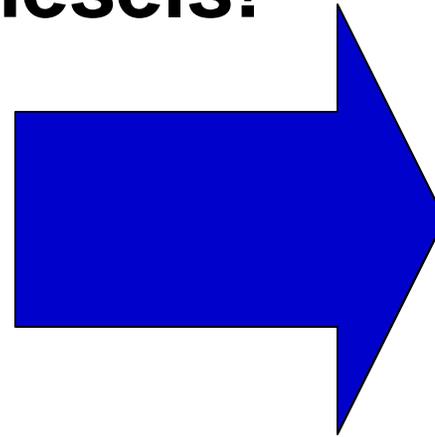
THE CUMMINS DIESEL
*"Twice as Far for
Half as Much"*

Powering the Planet - Protecting the Dream 

Emissions Laws Will Get Tougher

- **This is a big deal for diesels!**

- More expensive
- More complex
- Reduced fuel economy
- Reduced performance



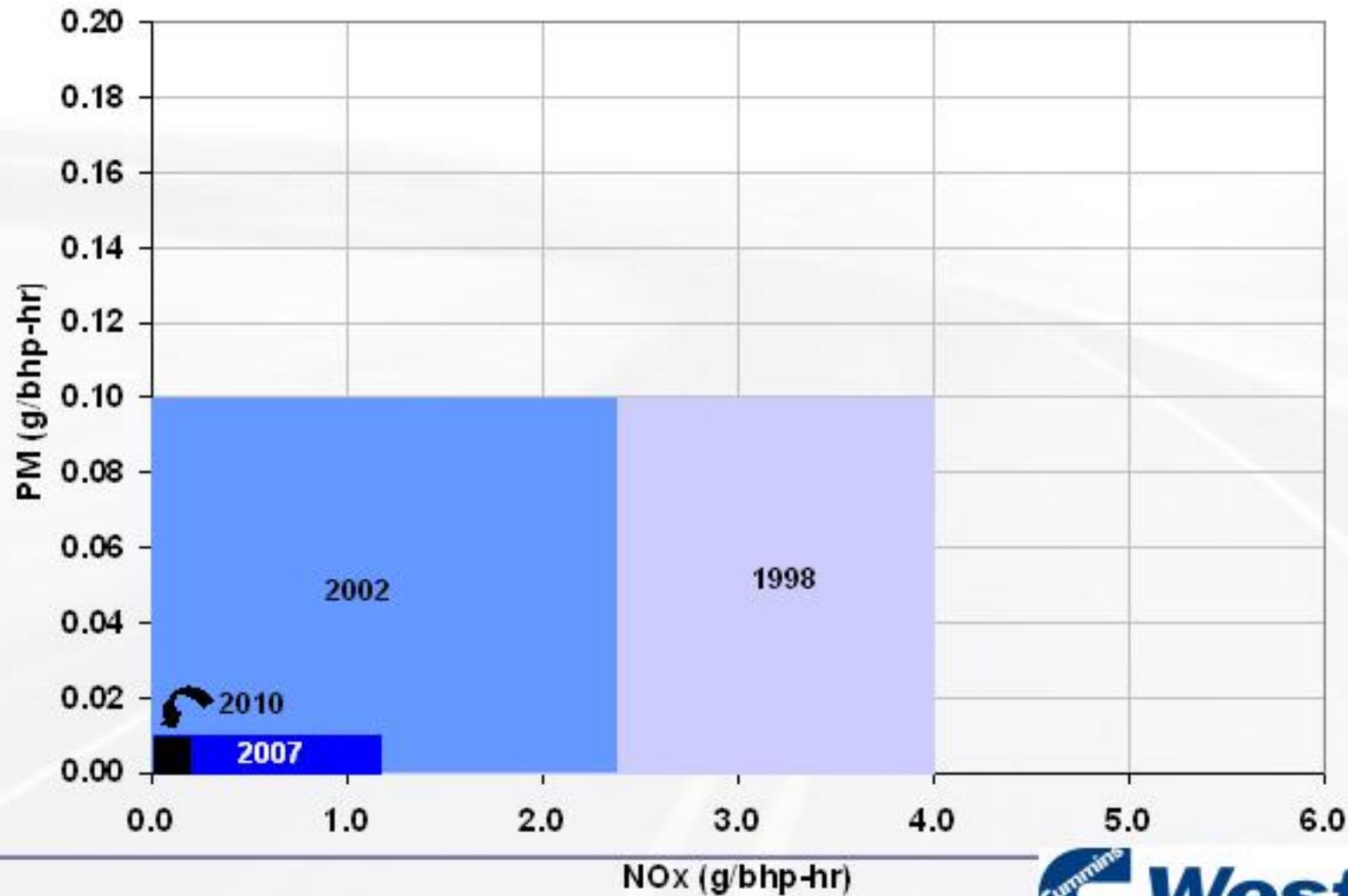
Started
10/02

- Hard to see a technology road map beyond 2010





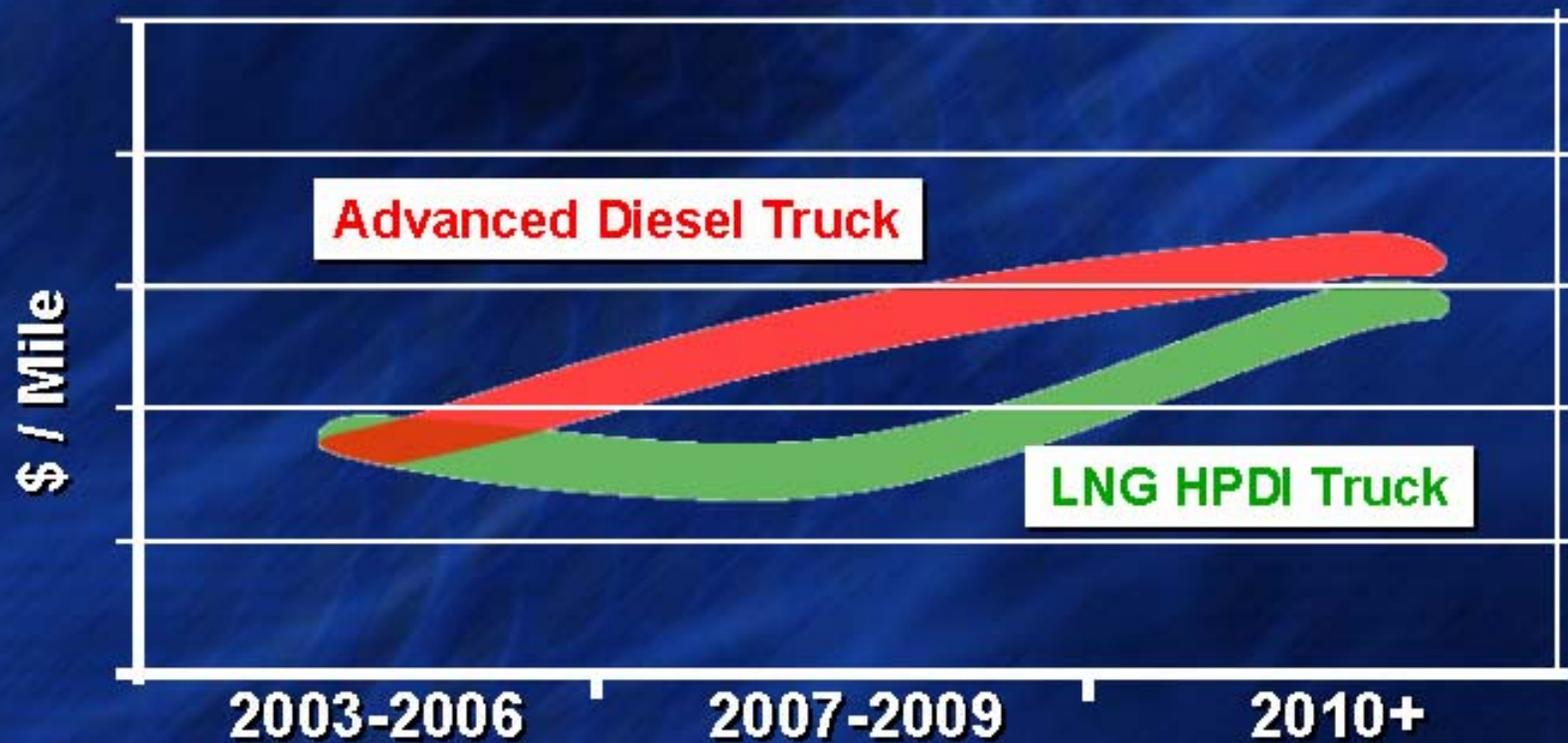
US HD Truck Standards



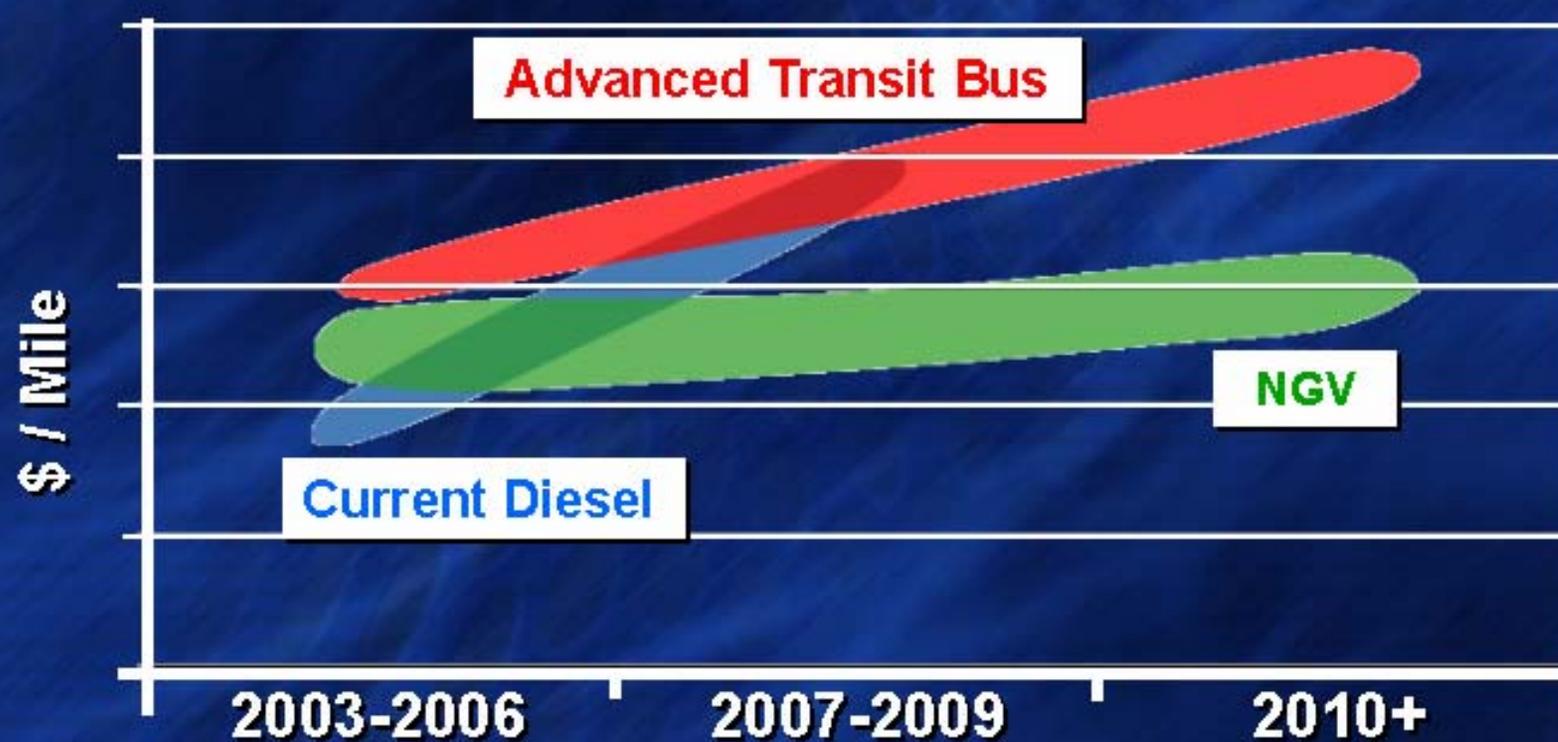
No easy solutions..Sooner or later

In-cylinder – Exhaust Gas Recirculation (EGR)	Introduced on Light-Duty, Heavy-Duty for EPA 2002, improves NOx, worsens PM
In-cylinder – Change the fuel	Synthetic fuels; biofuels; water blends; expensive, limited emissions reduction
In-cylinder - Change the operating cycle to spark ignition or dual fuel	Highly effective in many applications but do not match diesel performance and efficiency.
External - Clean up the exhaust	No good solution for NOx today. Affects durability and efficiency. Will be needed by end of decade.
Change to new technologies – fuel cells, hybrids	If all technical and infrastructure issues resolved, high costs remains a problem, especially in commercial applications

HD Cost/Mile Trends



Transit Cost / Mile Trends



10 Reasons To Be Bullish About N/Gas

1: Concern About Air Quality is Growing

Urban Pollution

Global Warming



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10 Reasons To Be Bullish About N/Gas

2: Emissions Laws Will Get Tougher

- **EPA & Euro will squeeze allowable emissions:**
 - NOx - smog
 - PM - health issues
 - CO2 - global warming
- **U.S. EPA NOx standard (g/hp hr)**
 - 2002 2.5g
 - 2007 1.2g
 - 2010 0.2g Proposed



10 Reasons To Be Bullish About N/Gas

3: Many Regions Will Go Further than the Legal Minimum with a Stick or Carrot

- **Mandates or regional rules will be more common**
 - Like AQMD 1190 rules
 - » NO diesel school buses or refuse trucks in Southern California
- **Incentives will increase & more programs to help adoption:**
 - California Moyer Fund
 - U.S. federal bus funding pays 80% for clean buses
 - Powershift in U.K. pays 75%
 - Proposed US Clear Act



10 Reasons To Be Bullish About N/Gas

4: Natural Gas Infrastructure is Improving

- More Fuel stations
- Long run economics look good
- LNG market is emerging:
 - more range
 - lower tank & vehicle cost



10 Reasons To Be Bullish About N/Gas

5: NG Engine Technology is Getting Better

There's very few problems with natural gas power that can't be solved by just building better engines

- **Current reliability is 3X better than 1995**
- **Finally more customers are satisfied than mad**



10 Reasons To Be Bullish About N/Gas

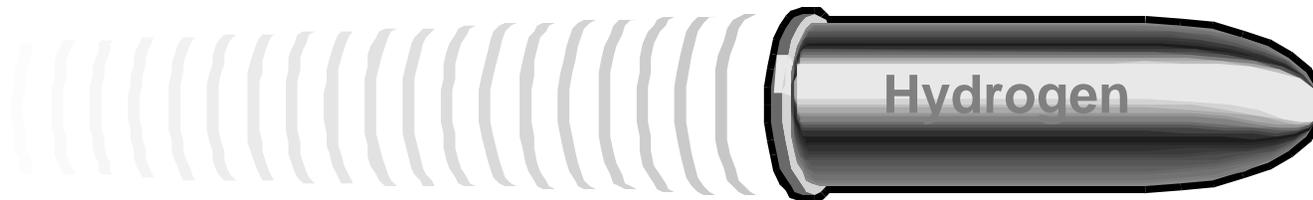
6: Nat Gas Trucks are Finally Available

- **Technology has no value if you can't buy it**
 - Autocar - available today
 - Freightliner Condor - available today
 - Freightliner Business Class - available soon
 - Peterbilt 320 - being evaluated



10 Reasons To Be Bullish About N/Gas

7: The Silver Bullet of Alternate Technologies is Pretty Slow



Hydrogen is very compelling, but issues like economics / technology / availability = TIME



10 Reasons To Be Bullish About N/Gas

8: Reciprocating Engines Will be Hard to Beat

- **The economics for reciprocating internal combustion engines are undisputed**
 - Cost effective & productive
- **Advanced reciprocating technology can offer very low emissions, e.g.. HYBRIDS**
 - Diesel hybrids make great sense
 - Natural gas hybrids make even more sense
- **“Well to Wheels”, “recips” are pretty good**



10 Reasons To Be Bullish About N/Gas

9: Natural gas is the ideal reciprocating engine fuel

- Clean, Abundant & Economic
- Lowest carbon fuel
 - 50 % lower NOx
 - 90 % lower PM
- May be our best alternative for energy security
- May be the path to the Hydrogen economy:
 - » Short term
 - » Natural Gas infrastructure
 - » Natural gas in reciprocating internal combustion engines



10 Reasons To Be Bullish About N/Gas

10: Cummins Westport Commitment

1. Continue the development of spark ignited natural gas engines 150 – 320 hp



Available TODAY

2. Develop new Westport cycle technology for larger HD engines of 400 - 550 Plus Horsepower

Available 2004



Powering the Planet - Protecting the Dream

Cummins Westport Inc

- **50 / 50 Joint Venture formed
March, 2001**
- **Cummins**
 - World's largest builder of commercial diesels
 - +26,000 employees
- **Westport**
 - Small incubation technology company focused on natural gas
 - 200 employees



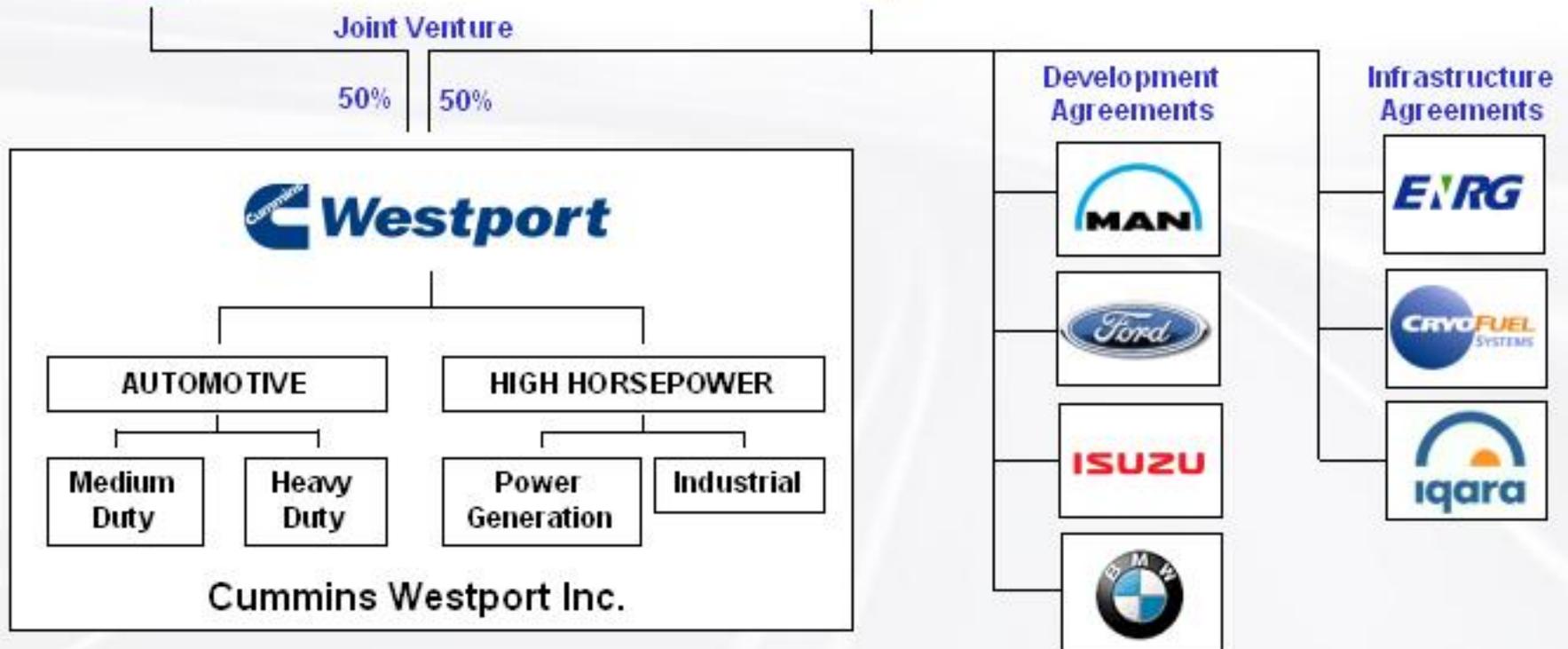
Powering the Planet - Protecting



Westport Relationships



Westport



Westport's Views

- Diesel engines will continue to dominate commercial transportation and power generation markets for the foreseeable future
- Diesel fuel's environmental challenges are real and difficult; but will be solved – at a cost
- But leading customers have already begun the shift to natural gas fuel in many geographic markets
- *An historic opportunity to change the market over the next decade*



The Joint Venture's Mission

Big in Clean Power

Powering the Planet - Protecting the Dream



The JV's Mission

Big in Clean Power

- A. Make the existing spark-ignited natural gas business work today**

- B. Develop the new Westport HPDI Technology for the future**



Westport's HPDI Approach

Keep the diesel engine - - -

**Change the fuel with HPDI
“plug-in” natural gas injection.**



HPDI Technology Proposition

HEAVY DUTY: YOU CAN HAVE IT ALL!

– Low Emissions

Natural Gas

– High Performance/BMEP

Like a Diesel

package & performance

– High Efficiency

Same as diesel, better than Spark Ignited, better than “Dual Fuel”

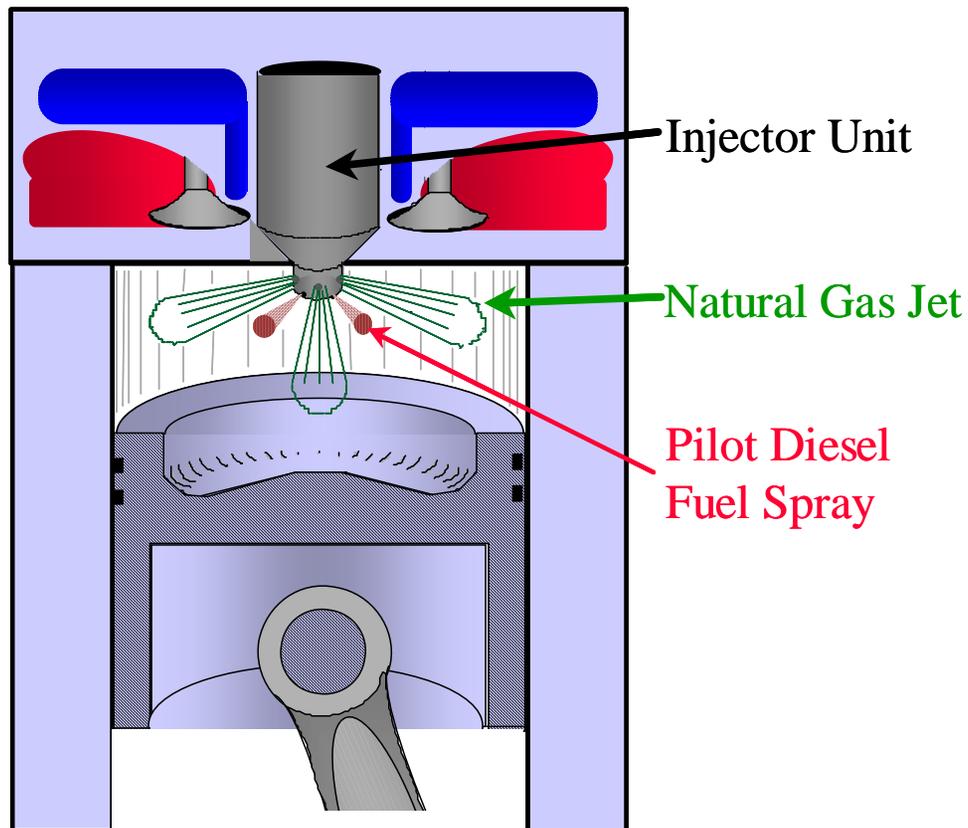
– Economic Payback

Fuel Saving – 2-3 yr payback

Low Maintenance -no spark plugs



Direct Injection Technology

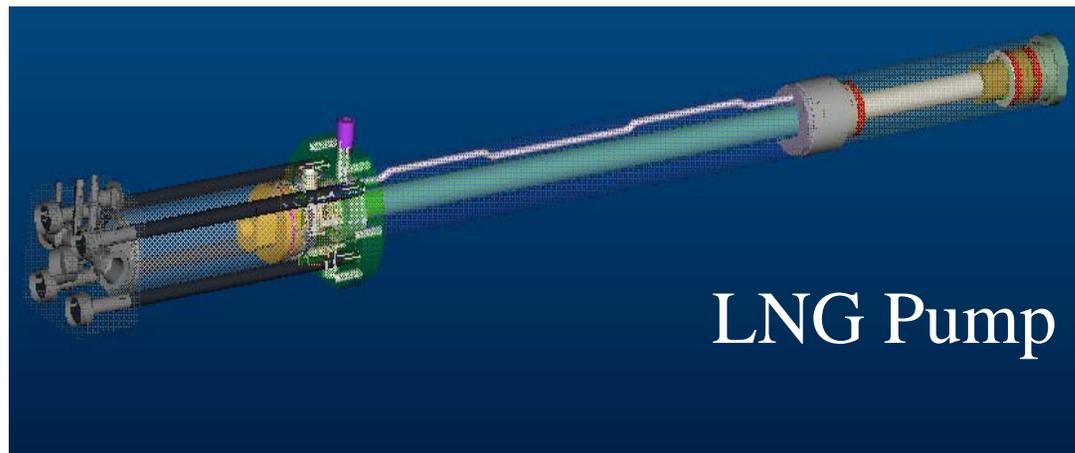
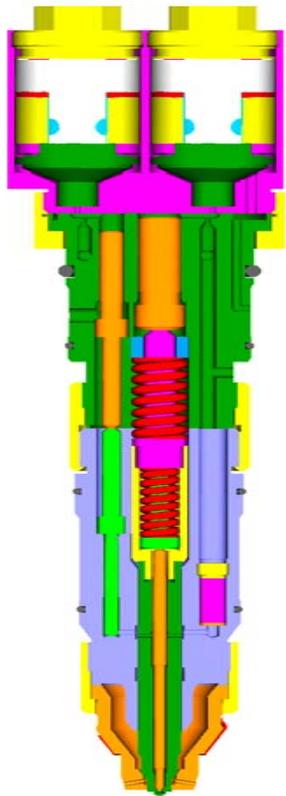


High-Pressure Direct Injection

- Natural gas injected at hi pressure
- Pilot diesel injected for ignition
- Engine remains the same:
 - Same power and torque
 - Same high efficiency
 - Diesel cycle, not Otto cycle
 - not knock limited
 - not sensitive to natural gas
- 40% less NO_x
- 60% less PM
- 20% less CO₂

Average 95% Natural Gas

Key HPDI Components



Electronic
Control Module

- HPDI Injector similar in design to diesel injector



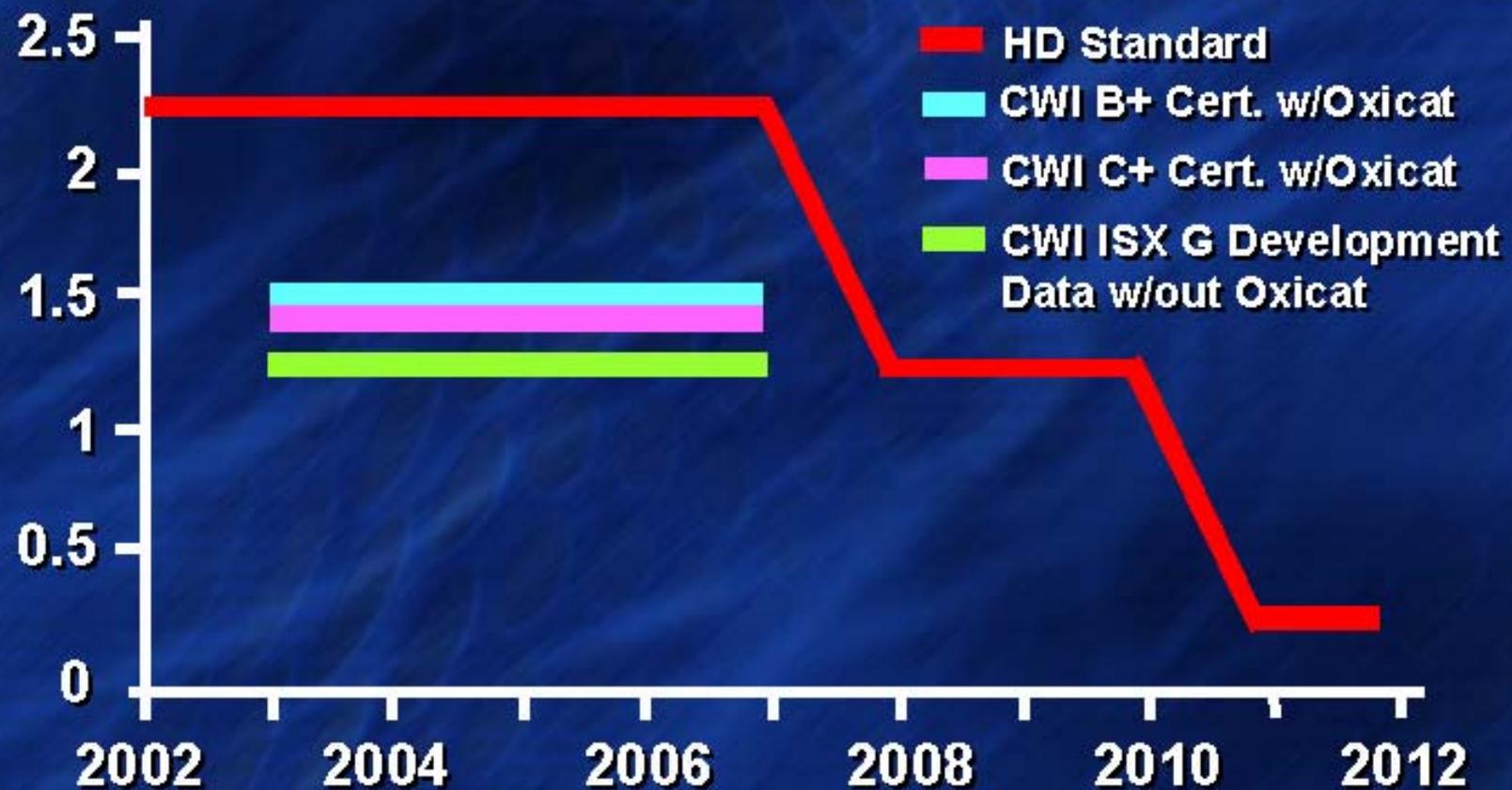
HPDI Technology is Real



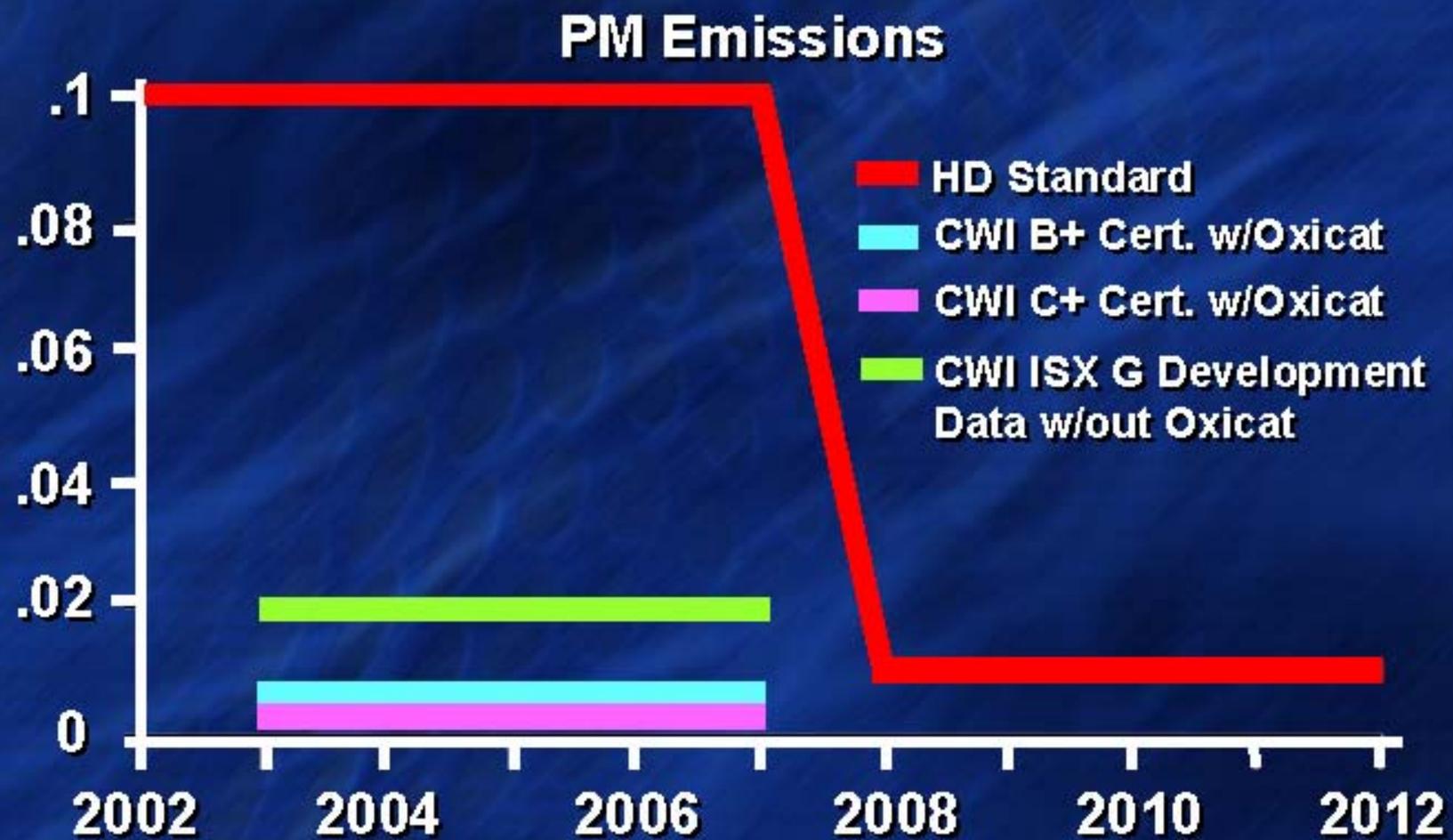
HPDI version of ISX-400 (1450 ft-lbs)

- 2000 - Engineering Truck
- Jan 01 - Delivered Raley's Truck (KW T-800)
- Feb 01 - Certified to CARB Optional low NOx (2.5g) emissions standard
- Mar 01 - Delivered Bobell Truck (KW T-800)
- 3Q01 - 14 trucks to Norcal Waste Systems in San Francisco (Peterbilt 378)

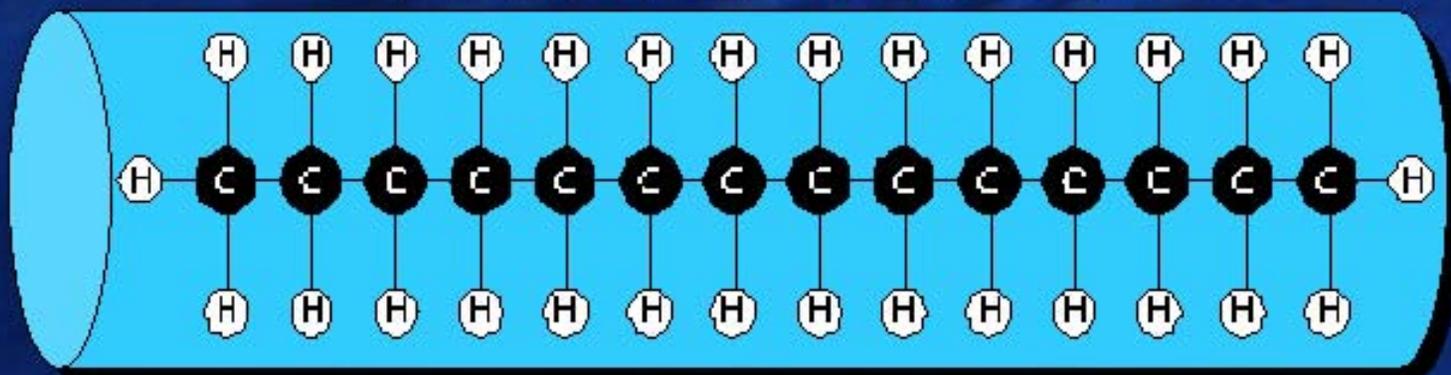
40% Lower NOx



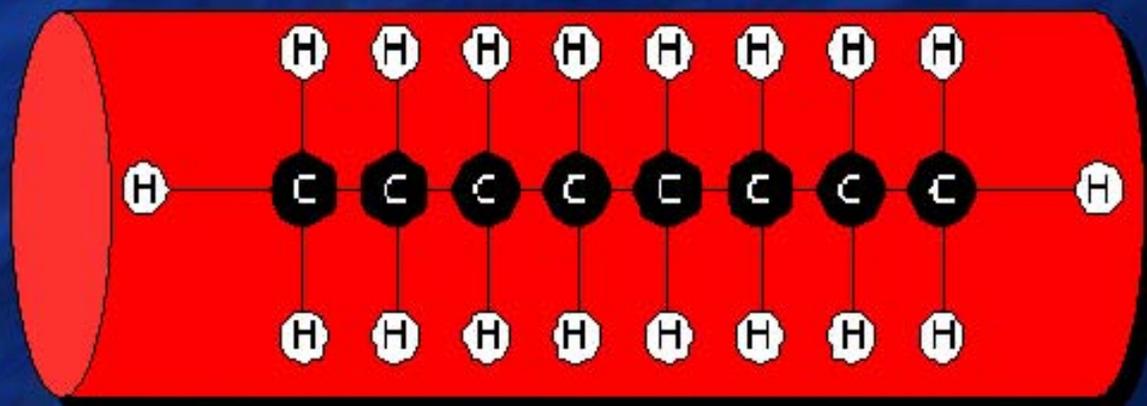
95% Lower Particulate



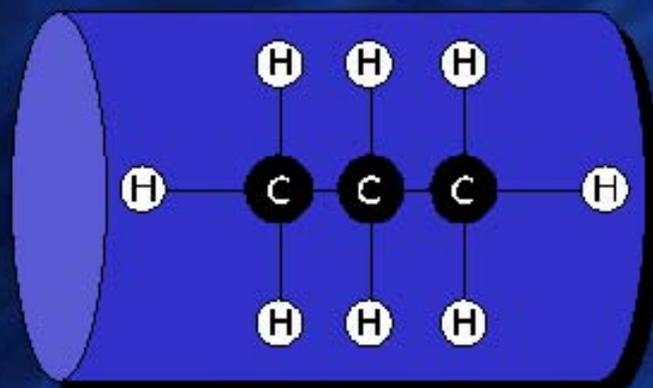
Diesel $C_{14}H_{30}$



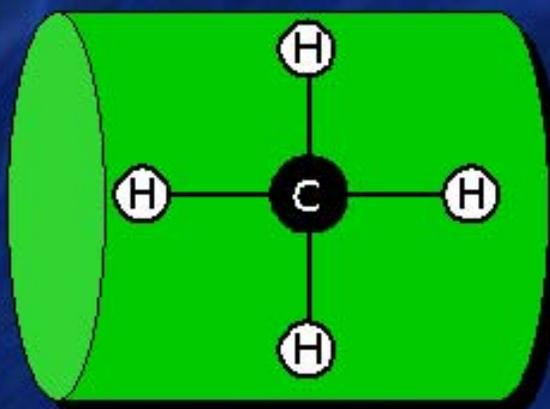
Gasoline C_8H_{18}



Propane (LPG) C_3H_8



Methane CH_4



The JV's Mission

Big in Clean Power

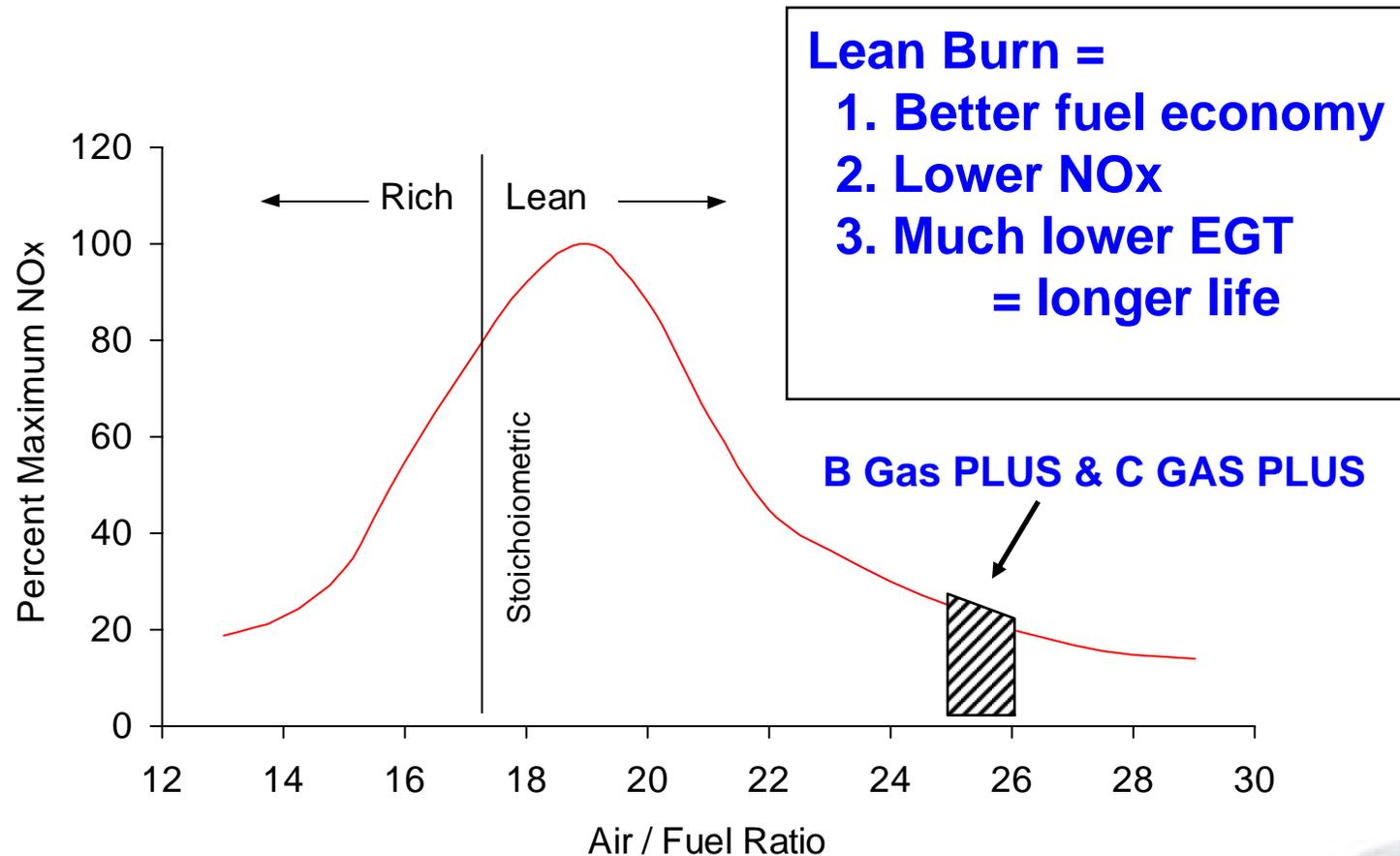
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Lean Burn Combustion System

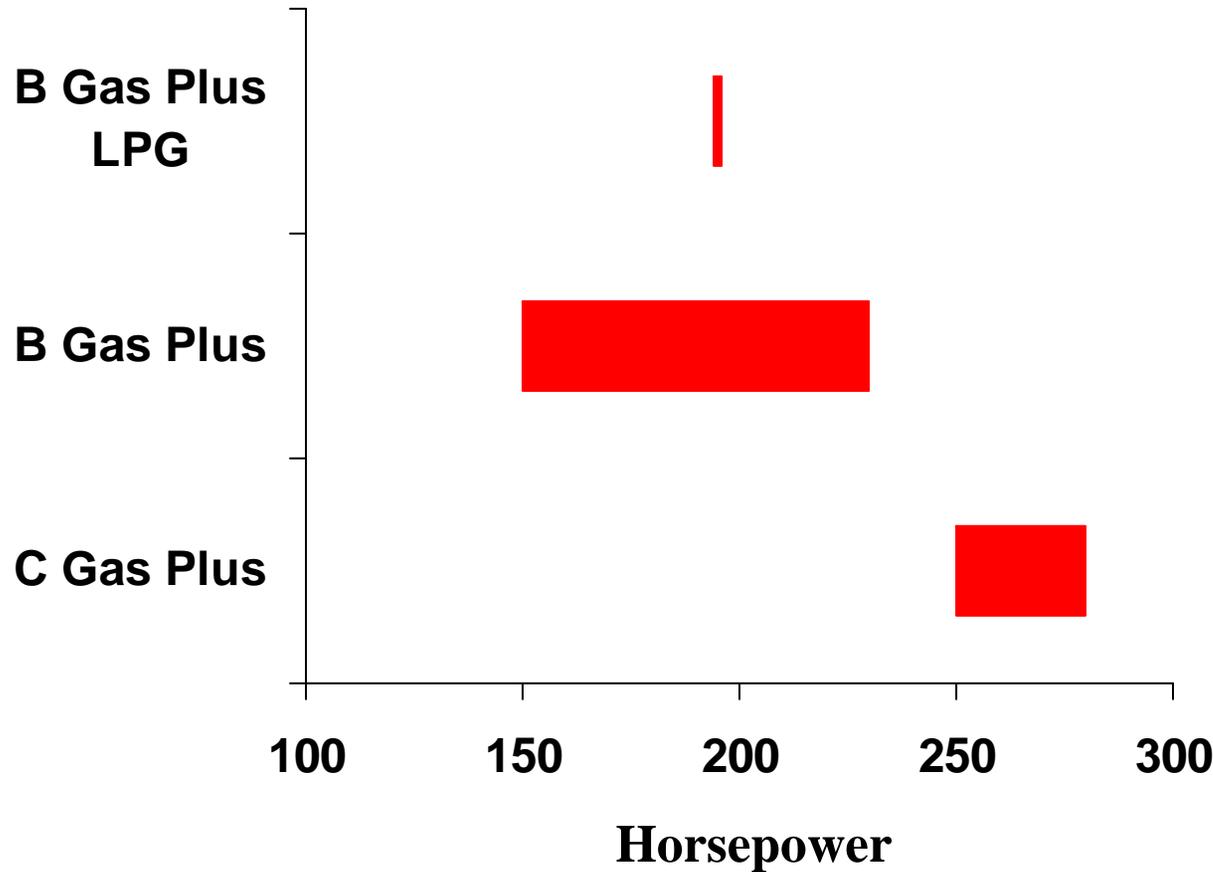


Lean Burn =
1. Better fuel economy
2. Lower NOx
3. Much lower EGT
= longer life

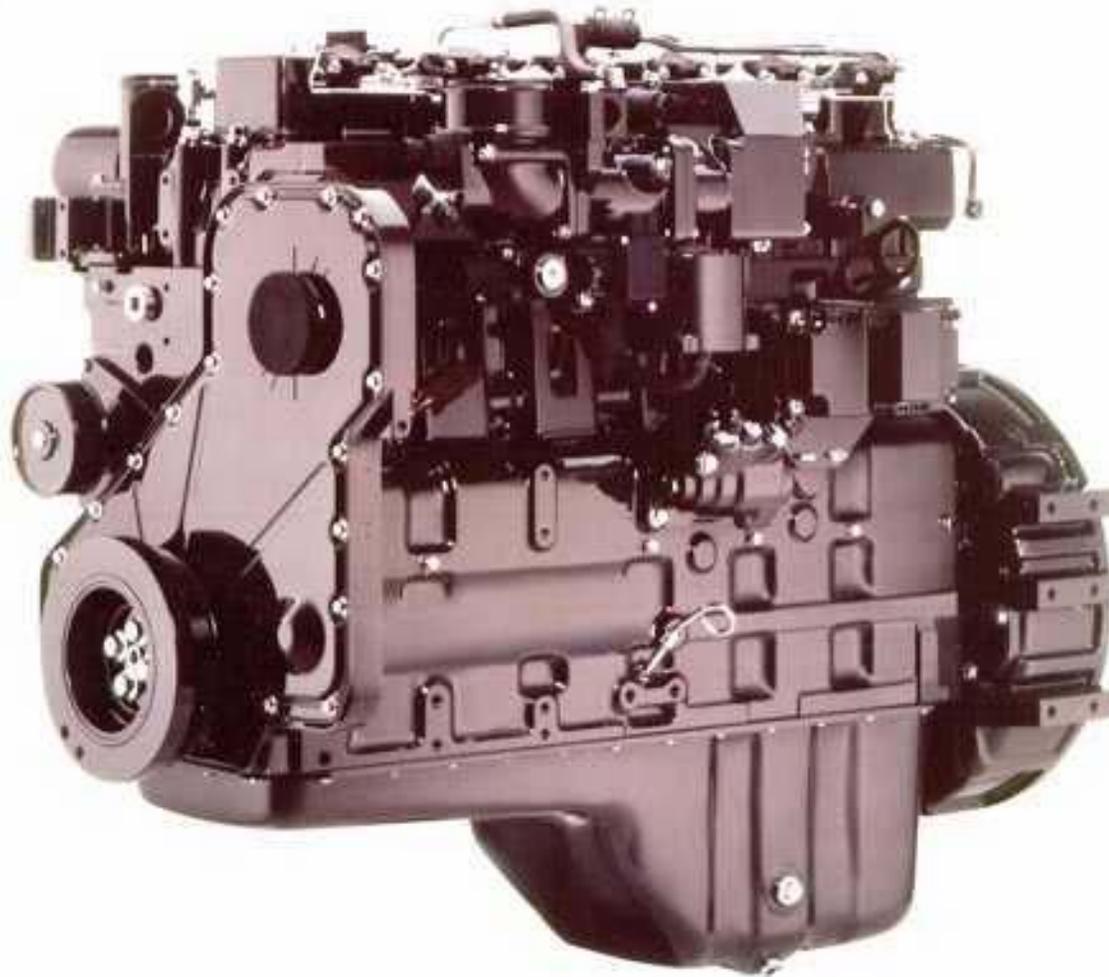
B Gas PLUS & C GAS PLUS



Cummins Natural Gas & Propane Engines



C Gas Plus

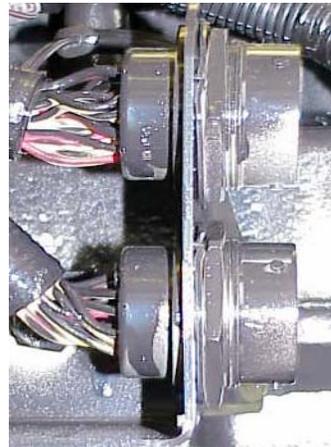


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Why the C Gas Plus is Better

- **By Design**
 - Engine back pressure compensation
 - Fuel supply pressure is measured
 - Cooling fan drive available
 - IMT monitor and protection
 - Supply voltage is measured
 - J1939 datalink
 - Diesel-like wiring
 - Diesel-like features



Why the C Gas Plus is Better

- **By Design**

- No Woodward governor
- Wide range fuel composition capability
- Knock sensing and control
- Robust Oxygen sensor design
- Improved oil consumption
- Improved throttle actuator
- Adaptive learn
- Modern engine controller
- Improved controls
- More sensed parameters
- Humidity sensing and compensation(Late '02)





Cummins B Gas Plus B LPG Plus



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Plus Engine Diagnostics

Insite



Assists mechanics to quickly program engine, analyze faults & troubleshoot engines

Cummins QuickCheck

- PalmPilot handheld device to:
 - Displays SAE fault code information
 - View sensor output data



C Gas Plus NGV OEM Availability

School/Shuttle/Transit

NABI
New Flyer
El Dorado
Orion Bus
Neoplan
Gillig (LNG)

Refuse/Specialty

Crane Carrier
AutoCar WX, WXLL
Sterling - Condor
Peterbilt 320
Elgin Sweeper

H.D.Truck

Freightliner FL70/80

Europe

Ponticelli (refuse)

Australia

Iveco ACCO (refuse)



B Gas Plus NGV OEM Availability

School / Shuttle / Transit

El Dorado National

Chance Coach*

Specialty Vehicles

Goshen Coach

Ottawa *

Molly

Champion

Europe

CSAD/SOR (Czech)

Asia –

Dong Feng Bus (China)

Anhui Ankai Motor (Bus – China)

Refuse – Industrial

Crane Carrier *

Elgin – sweeper *

TYMCO – sweeper *

Medium-Duty Truck - Chassis

Freightliner Custom Chassis

* Denotes B5.9G was available. Availability of B Gas Plus being confirmed



B LPG Plus OEM Availability

School / Shuttle / Transit

El Dorado National
Specialty Vehicles*
Dupont Trolley*
Ottawa *
Capacity*
Molly Trolley*

Refuse – Industrial

Crane Carrier *
Elgin – sweeper *
TYMCO – sweeper *

Medium-Duty Truck - Chassis

Freightliner Custom Chassis*

* Denotes B5.9LPG was available. Availability of B LPG Plus being confirmed

L Gas Development

- Cummins 8.9 litre ISL engine will be launched using “C Plus” engineering
- 320 horsepower rating
- Available 2004
- Aimed at urban transit and trucks needing more power than the C Gas Plus



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Builds on Strengths of Cummins, Inc. and Westport Innovations

Innovation

Integrity

**Concern for
the Environment**

**Customer
Service**

**Customer
Solutions**

Westport
INNOVATIONS INC.

*Have you changed your
view of the future?*

How do you see the future?





Westport



Cummins Westport Inc.

T h e F u t u r e i s C l e a r

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