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ALTERNATIVE.**

**Air Quality - Transportation - Costs**

**David Lynch  
Cummins Westport Inc.**

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**Why Diesel ?**

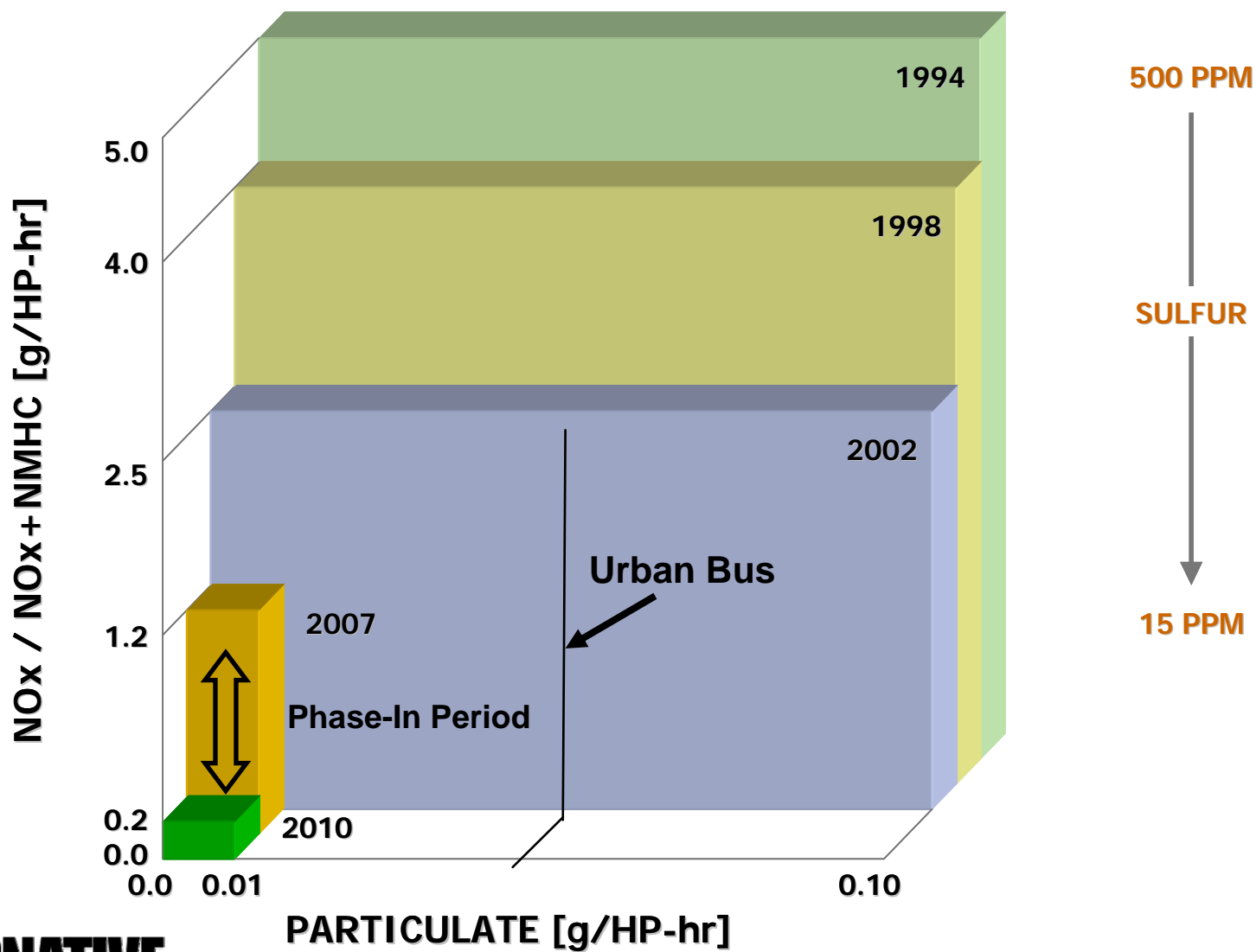




THE CUMMINS DIESEL  
*"Twice as Far for  
Half as Much"*

C15 Rev 6/98

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# What is changing ?



- Higher vehicle pricing for new technology
- Higher cost of Ultra Low Sulfur diesel fuel
- SCR for 2010
- The shifting economics of diesel operation

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# What are your alternatives ?

- Get out your checkbook
- Conserve diesel fuel however you can
- Change vehicle specifications
- Consider other alternatives
- Manage better

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# Consider a lower cost alternative



- Cleanest Available - Meets 2010
- Domestic Fuel
- Renewable Fuel - LFG to CNG/LNG
- Pathway to Hydrogen

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**Next Generation Natural Gas Engine**

**2007**

***ISL G***



# The Two Key Emission Technologies for 2007 ISL G Natural Gas Engines

- Cooled Exhaust Gas Recirculation (CEGR)
- Three Way Catalyst (TWC)

Cummins

Cummins  
Emissions Solutions

# Introducing Next Generation 2007 Natural Gas Engine Technology

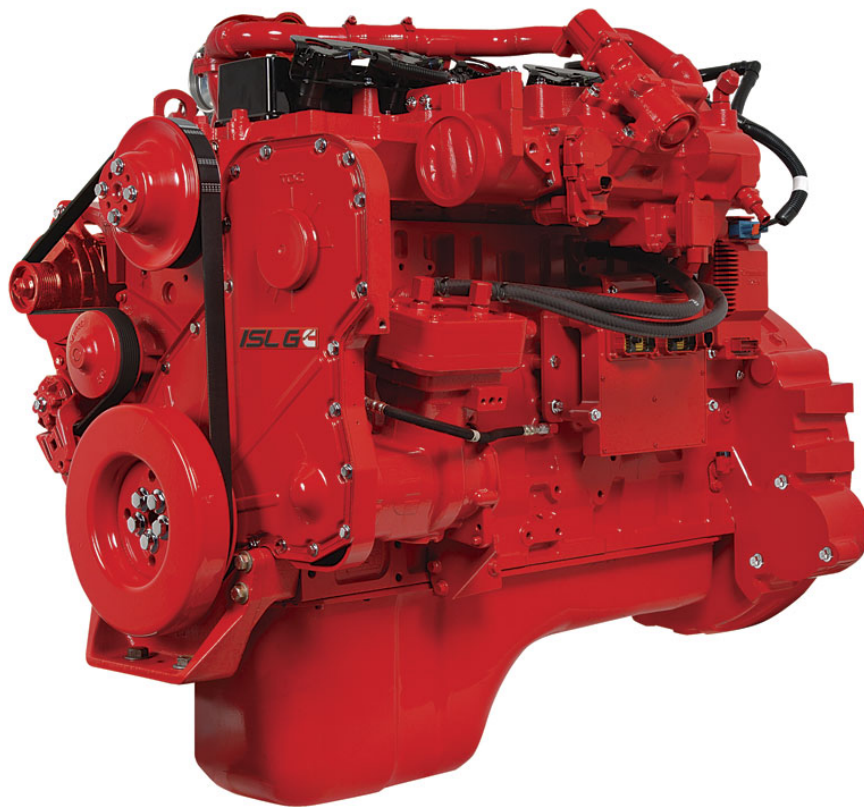


- ISL G will meet 2010 emissions standards ahead of schedule (0.2 g/bhp-hr NOx, 0.01 g/bhp-hr PM)
- 85% lower NOx than C Gas Plus
- 34% more torque at idle
- Improved efficiency=improved fuel economy
- No exhaust related maintenance costs

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# Next Generation Natural Gas Technology

## Stoichiometric Featuring Cooled EGR



**ISL G**

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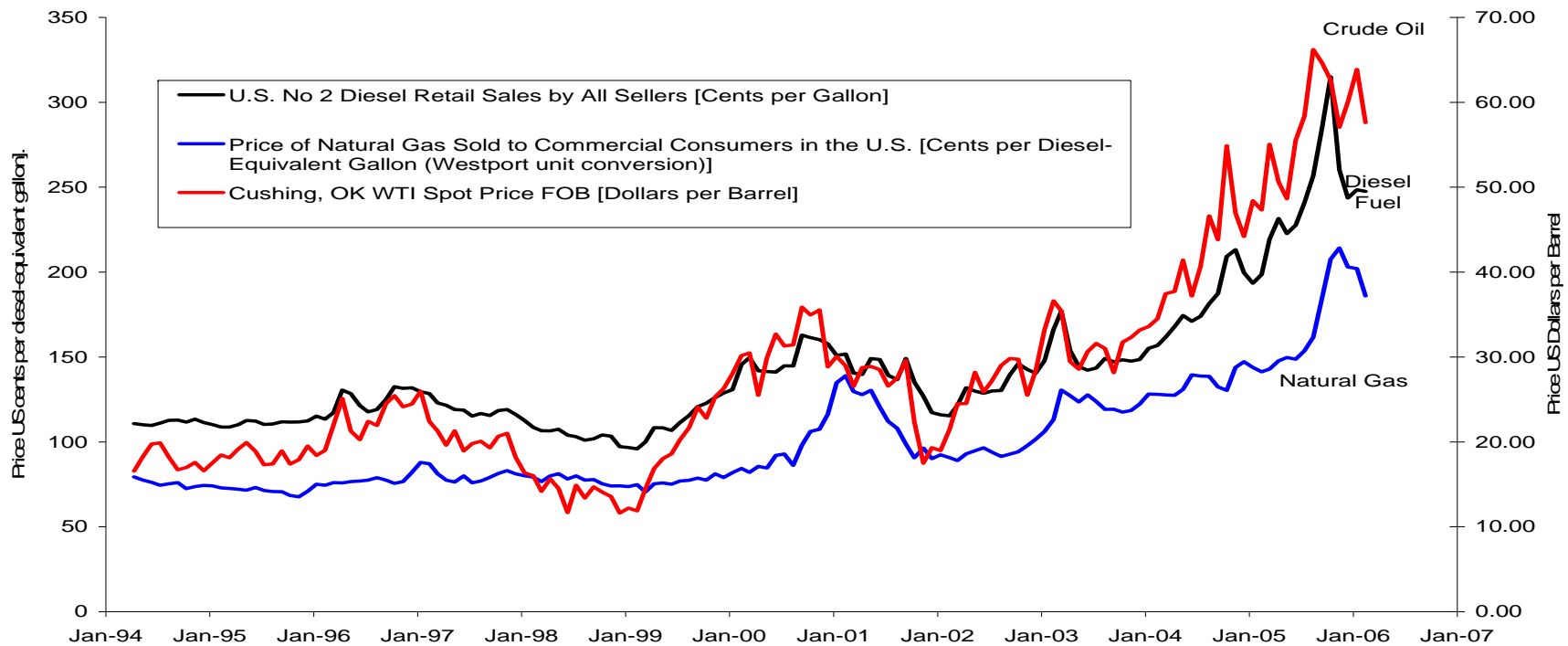
Lowest emissions with use of simple passive TWC  
Higher efficiency with combustion enhancements  
8.9 litre stoichiometric EGR engine with ratings 250- 320 hp

Improved clutch engagement torque  
Higher efficiency/improved fuel economy  
Reliability/Durability  
Cummins diesel parts

*0.2 NOx in 2007  
vs. 1.2 Phase in  
Provision*

# Fuel Price History

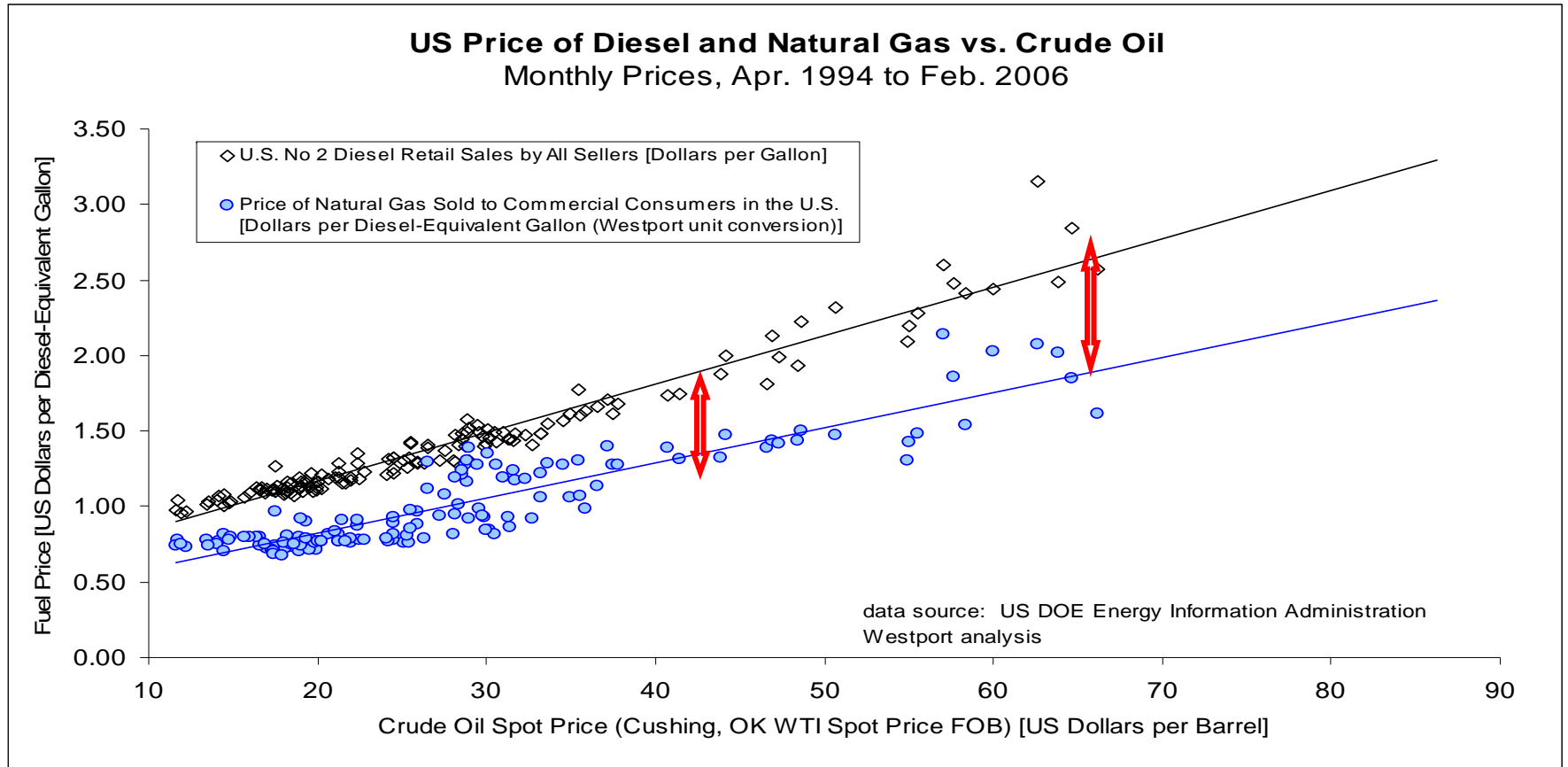
Price History for Crude Oil, Diesel Fuel, and Pipeline Industrial Natural Gas



Natural gas has been 25- 42% cheaper than Diesel over last 14 years

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# Updated Price Comparison Plot



**Price advantage of Natural Gas grows as crude prices rise**

# Highway/Energy Bill

## Highway Bill\*

	Old Tax	New Tax Oct 1, 2006	Net Tax Increase	Tax Credit	Net Benefit Oct 1, 2006	
CNG\$ / DGE	0.067	0.203	0.136	0.55	0.419	To Fleet
			Own Infrastructure			
CNG\$ / DGE	0.067	0.203	0.136	0.55	0.419	To Fuel Provider
			Don't Own Infrastructure			
LNG \$/ DGE	0.202	0.413	0.211	0.85	0.639	To Fuel Provider
			All Infrastructure			

## Energy Bill\*

Up to \$32,000 Vehicle Tax Credit	To Fleet
Up to \$30,000 Infrastructure Tax Credit	To Fleet

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\* CWI's Interpretation Subject to IRS Rule Making

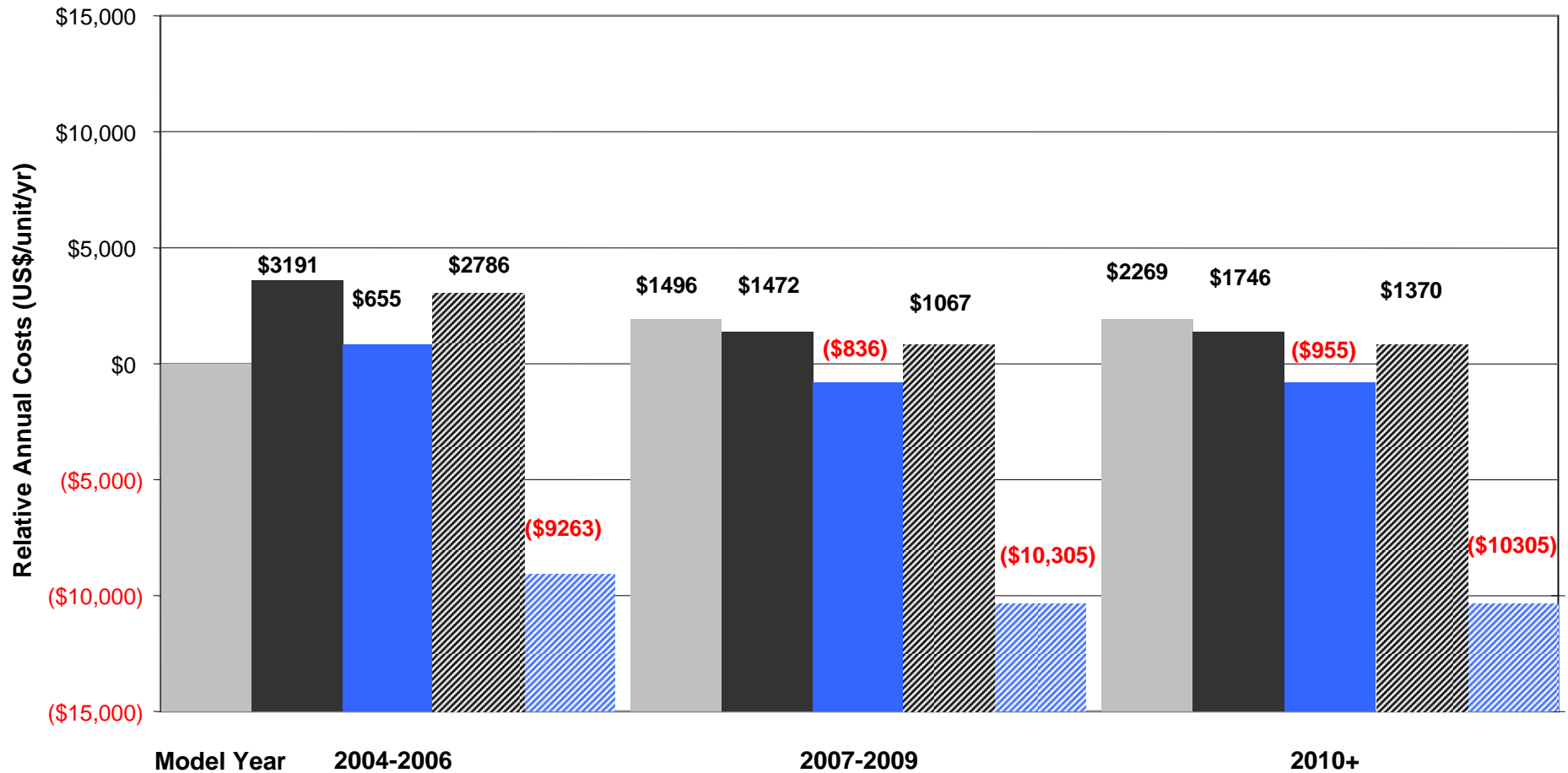
# Assumptions

- Standard CWI LCC model default assumption set
  - Not whole vehicle cost
  - Incremental natural gas related capital, and engine, fuel system, detection maintenance
  - Also includes capital and maintenance required for fuel infrastructure, and maintenance facilities
- \$1 Million facility modifications for both refuse and transit
- 50 truck fleet refuse and 70 bus fleet transit - actual property-southern US
- Urban Bus analysis assumes CNG
- Refuse analysis assumes LNG Fuel Prices:
  - Diesel Fuel (refuse): \$2.30 / gallon (\$0.05 added for ULSD)
  - Diesel Fuel (urban bus): **\$2.20 / gallon** (\$0.05 added for ULSD)
  - Liquid Natural Gas (refuse): \$1.72 DGE (prior to application of Highway Bill excise tax credit)
    - \$675,000 LNG infrastructure capital not included in fuel price but included in model
  - Natural Gas (transit): **\$1.70 DGE** (prior to application of Highway Bill excise tax credit)
    - Includes commodity, O&M, electricity and \$2 Million station 80% FTA funded
- Assume that Highway/Energy Bill tax credit flows fully & completely to end-user
  - Actual impact on end-user TBD
- Assume Energy Bill credit applies to net incremental cost after FTA funding (83%) is applied (Urban Bus only)
- Maximum \$12,000 Energy Bill Credit to OEM for Hybrid (no Highway Bill credits)
- Assume that Energy & Highway Bill provisions remain in effect beyond 2010
- Diesel Electric Hybrid fuel economy benefit assumed to be 20%, based on recent projections from fleets (e.g. Ottawa)

# LCC Analysis – US Urban Bus

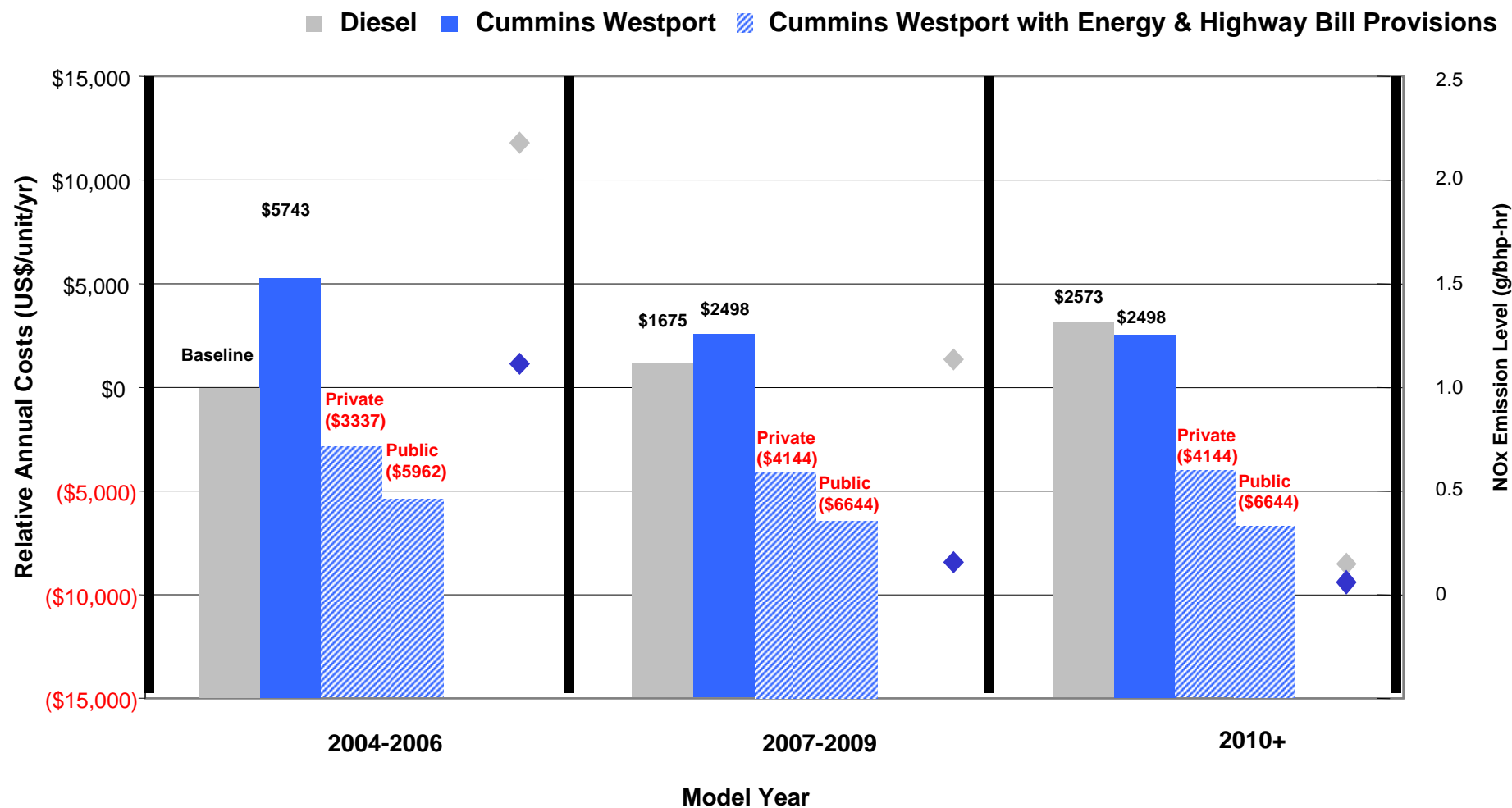
■ Diesel ■ Diesel Electric Hybrid ■ Natural Gas

▨ Diesel Electric Hybrid with Energy Bill Provisions ▨ Natural Gas with Energy & Highway Bill Provisions



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# LCC Analysis - Refuse Collection



# What is changing ?

- Higher vehicle pricing for new technology
- Higher cost of Ultra Low Sulfur diesel fuel
- SCR for 2010
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# Key Characteristics-Diesel vs. NG Natural Gas Engines Continuous Improvement



	L 10 G	C 8.3	C Plus	'07 Gas
Emissions	Better	Better	Better	Better
Reliability	Worse	Worse	Similar	Similar
Fuel Cost/Mile	Worse	Worse	Similar	Better
Durability	Worse	Worse	Similar	Similar
LCC	Worse	Worse	Worse	Better
Timeline	1989	1996	2001	2007

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# Diesel / NG Pathways to 2010

## Diesel

- ULSD
- Active Diesel Particulate Filters
- CEGR (ISC/ISL)
- NOx Adsorber or SCR
  - SCR more efficient but a liquid that will be regulated and taxed
- Crank Case Ventilation (CV) '07
- Lube Oil
  - Will require new, low ash oil
- New Oil Filters

=

1.2 NOx + 0.01 PM in 2007  
0.2 NOx + 0.01 PM in 2010

## Natural Gas

- No change- CNG or LNG capable
- Replace Oxicat with Three Way Catalyst
- Add- CEGR (ISL G)
- No NOx adsorber required
- No CV required—reduced maintenance vs. LBSI
- No Change- Low Ash Oil in use today
  - CES20074
- Fleetguard Filter

=

0.2 NOx + 0.01 PM in 2007

# Consider the Natural Gas Alternative

- Things have changed
- Natural gas not for everyone
- Natural gas as the lower cost alternative

# Conclusions



- The economics of vehicle operations are shifting
- Energy/Highway Bill funding makes Natural Gas a Bargain.
- Some businesses will profit from the opportunity.

# Why Natural Gas Engines for Buses & Trucks?

## Emissions Leadership

- Meet 2010 EPA Emissions in 2007



## Economic Benefits

- Continued reliability improvement
- Improved Efficiency
- Greatest benefits in high fuel use applications

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## Energy Security

- Reduced reliance on imported oil
- Pathway to hydrogen

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**Change is Inevitable**

**"except from a vending machine"**

