



Move to Zero

Cummins Westport
Near Zero Engines

Cummins Westport Inc. (CWI)

- Cummins Westport is a joint venture company established in 2001
 - 50% - Cummins Inc. - world's largest builder of commercial diesels
 - 50% - Westport Innovations Inc. - world leader in gaseous fuel engine technology
- CWI offers 6 to 12 liter alternative fuel automotive engines. (CNG, LNG, RNG)
- Engines are manufactured by Cummins with over 80% parts commonality as the diesel platform
- Parts, warranty, service and training support through the Cummins Sales and Service network
- Over 70,000 engines delivered worldwide



Continued Emission Leading Performance

C Gas Plus



First engine 2004 EPA Certified

1.8 g/bhp-hr. NOx

Lean Burn Combustion

ISL G



First HD engine certified 2010 EPA/ARB

0.2 g/bhp-hr. NOx

SEGR Combustion

ISX12 G



HD Truck engine certified EPA/ARB

0.15 g/bhp-hr. NOx

SEGR Combustion

ISB6.7 G



Mid range engine certified EPA/ARB

0.1 g/bhp-hr. NOx

SEGR Combustion

ISL G NEAR ZERO



First engine Certified Near Zero ARB

0.02 g/bhp NOx

SEGR Combustion

ISX12N



HD OBD

0.02 g/bhp NOx

SEGR Combustion

2002

2007

2013

2016

2016

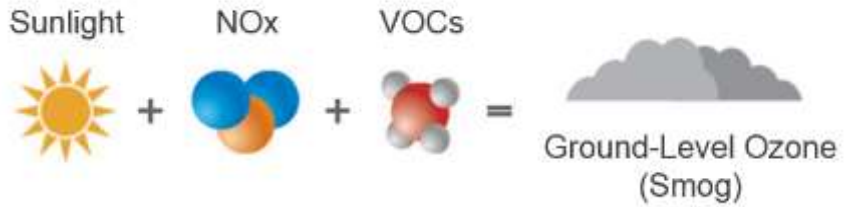
2018

Particulate Matter (PM)

All CWI engines have met the 2010 EPA/ARB Particulate Matter (PM) standard (0.01 g/bhp-hr.) with a catalyst since 2001



Why Lower Emissions?



- Many of the largest US cities are not meeting Clean Air Act standards, including most larger cities in California
- The focus is NOx reduction which will reduce ground level ozone in most urban areas
- California ARB has defined new NOx standards to reduce emissions.

NOx Standard	NOx (g/bhp-hr)	Engine
2010 Standard	0.2	Diesel, ISL G
CA Optional Low-NOx	0.1	B6.7N
CA Optional Low-NOx	0.05	
CA Optional Low-NOx (Near Zero)	0.02	L9N, ISX12N

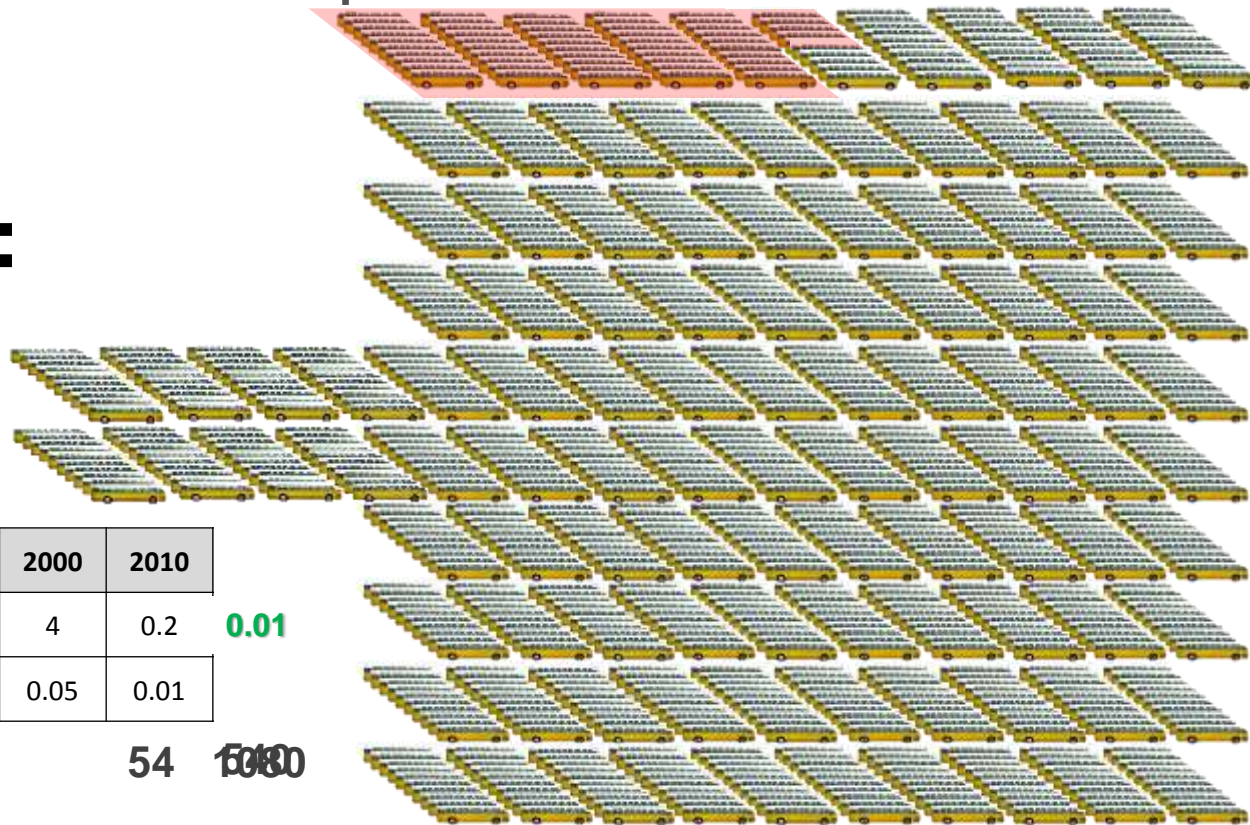
CEC has defined this certified Near Zero emission level as equivalent to a 100% battery truck using electricity from a modern combined cycle natural gas power plant.



Emission Reduction Impact



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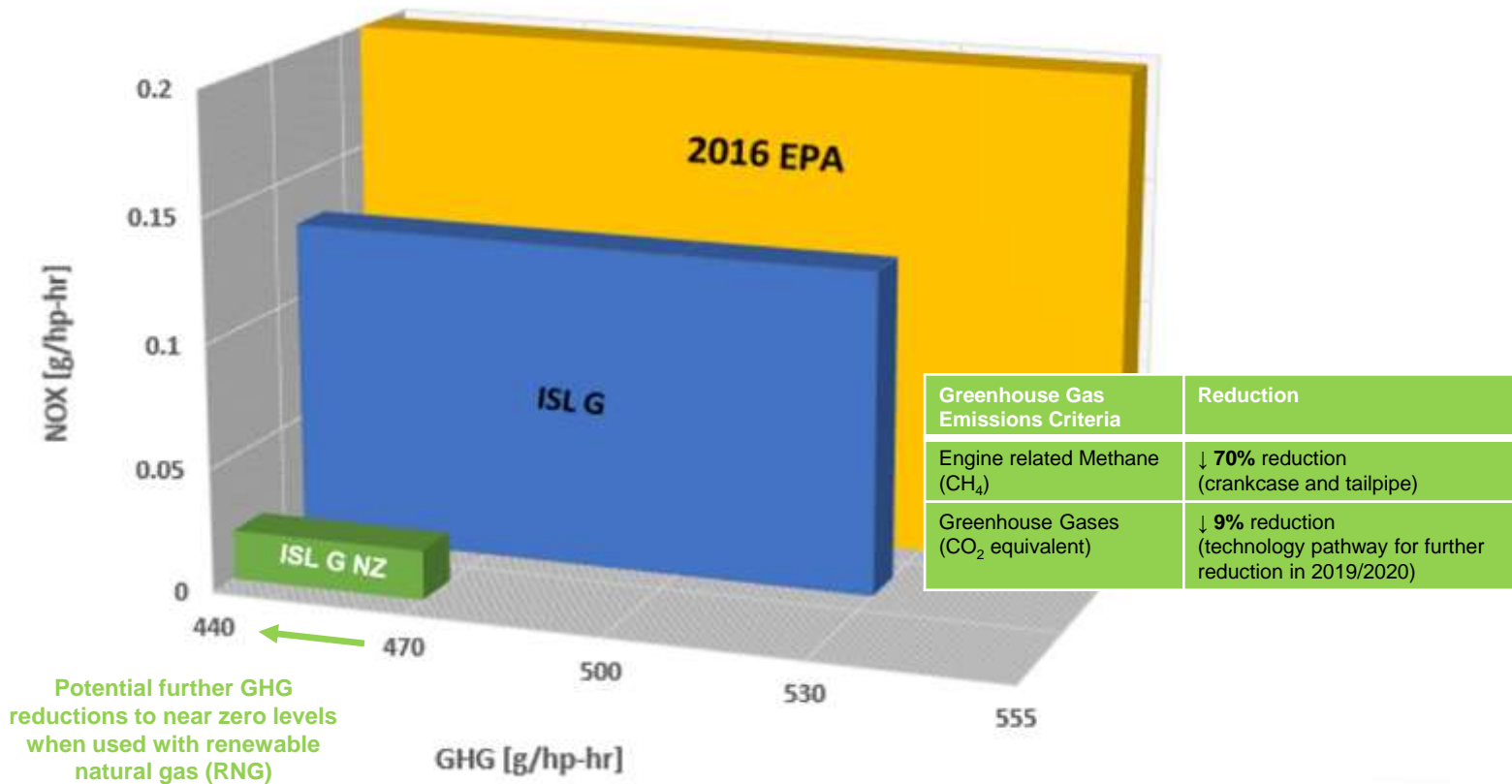
	1985	1990	1991	2000	2010
NOx (g/hp-hr)	10.8	6	5	4	0.2
PM (g/hp-hr)	0.59	0.59	0.25	0.05	0.01

0.01

54 ~~1080~~

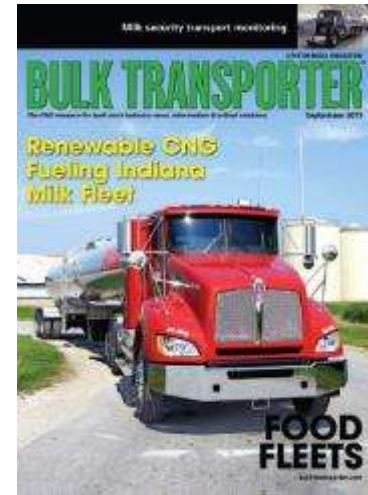


Greenhouse Gas Reduction



Renewable Natural Gas Improves GHG Profile

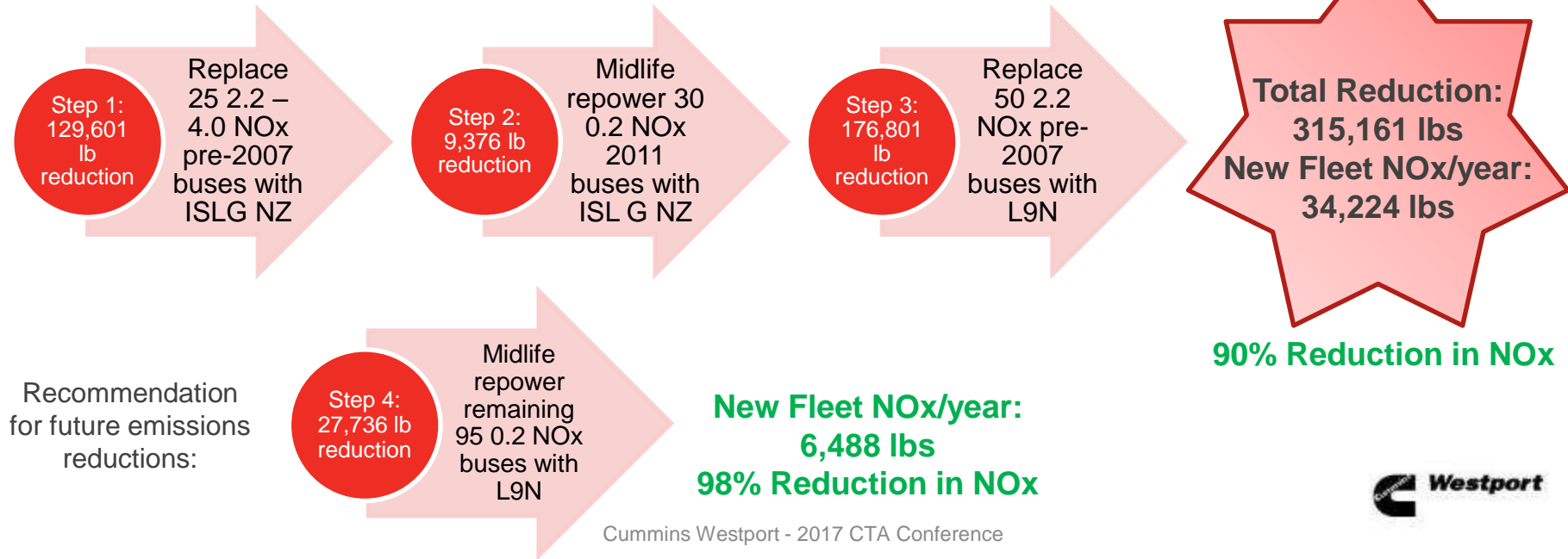
- Landfill gas and biogas that has been processed to “pipeline quality” is **RNG**
- CWI engines can operate on up to 100% **RNG** and are currently in operation with RNG from landfills (landfill gas) & dairy farms (biogas)
- RNG from some sources produces a negative carbon intensity – or sub-zero GHG emissions



Transit Agency Case Study: NOx Reduction

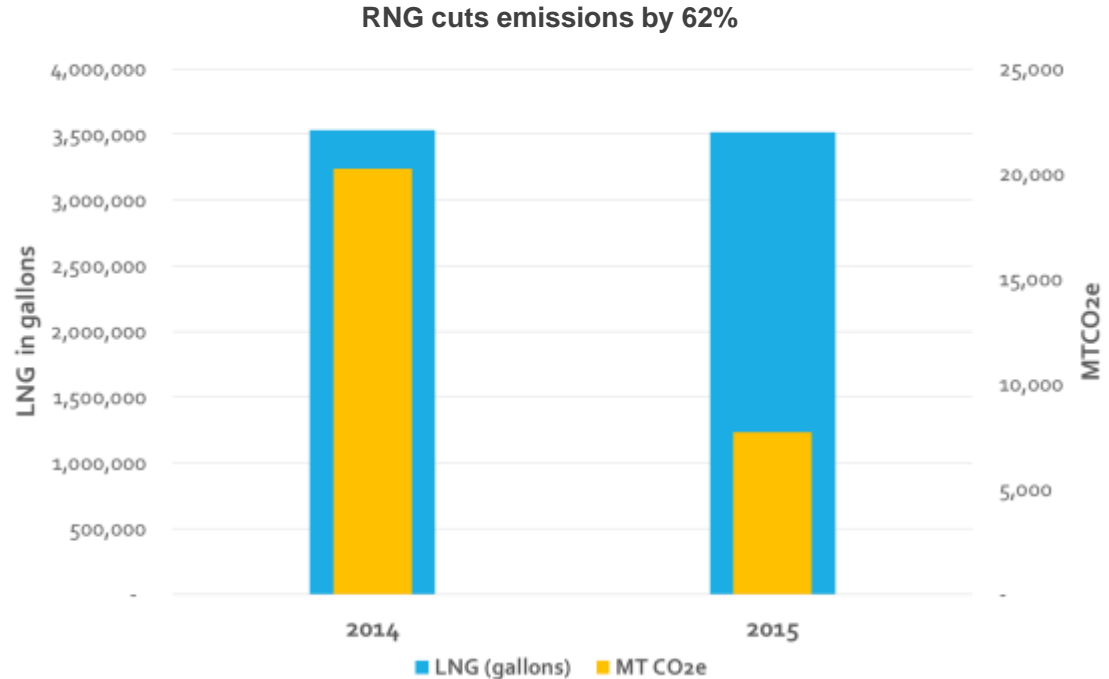
Current Fleet: 125 2007 and newer (0.2 NOx) and 75 Pre-2007 (2.2 and 4.0 NOx)

These 200 buses collectively run approximately 6,000,000 miles and produce 349,384 lbs NOx per year



Transit Agency Case Study: RNG and GHG

- In 2015, the agency changed to using 100% RNG
- Cut GHG emissions by 62%
- With LCFS credits, decreased their fuel costs by 26%



Transit Agency Case Study: Summary

98% reduction in NOx
by changing to Near
Zero engines

62% reduction in GHG by
changing to renewable
natural gas

All of this completed with:

- No changes to infrastructure
 - No real estate costs
- No changes to operational tasks
 - No range limitations
 - No mid-day re-fueling
 - Any bus can run any route

**Minimal
Incremental
Costs**

2018 North America Product Line



B6.7N™

6.7L

Peak Rating: 240 hp
560 lb-ft torque
33,000 lb. GVW
School bus/Shuttle bus
EPA/ARB Low NOx
0.1 g/bhp-hr (50% reduction)



L9N™

8.9L

Peak Rating: 320 hp
1000 lb-ft torque
66,000 lb. GVW
Transit Bus
EPA/ARB Near Zero NOx
0.02 g/bhp-hr (90% Reduction)



ISX12N™

11.9L

Peak Rating: 400 hp
1450 lb-ft torque
80,000 lb. GVW
Coach Bus
EPA/ARB Near Zero NOx – 0.02
g/bhp-hr (90% Reduction)



Key Product Attributes

- 4 cycle, spark ignited, in-line 6 cylinder, turbocharged, CAC
- Displacement - 8.9 Litre (540 cu. In.)
- Certified to CARB Optional Low NOx 0.02g Standard (ISL G NZ introduced in 2016)
- Exceeds 2017 EPA GHG requirements
- **2018 On-board Diagnostic (OBD) compliant**
- Dedicated 100% natural gas engine
- Peak rating: 320 hp, 1000 lb-ft
- Maintenance free Three Way Catalyst aftertreatment
- Up to 66,000 lb GVW



Changes for 2018

Engine	NOx Certification	OBD
B6.7N	0.1 Low NOx	HD OBD for optimal emissions performance
L9N	0.02 Near Zero	
ISX12N	0.02 Near Zero	

Product Changes:

- ECM
- ICM
- Wiring harness
- Crankcase pressure sensor
- Steel Pistons

Catalyst Changes:

- One piece design
- L9N catalyst size similar to ISL G
- Mid-catalyst O2/Temp Sensor



End Customer Impact

- No changes to power ratings, fuel economy or range from current products. Meets the demand for all transit routes
- Continued high durability with minimal engine changes for MY2018
 - Product improvements introduced on the ISL G will be carried over to the L9N – steel pistons, tube EGR cooler, 3-piece exhaust manifold, as well as a new ECM and ICM
- Same Base Warranty and Extended Coverage options
- Maintenance free Three Way Catalyst aftertreatment
 - Similar in size to ISL G. Allows for easy repower to lower emissions
- Technician certification requirement is same as current products
- Lowest cost Near Zero emissions alternative



NG Playbook

- www.cwiplaybook.com
- Helps customers assess the natural gas opportunity and successfully incorporate natural gas powered trucks and buses into their fleet operation.
 - Helps identify fleet opportunities with natural gas
 - Provides technical product information
 - Addressed questions/concerns about purchasing and operating NG engines
 - GHG Emissions Calculator
 - Diesel v. NG Payback Calculator



Customers often ask us many questions about natural gas.

- What is natural gas?
- How does natural gas reduce fleet emissions?
- Can I calculate the emissions reductions with natural gas?
- What engines are available for my operation? What about costs and maintenance?

Welcome to the Natural Gas Playbook - Cummins Westport's new website designed to provide new and existing natural gas customers with guidance on evaluating and operating natural gas vehicles.

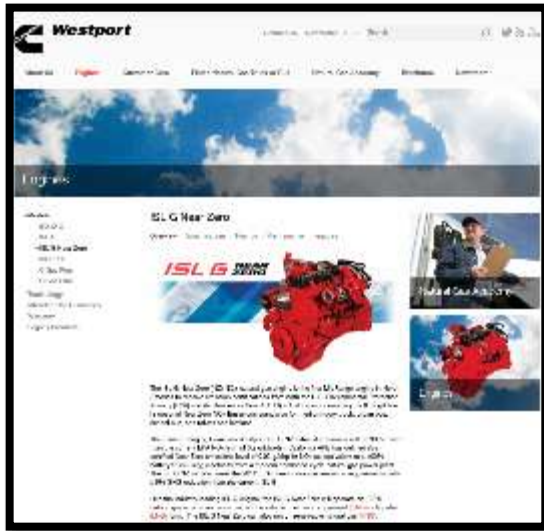
The information is organized into five sections: Assess, Specify, Prepare, Implement, and Operate & Maintain. We provide emissions and economic calculators, resources, tools, and information to help you successfully manage your natural gas fleet. You can also save and print information specific to your playbook.

Click on the Assess button below to get started.

Cummins Westport
The Natural Choice 



www.cumminswestport.com



- More information on natural gas engines
- Features the Natural Gas Academy, a series of instructional videos
- Designed to provide a general overview of operating a natural gas fleet whether it is compressed (CNG) or liquefied (LNG)
- ISX12 G and ISL G engine walk around, service and driver training videos



Summary

- ISL G Near Zero is in production today with several hundred already successfully operating on the road.
- Successful repowers of the ISL G to ISL G Near Zero have been completed. Repowers even easier with the L9N and new catalyst.
- The L9N will incorporate all recent ISL G product updates
- Near Zero emissions is considered equivalent to a 100% BEB using electricity from a modern natural gas power plant

**Mature. Reliable. Affordable.
Ready Now**



THANK YOU

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Please come visit us in our booth during the Expo and join us Thursday for the Evening Reception at the Mission Inn Hotel

