Cummins Westport
The Natural Choice

ISL G NEAR ZERO

Near Zero Emissions Natural Gas Engine

- CWI has been working on a project supported by the SCAQMD, CEC & SoCal Gas to develop technology that would reduce NOx emissions to below the 0.02 g/bhp-hr “Near Zero” level

- In 2014, CWI completed laboratory-based R&D, using prototype hardware, testing the ISL G for near zero emissions while maintaining current architecture

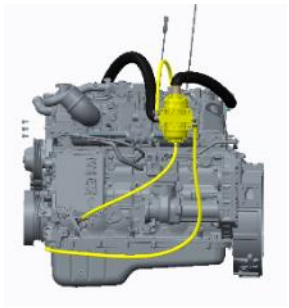
Emissions Criteria	Reduction	Near Zero
Particulate Matter (PM)	↓ **80%** below EPA standards	✓
Nitrogen Oxides (NOx)	↓ **90%** below EPA standards	✓
Engine related Methane (CH_4)	↓ **70%** reduction (crankcase and tailpipe)	
Greenhouse Gases (CO_2 equivalent)	↓ **9%** reduction (technology pathway for further reduction in 2019/2020)	✓

- 2015 work included
  - Component and engine design for high volume manufacture
  - Extensive component / system validation to demonstrate performance, reliability and durability, including field testing in California
  - Emissions certification

- 2016 Production begins

ISL G NEAR ZERO

- Base ISL G engine design is the same
  - Engine will be factory built at Cummins Rocky Mount Engine Plant
  - Ratings, warranty and operational / maintenance procedures will be the same
  - No change in technician service certification requirements
  - Compatible with CNG, LNG, or RNG
- Closed Crankcase Ventilation (CCV) will be added to engine
  - CCV system reduces engine related methane emissions by 70%
  - CCV filter change required at 2,000 hours
- Three Way Catalyst will change to meet next level emissions
  - Remains maintenance free
  - Larger size catalyst with addition sensor added
  - New substrate composition for durability and emission performance



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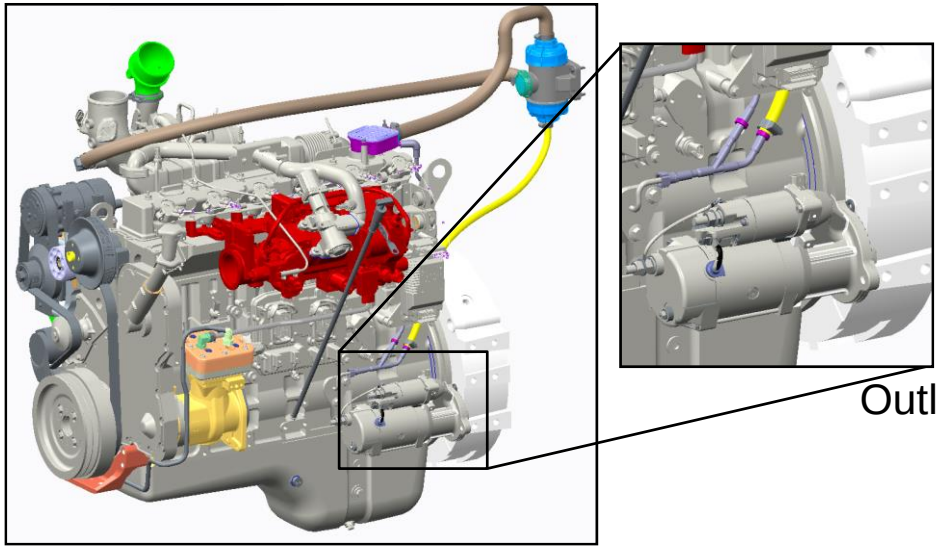
Closed Crankcase Ventilation (CCV) System



Inlet (from valve cover)

Chassis Mounted

Filter (2,000 hour change)

Coolant supply/return

Outlet (to compressor inlet elbow)

Oil drain (to supplied connection on block)

ISL G Near Zero Ratings (same as MY2015 ISL G)

ENGINE MODEL	ADVERTISED HP(KW) @ RPM	PEAK TORQUE LB-FT @ RPM	GOVERNED SPEED
ISL G NZ 320	320 (239) @ 2000	1000 (1356) @ 1300	2200 RPM
ISL G NZ 300	300 (224) @ 2100	860 (1166) @ 1300	2200 RPM
ISL G NZ 280	280 (209) @ 2000	900 (1220) @ 1300	2200 RPM
ISL G NZ 260	260 (194) @ 2200	660 (895) @ 1300	2200 RPM
ISL G NZ 250	250 (186) @ 2200	730 (990) @ 1300	2200 RPM

Application guidelines are the same as ISL G i.e. up to 66,000 lb. GVW.

Why ISL G Near Zero vs Current ISL G?

- 90% lower NOx and 9% better GHG profile
  - Lowest emission mid range engine in North America
  - 10 ISL G Near Zero engines equal one ISL G in NOx emissions
- Better qualified for Non Attainment funding
- Features all the latest engineering improvements from the ISL G
  - Natural gas fleets looking to replace existing natural gas vehicles or engines will notice a dramatic improvement in reliability and uptime performance
- Allows fleets the opportunity to market “Near Zero” emissions
- “Go forward” product for CWI
  - OBD in 2018 will obsolete base ISL G

Near Zero Product Plan – Feb 2016

(Certified to ARB Near Zero NOx standard - 0.02 gm/bhp.hr.)

Engine	2016	2017	OBD	2018	2019
ISB6.7G *					
ISB6.7G NEAR ZERO				Development Program Not Funded	
ISL G					
ISL G NEAR ZERO					
ISX12 G					
ISX12 G NEAR ZERO					

Legend

- Available
- Not Available

- * ISB6.7 G will be certified at launch to California ARB optional Low NOx (0.1 gm/bhp-hr.)
- Near Zero development funding for the ISB6.7 G has not be secured – no ISB6.7 G NZ in plan without funding
- ISX12 G NZ will be available in 2018
- Base ISL G and ISX12 G engines are not available post 2017 (not OBD compliant)

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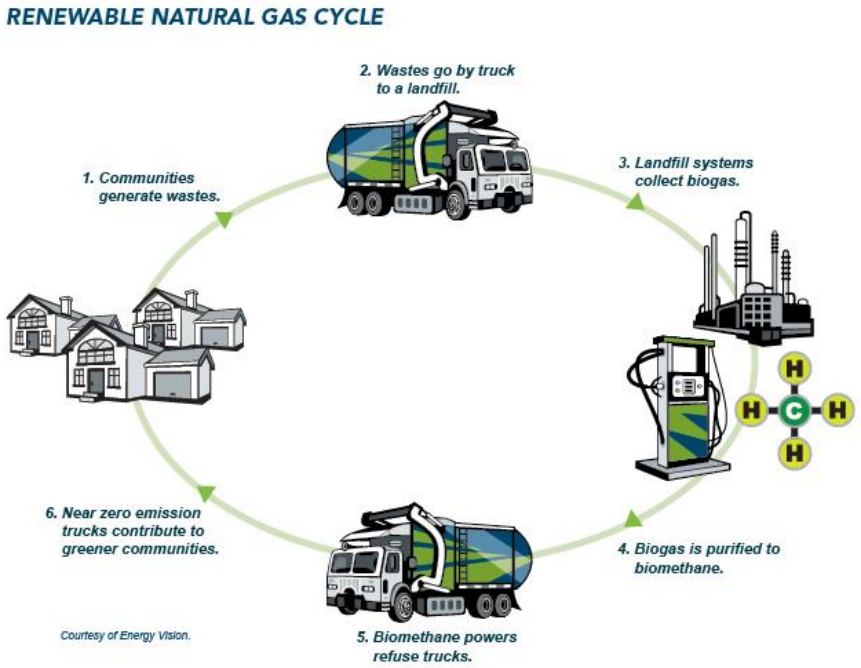
Use Renewable Natural Gas

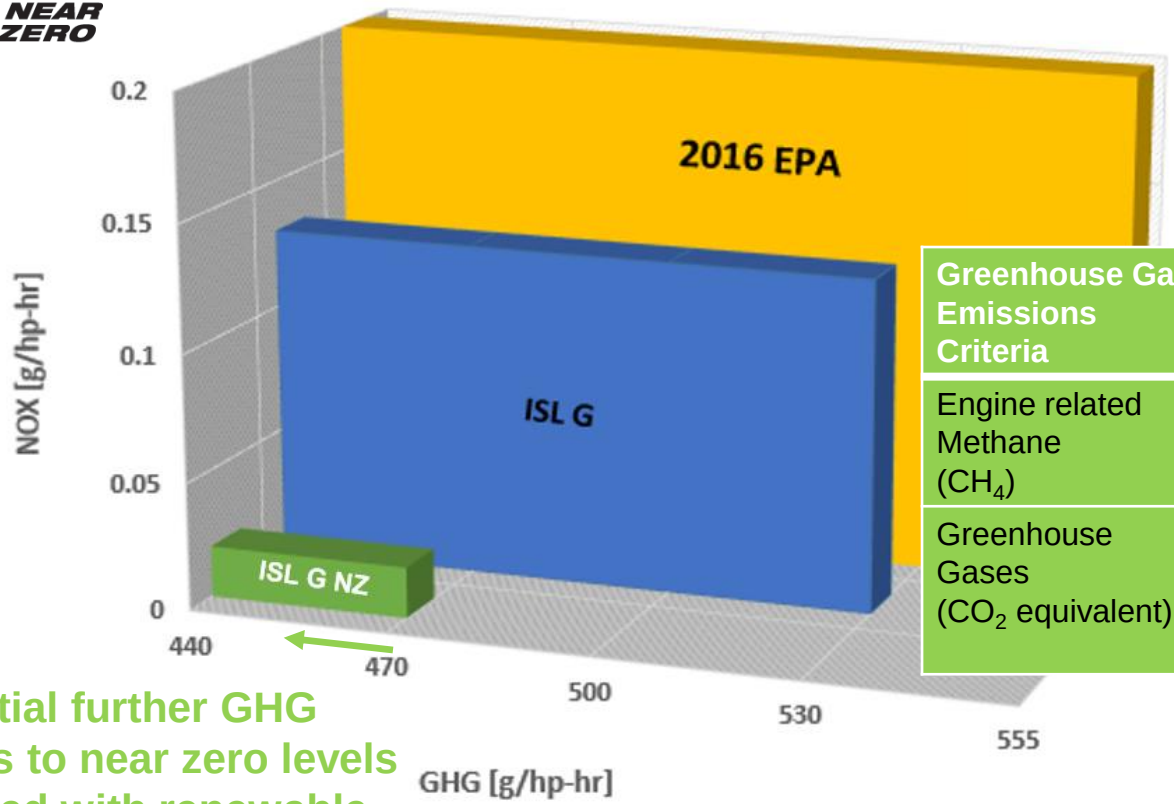
- Converting the methane that leaks from landfills or other sources to **RNG** fuel **has significant greenhouse gas emissions reduction benefits.**

- Use of **RNG** with ISL G Near Zero provides a GHG reduction over 80%
- In addition, there's a 100% displacement of fossil fuels as RNG is a renewable resource.



Greenhouse Gas Reduction

ISL G NEAR ZERO



Greenhouse Gas Emissions Criteria	Reduction
Engine related Methane (CH_4)	↓ **70%** reduction (crankcase and tailpipe)
Greenhouse Gases (CO_2 equivalent)	↓ **9%** reduction (technology pathway for further reduction in 2019/2020)

Potential further GHG reductions to near zero levels when used with renewable natural gas (RNG)

ISL G NEAR ZERO

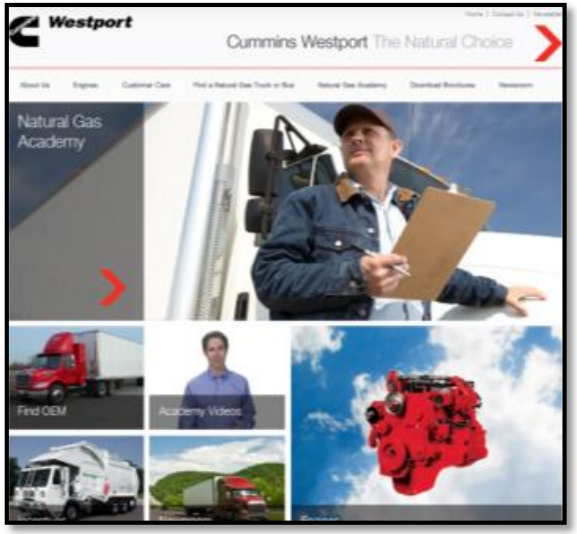
Summary

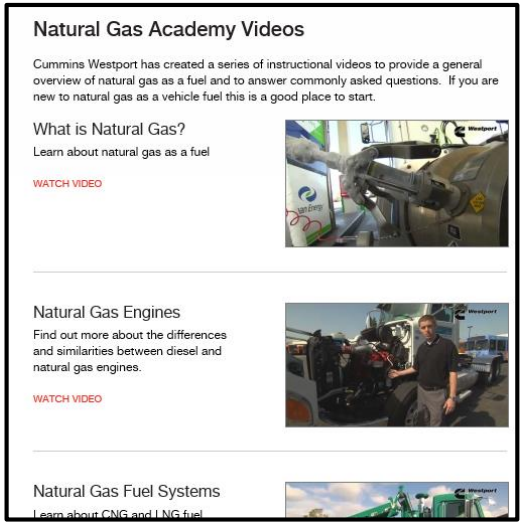
- Cummins Westport has certified the ISL G Near Zero (NZ) NOx with EPA and California ARB for Bus and Truck applications

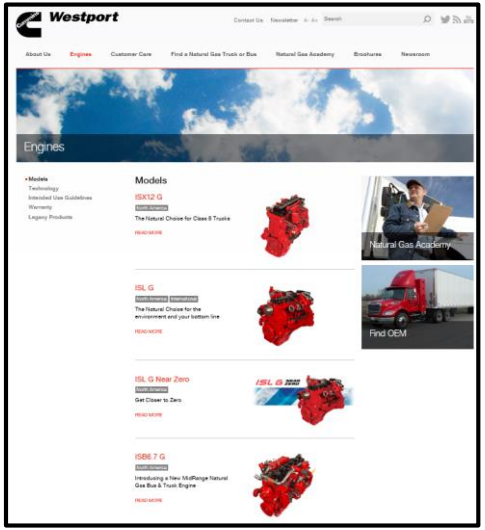
- Field testing is in progress in transit and refuse applications.
  - New orders daily

- ISL G NZ NOx engines will be factory built and available in 2016 for new Bus and Truck installations as well as for repowers of existing natural gas vehicles.
  - There are no plans for retrofit kits for existing engines

More information…www.cumminswestport.com







- Natural Gas Academy: great source of information about NG, technology, vehicles
- Series of instructional videos, including engine walk-arounds and service & driver training videos
- Engine information – specs, features, maintenance intervals
- Product Brochures & Bulletins available for download

CNG LNG RNG

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Thank You

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