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 litre alternative fuel automotive engines. (CNG, LNG, RNG)
- Engines are manufactured by Cummins.
- Parts, service and training support through the Cummins Sales and Service network.
Natural gas use in vehicles has grown and evolved!
What’s the Natural Gas Value Proposition?

Natural Gas as a Transportation Fuel

**ECONOMICS**
- Historically ~8:1+ price advantage Btu basis
- Long-term price stability
- Long-term price outlook
- No costly emissions control systems

**ABUNDANCE**
- U.S. #1 natural gas producer in the world
- 100+ years of affordable reserves
- Basins provide increased access to markets
- Production can grow rapidly with demand

**ENVIRONMENTAL**
- 27% lower CO2 emissions than petroleum
- 13 – 17% lower WTW GHG emissions
- Lower in-use NOx emissions
- Lower PM emissions
- Quieter engines
For these reasons, natural gas adoption rate will continue to increase.

- Continued low NG fuel costs
- Increased fueling infrastructure
- More NG engines & vehicles available

### Market Segment

<table>
<thead>
<tr>
<th>Market Segment</th>
<th>NG Market Adoption Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2016</td>
</tr>
<tr>
<td>Transit Bus</td>
<td>25%</td>
</tr>
<tr>
<td>Refuse Truck</td>
<td>49%</td>
</tr>
<tr>
<td>HD Truck</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>
Do NGV’s make sense for me? - Infrastructure

- Use Existing natural gas pipeline network
- Build fleet specific infrastructure, consider:
  - # vehicles in fleet
  - Daily fuel consumption
  - Do vehicles return to base every day
  - How much time is available for refueling?
  - Need for Fast Fill or Time Fill?

<table>
<thead>
<tr>
<th>Type</th>
<th>Pressure</th>
<th>Time to Fill</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG</td>
<td>Low</td>
<td>Similar to diesel</td>
<td>$$$</td>
</tr>
<tr>
<td>CNG – Fast Fill</td>
<td>Higher</td>
<td>Similar to diesel</td>
<td>$$</td>
</tr>
<tr>
<td>CNG – Time (Slow) Fill</td>
<td>Lower</td>
<td>Overnight (&gt;4hr)</td>
<td>$</td>
</tr>
</tbody>
</table>

(most School Bus fleets use Time Fill)
Why Low NOx Emissions?

• The Clean Air Act is a United States federal law designed to control air pollution on a national level. It is one of the United States' first and most influential modern environmental laws, and one of the most comprehensive air quality laws in the world.

• Much of urban California is not attaining Clean Air standards pushing government to take significant steps to improve air quality by reducing emissions, particularly from motor vehicles.

• The focus is NOx reduction, and California has defined new NOx standards to reduce emissions.

• Many of the largest US cities are also not meeting Clean Air standards.
Move to Zero remembering why we did this

1. Air quality goals
2. Mobile sources key
3. Not just California

Heavy Duty Vehicles

South Coast NOx (tons per day)

- 2016
- 2023 Target
- 2031 Target

Can move now with NG

Potential with Move to Zero

*The scenarios illustrated in this figure reflect natural turnover rates.*
Greenhouse Gas Reduction

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

<table>
<thead>
<tr>
<th>Greenhouse Gas Emissions Criteria</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine related Methane (CH₄)</td>
<td>↓ 70% reduction (crankcase and tailpipe)</td>
</tr>
<tr>
<td>Greenhouse Gases (CO₂ equivalent)</td>
<td>↓ 9% reduction (technology pathway for further reduction in 2019/2020)</td>
</tr>
</tbody>
</table>
Heavy Duty Truck/Bus Emissions Reduction Impact - NOx

<table>
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</thead>
<tbody>
<tr>
<td>NOx (g/hp-hr)</td>
<td>10.8</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>0.2</td>
</tr>
<tr>
<td>PM (g/hp-hr)</td>
<td>0.59</td>
<td>0.59</td>
<td>0.25</td>
<td>0.05</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Cummins Westport Inc
Why CWI NZ Technology?

• **Environmental Durability**
  - NOx is reduced by 90% below standard
  - PM is reduced 90% below standard
  - CO2 equivalent is 16% below standard

• RNG compatibility enables WTW GHG emissions reduction to Near Zero levels
  - Landfill source (GREET1_2015 and CA GREET2.0)
    - Up to 97% reduction in CO2
    - Up to 80% reduction in GHG
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
Case Study: RNG and GHG

• In 2015, California Transit Agency changed to using 100% RNG
• Cut GHG emissions by 62%
• With LCFS credits, decreased their fuel costs by 26%

RNG cuts emissions by 62%
Move to Zero sub-zero carbon intensity

Cummins Westport

Heavy Duty Engines Designed Specifically for Alternative Fuels

• Based on Reliable Cummins Engine Platforms
• Common parts and design provide heavy duty performance
• Engineered and Optimized Specifically for Alternative Fuel
• Continued improvement in reliability and cost of ownership
• Service Support through the Global Cummins Distributor network
Introducing CWI 2018 North American Products

• New Product Names
• EPA/ARB Ultra Low emissions certification
• Lowest Emission MR and HD engines in North America
• On-Board Diagnostics (OBD) applied for optimal emissions system performance
2018 North America Product Line

**6.7L**
- Peak Rating: 240 hp / 560 lb-ft torque
- 33,000 lb. GVW
- School bus/MD Truck/Shuttle
- bus/Sweeper/Yard spotter
- EPA/ARB Low NOx
- 0.1 g/bhp-hr (50% reduction)

**8.9L**
- Peak Rating: 320 hp / 1000 lb-ft torque
- 66,000 lb. GVW
- Refuse/Transit/Regional P&D Truck/Mixers
- EPA/ARB Near Zero NOx
- 0.02 g/bhp-hr (90% Reduction)

**11.9L**
- Peak Rating: 400 hp / 1450 lb-ft torque
- 80,000 lb. GVW
- Regional Haul Truck/Tractor/Refuse
- EPA/ARB Near Zero NOx – 0.02 g/bhp-hr (90% Reduction)
Natural Gas Engine

- **Customer Impacts**
  - Continued cost-efficient and ultra reliable performance from B6.7N with HD-OBD
  - No changes to fuel economy expected, exceeds EPA / DOT 2017 GHG standards and a clear path to exceed proposed Phase II GHG standards
  - Offering same ratings (power and torque curves) as ISB6.7 G
  - Cost-efficient and ultra reliable performance continues with minimal engine changes for MY2018
  - Technician certification requirement is same as ISB6.7 G
  - Full production from Rocky Mount Engine Plant (RMEP) Q1 2018

- **Key Markets**
  - School Bus
  - MD Truck (Class 6-8)
  - Vocational
  - Shuttle Bus
  - Yard Spotters
• Key Product Attributes
  • 4 cycle, spark ignited, in-line 6 cylinder, turbocharged, CAC
  • Displacement - 8.9 Liter (540 cu. In.)
  • *Certified to CARB Optional Near Zero NOx 0.02g Standard
  • 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
  • Markets Include:
    • Transit
    • Refuse
    • Truck
KEY PRODUCT ATTRIBUTES

- 4 cycle, spark ignited, in-line 6 cylinder, turbocharged, CAC
- Displacement – 11.9 liters (726.2 cu in)
- Certified to CARB Optional Near Zero NOx 0.02g Standard
- Exceeds 2017 EPA GHG requirements
- 2018 On-Board Diagnostics (OBD)
- 400 HP, 1450 Ft/lbs. Torque
- Engine braking
- Manual/Automatic/AMT Transmissions
- Maintenance-free Three-Way Catalyst after treatment
- Over 10,000 in service
- Up to 80,000 lb. GVW
- Markets Include:
  - Transit
  - Refuse
  - Truck
<table>
<thead>
<tr>
<th>RESULTS</th>
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<tbody>
<tr>
<td>Region</td>
<td></td>
<td>US Typical</td>
</tr>
<tr>
<td>GHG Specification/Model</td>
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<td>GREET1_2016</td>
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<tr>
<td>Annual Total WTW GHG (CO2eq) Savings with NGVs</td>
<td></td>
<td>5,893.3</td>
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<tr>
<td>(Metric Tonnes per year)</td>
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<td></td>
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<tr>
<td>% Reduction Relative to Current Vehicle Fleet</td>
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<td>80.4%</td>
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<tr>
<td>Truck Equivalent GHG Avoided by Converting to NGV</td>
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<td>20.1</td>
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<tr>
<td># of Near Zero Gas Trucks it Would Take to Generate GHG of Current Fleet</td>
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<td>127.4</td>
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<tr>
<td>Tailpipe NOx Emissions Reduction with NGV</td>
<td></td>
<td>90%</td>
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**CWI ENGINE SELECTED**

**ISX12N**
# OEM Availability for 2018

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<tr>
<th></th>
<th>Saf-T-Liner C2</th>
<th>Shuttle Bus</th>
<th>Yard Spotter</th>
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<tbody>
<tr>
<td>B6.7N</td>
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<tr>
<th></th>
<th>ACX - Xpeditor</th>
<th>ACMD - Xpert</th>
<th>M2 112</th>
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<tr>
<td>L9N</td>
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<td>All American RE</td>
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<td>Saf-T-Liner HDX</td>
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<tr>
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Thank You!

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  (330) 720-9785
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  bill.boyce@cummins.com

• Or visit
  www.cumminswestport.com