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- Sur Laquelle Vous Pouvez Compter
- 期待に答える技術革新 ▪
- Innovación En La Que Usted Puede
- Confiar ▪ 신뢰할 수 있는 혁신
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One World. One Mission.  
Technical Excellence.



## Fuel Efficiency Improvements and GHG Reduction From HD Vehicles

Dr. John C. Wall  
Vice President – Chief Technical Officer  
Cummins Inc.

ACCO Climate Change Leadership Summit  
November 8, 2010




### EPA / DOT (NHTSA) NPRM Greenhouse Gas Emission Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles October 25, 2010

- Vehicle + Engine Standards
- Three Vehicle Categories (>8500 lb GVW)
  - Combination Tractors (Class 7-8)
  - Vocational Trucks
  - Heavy-Duty Pickup Trucks and Vans (Class 2b-3)
- Current Engine Emission Certification Categories
  - HHD, MHD, LHD Diesel, HD Gasoline (SI)


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**EPA / DOT (NHTSA) NPRM  
Greenhouse Gas Emission Standards and Fuel Efficiency Standards for  
Medium- and Heavy-Duty Engines and Vehicles  
October 25, 2010**

- Model Years 2014 - 2018
- CO<sub>2</sub> reductions from 2010 baseline
  - 7 - 20% at vehicle level
  - 5 - 9% at engine level
- Includes CH<sub>4</sub>, N<sub>2</sub>O and air conditioning HFC leaks
  - GWP: 25 / 298 / 1430
- HD Engine and component test / truck simulation


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**EPA / DOT (NHTSA) NPRM  
Greenhouse Gas Emission Standards and Fuel Efficiency Standards for  
Medium- and Heavy-Duty Engines and Vehicles  
October 25, 2010**



- Flexibility: Averaging, Banking and Trading
- **Incentives**
  - Early introduction
  - **Advanced Technology Credits**
    - Hybrid powertrains with energy storage systems
    - Rankine cycle engines
    - All-electric vehicles
    - Fuel cell vehicles
  - **Innovative Technology Credits**

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## Partitioning the System





**Power Demand  
"Passive"**

- ▶ **Fuels**  
Reduced carbon intensity  
Bio Diesel, CNG, LNG
- ▶ **Engines**  
Efficiency improvements  
Reduced Carbon Fuels  
Hybrids / Waste Heat Recovery
- ▶ **Vehicles**  
Transmissions / Axles / Tires  
Aerodynamics  
Tractor & Trailer - Smartway
- ▶ **Fleets / Operators**  
Incentives for low GHG vehicles  
Logistics, Driver training & aids
- ▶ **Highways / Infrastructure**  
Highway Construction / Congestion  
Speed limits  
GVW


**Power Supply  
"Active"**





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### Framework for the Regulation of Greenhouse Gases from Commercial Vehicles

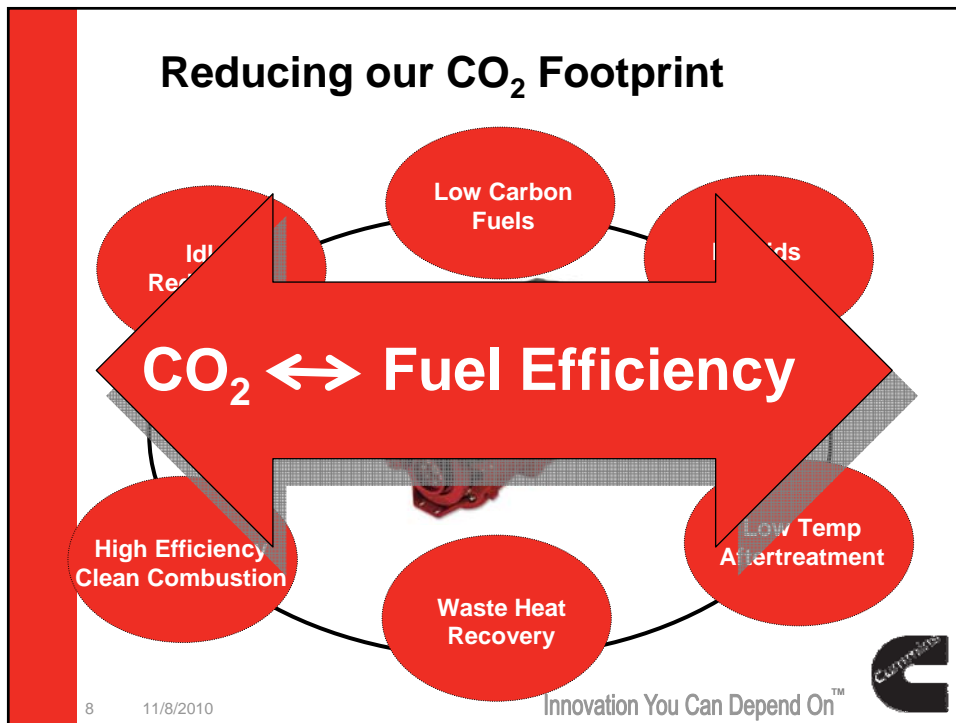
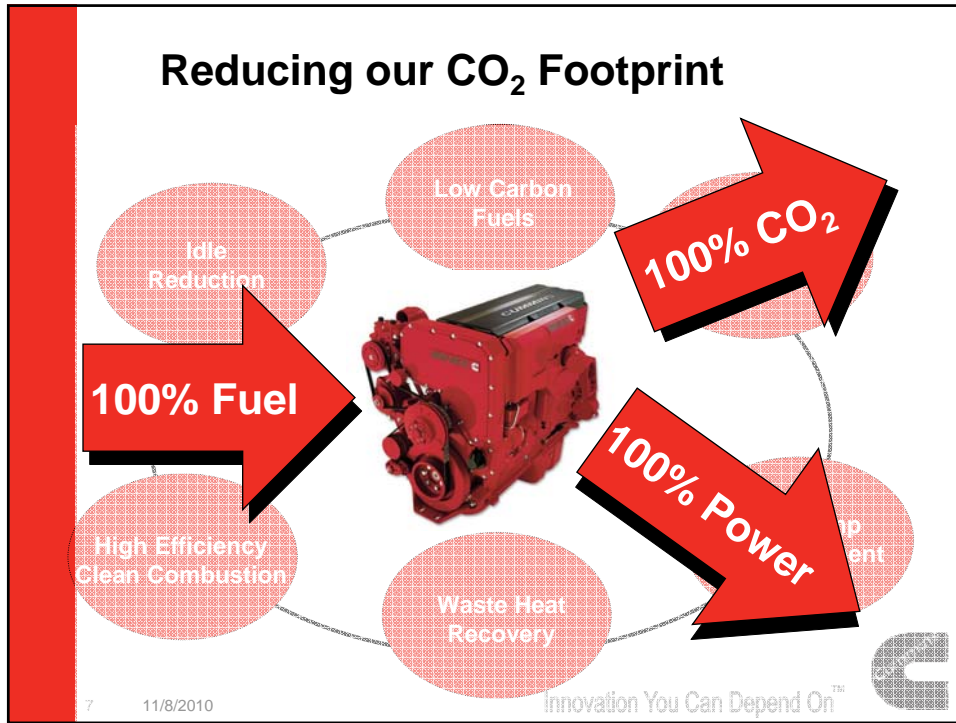
**Cummins Inc.  
Columbus, Indiana  
August 6, 2009**

This paper has been written at the request of the National Academy of Sciences following their site visit to Cummins Inc. May 15, 2009, in conjunction with the NAS project, "Assessment of Fuel Economy Technologies for Medium and Heavy Duty Vehicles". It documents Cummins' current perspective on a regulatory framework that could also provide a useful structure for technology assessment and grouping for fuel efficiency improvement and greenhouse gas reduction from medium and heavy-duty commercial vehicles. It was first presented to NAS on August 6, 2009. This document reflects revisions as of August 11, 2009. For more information, contact Jeffrey P. Seeger, Automotive Customer Engineering and Controls, at jseeger@cummins.com.


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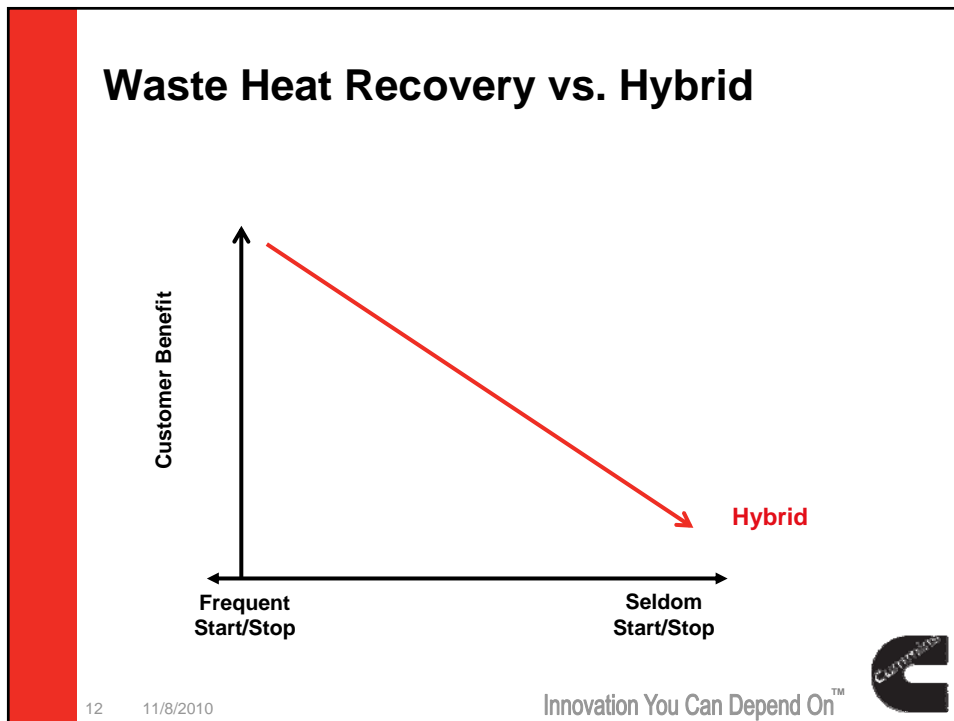
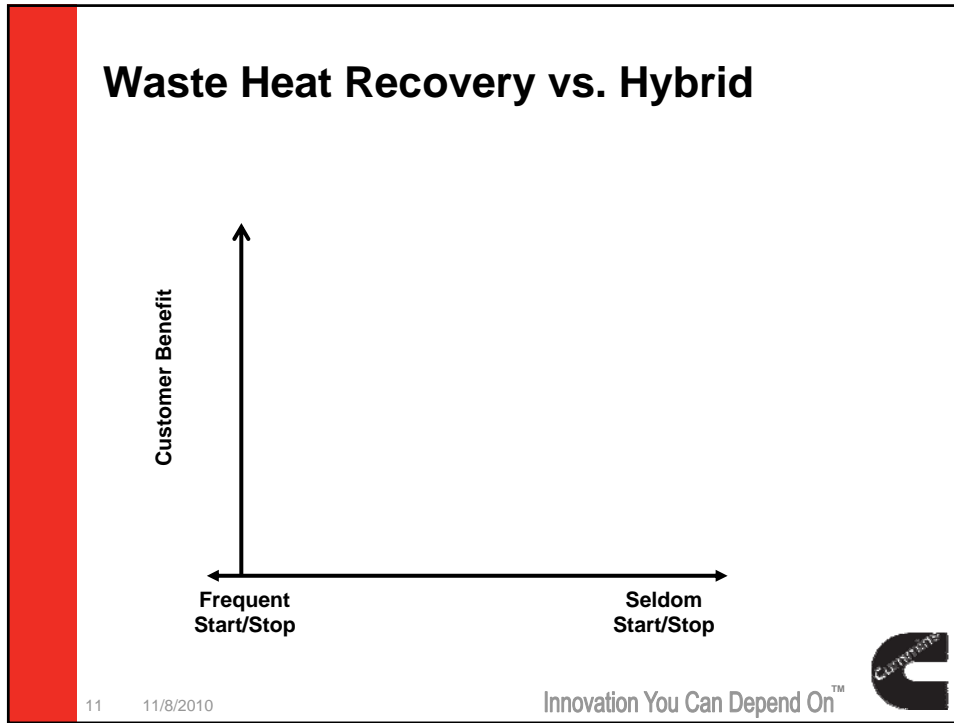


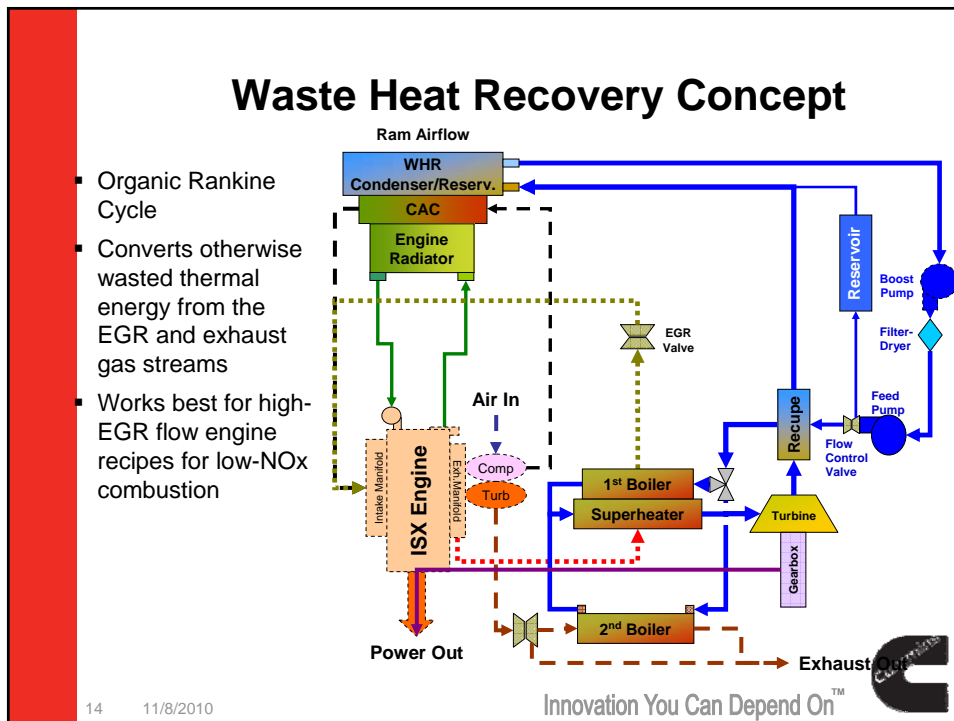
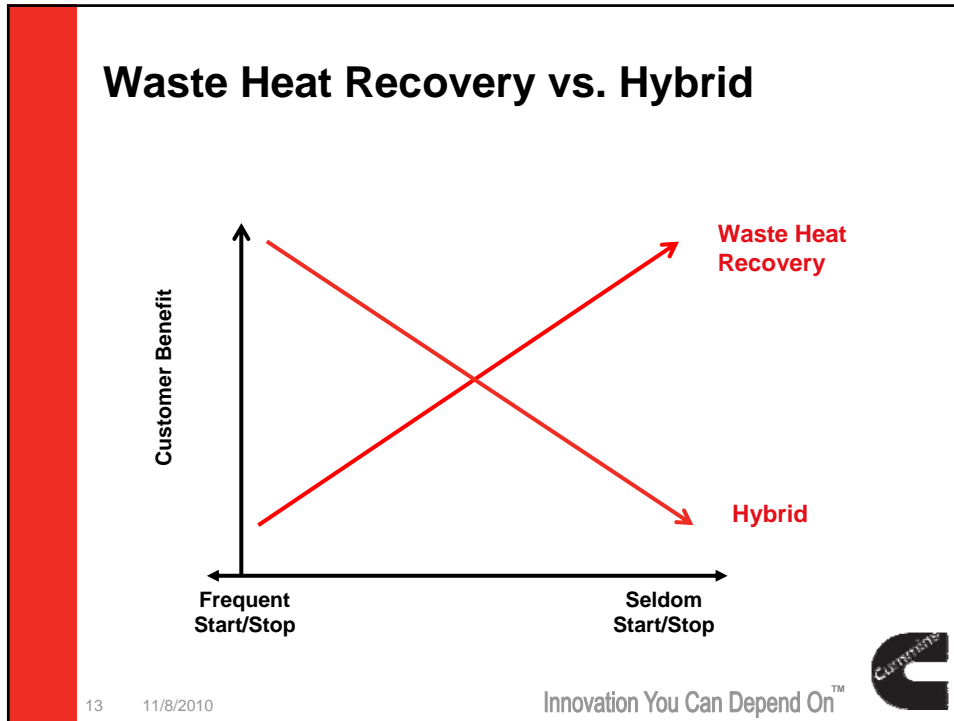
### Reducing our CO<sub>2</sub> Footprint

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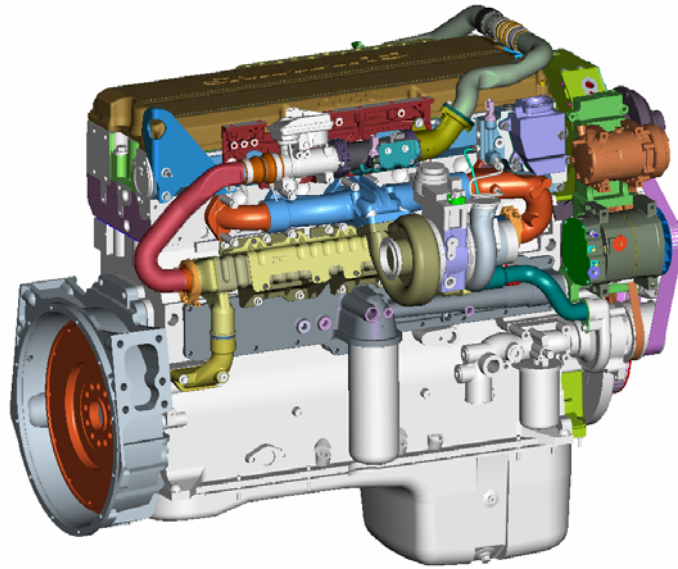
### Reducing our CO<sub>2</sub> Footprint

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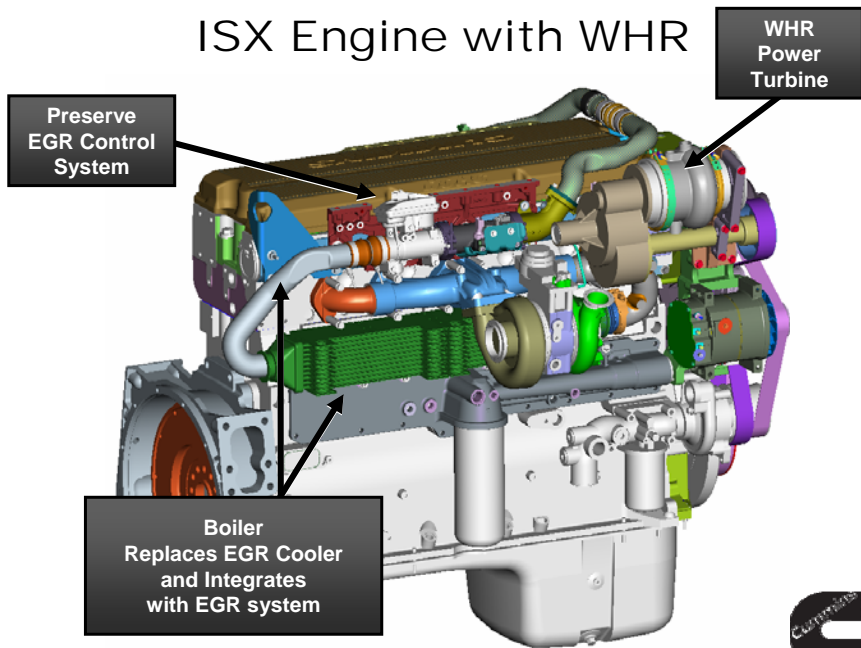
### ISX Engine with EGR



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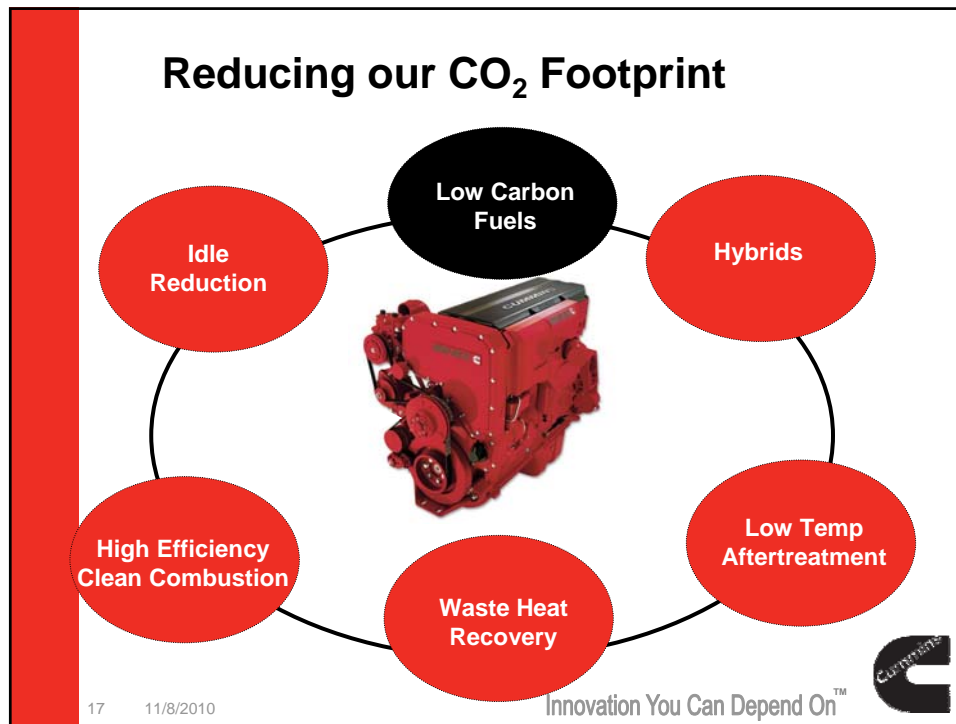
### ISX Engine with WHR




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- ## “Low Carbon” Fuels
- Renewable sources
  - Less carbon in the fuel molecule
  - Engine technologies are available today
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- 

## “Low Carbon” Fuels

- Renewable – Biodiesel
  
- Less carbon – Natural Gas (~methane)
  - May be gas (CNG) or liquid (LNG) ... and renewable
  - Much lower carbon than diesel
    - Methane C:H = 1:4
    - Diesel C:H ~ 1:2
  - Much lower energy per liter than diesel so more frequent refueling required

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## “The Right Technology Matters”



- Long-distance fleets
- Return home infrequently
- Good fit for **diesel - biodiesel**



- Locally domiciled fleets
- Limited range requirements
- Good fit for **natural gas**

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## Infrastructure: Natural gas fueling corridors are not enough

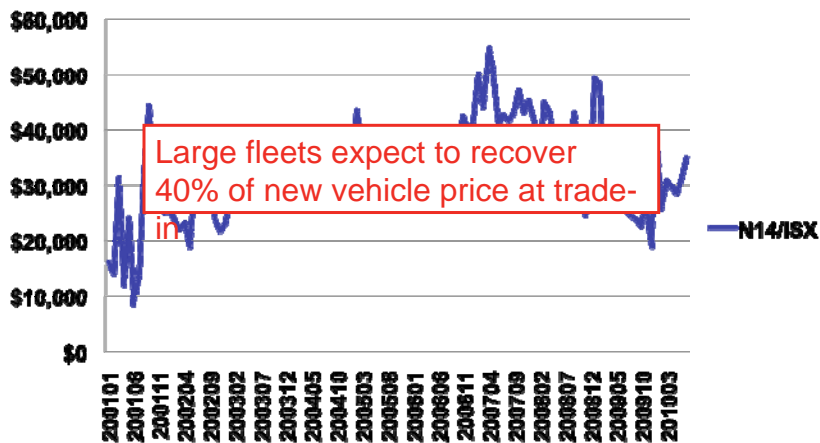
- Resale/Residual value important component of initial purchase decision
- Used truck markets are becoming international
- Natural gas vehicles captive to corridor undermines resale

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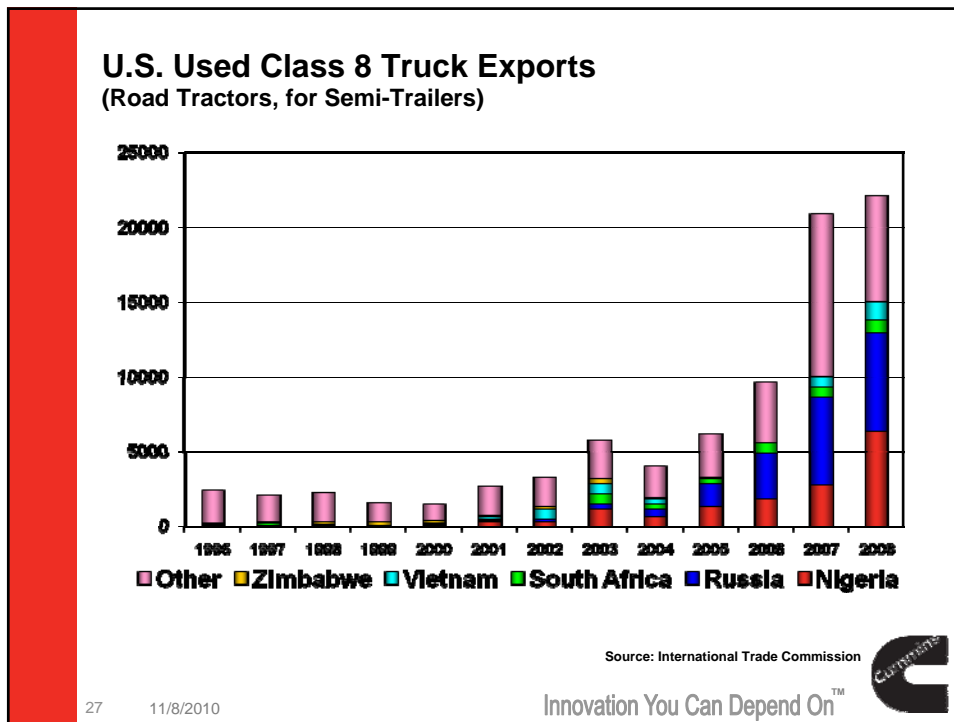
**USED U.S. CLASS 8 TRUCK SALES  
2001 - July 2010  
Average Selling Price  
Cummins N14/ISX**



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### Low-Carbon Fuel Policies must address full life cycle market economics

- Low fuel cost
- Low initial vehicle cost
- Availability of fueling stations / Productivity
- High resale value / broad resale markets

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