Metropolitan Washington Council of Governments

One Region Moving Forward

Moving goods in 2014 and beyond: engine, vehicle and fuel considerations

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Diesel Technology Forum members

- Amyris
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- BOSCH
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- Delphi Automotive
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- General Motors
- Honeywell
- Johnson Matthey
- Mazda North American Operations
- MTU
- Navistar
- Terra Environmental Technologies
- Umicore
- Volkswagen of America
- Volvo Group

Allied Members

- Association of Diesel Specialists
- Western States Petroleum Association

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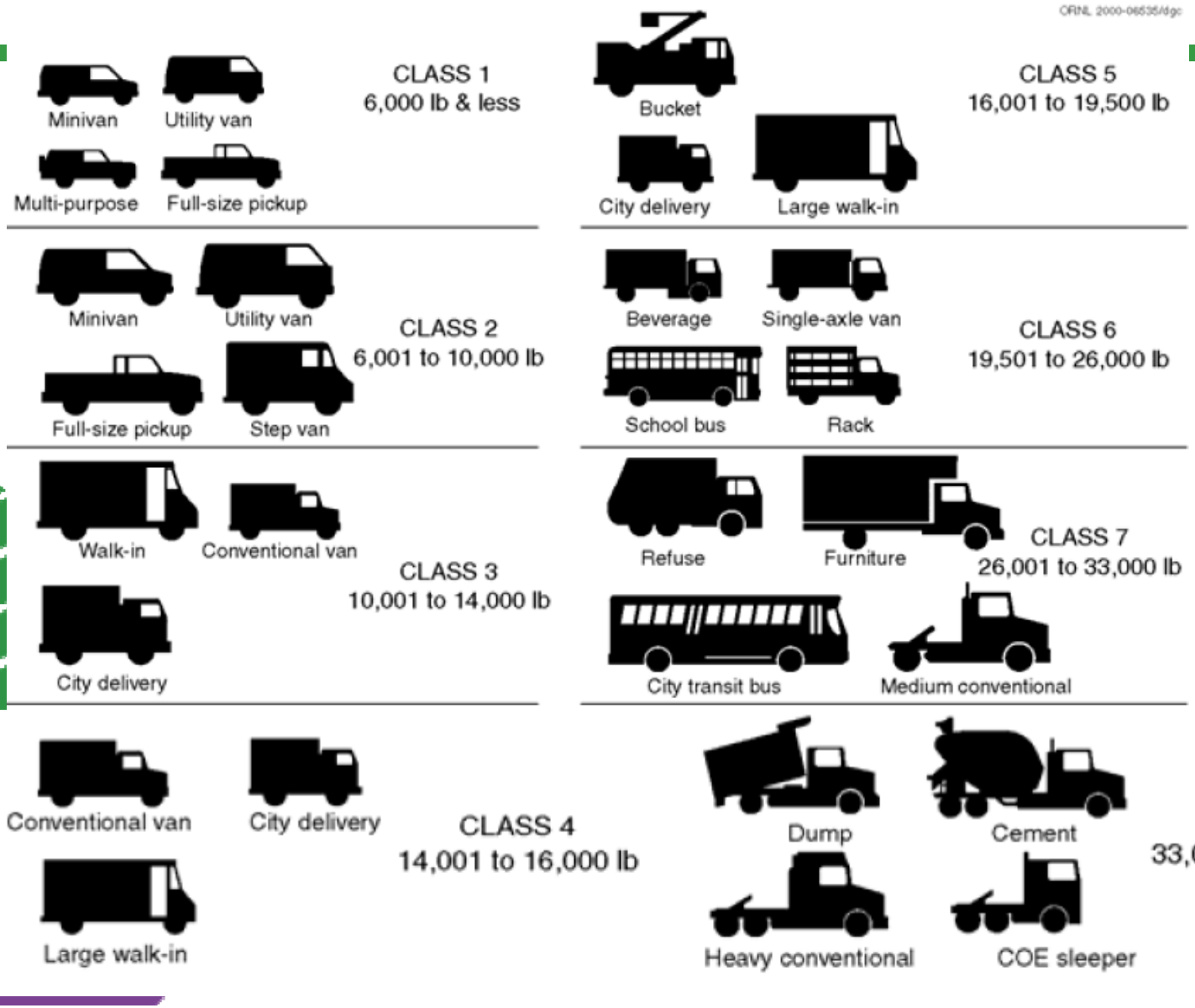
Lets talk about ….

- Where we are today
- Drivers for the Future
  - New Government requirements
  - Industry considerations
- Technology overview
  - Identify truck technologies which can help reduce fuel consumption
  - How truckers view fuel efficient technology and policy

First, what is a Truck? Trucks are tools of work; many different shapes and sizes



Here's what one truck is doing right now . . .

http://www.capitolchristmastree2011.org

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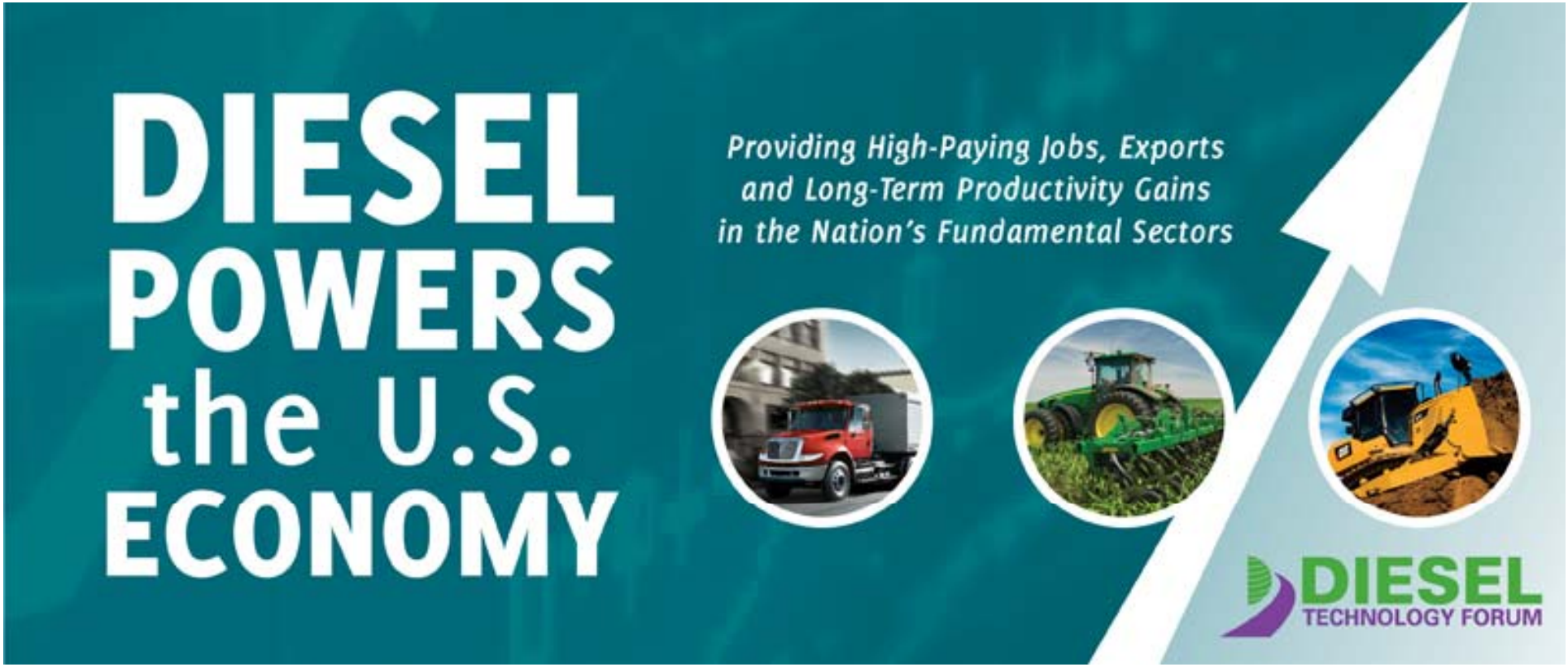
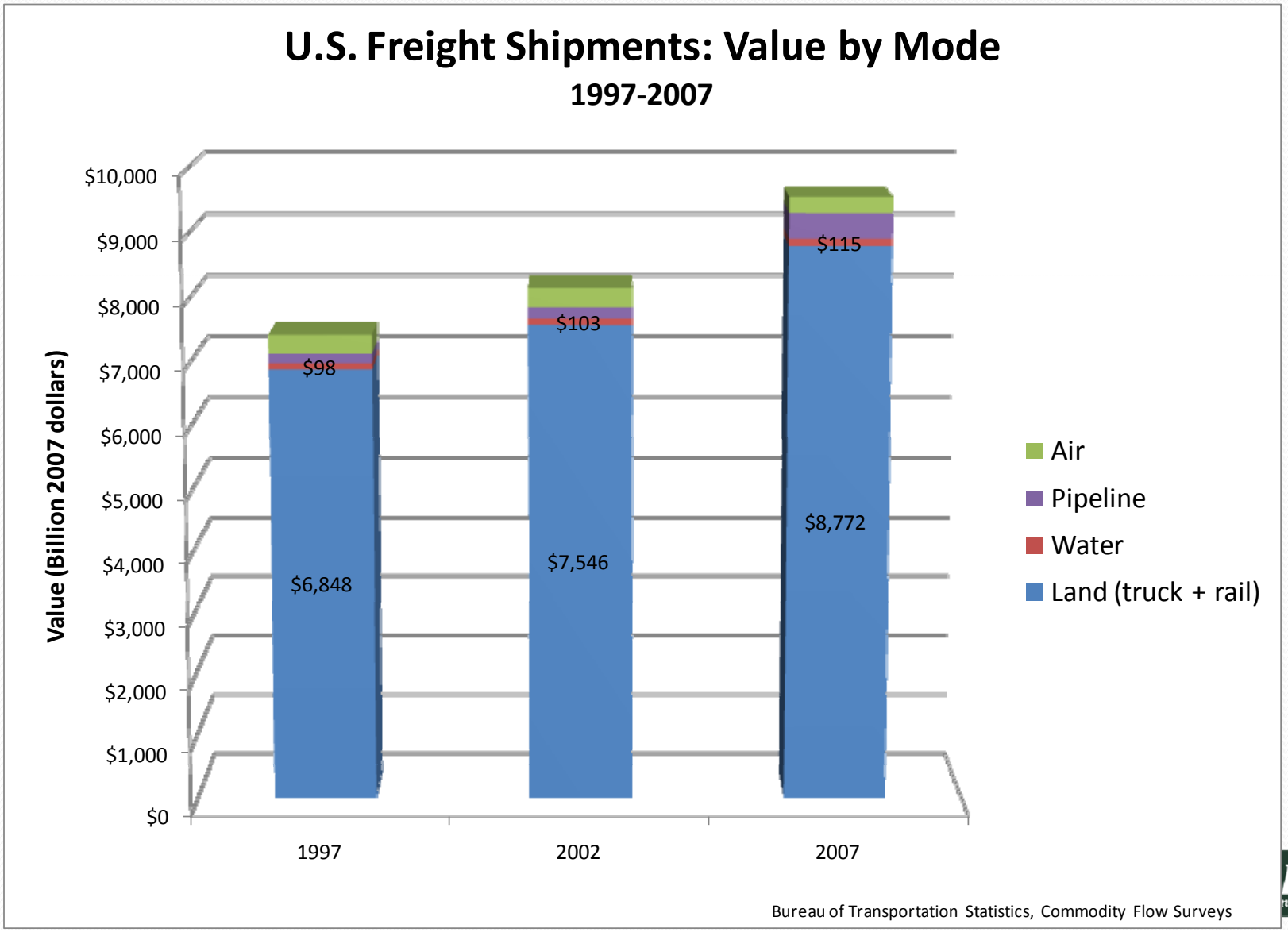


Study Findings

www.dieselforum.org/economicreport

83% of Freight Value Shipped Using Diesel



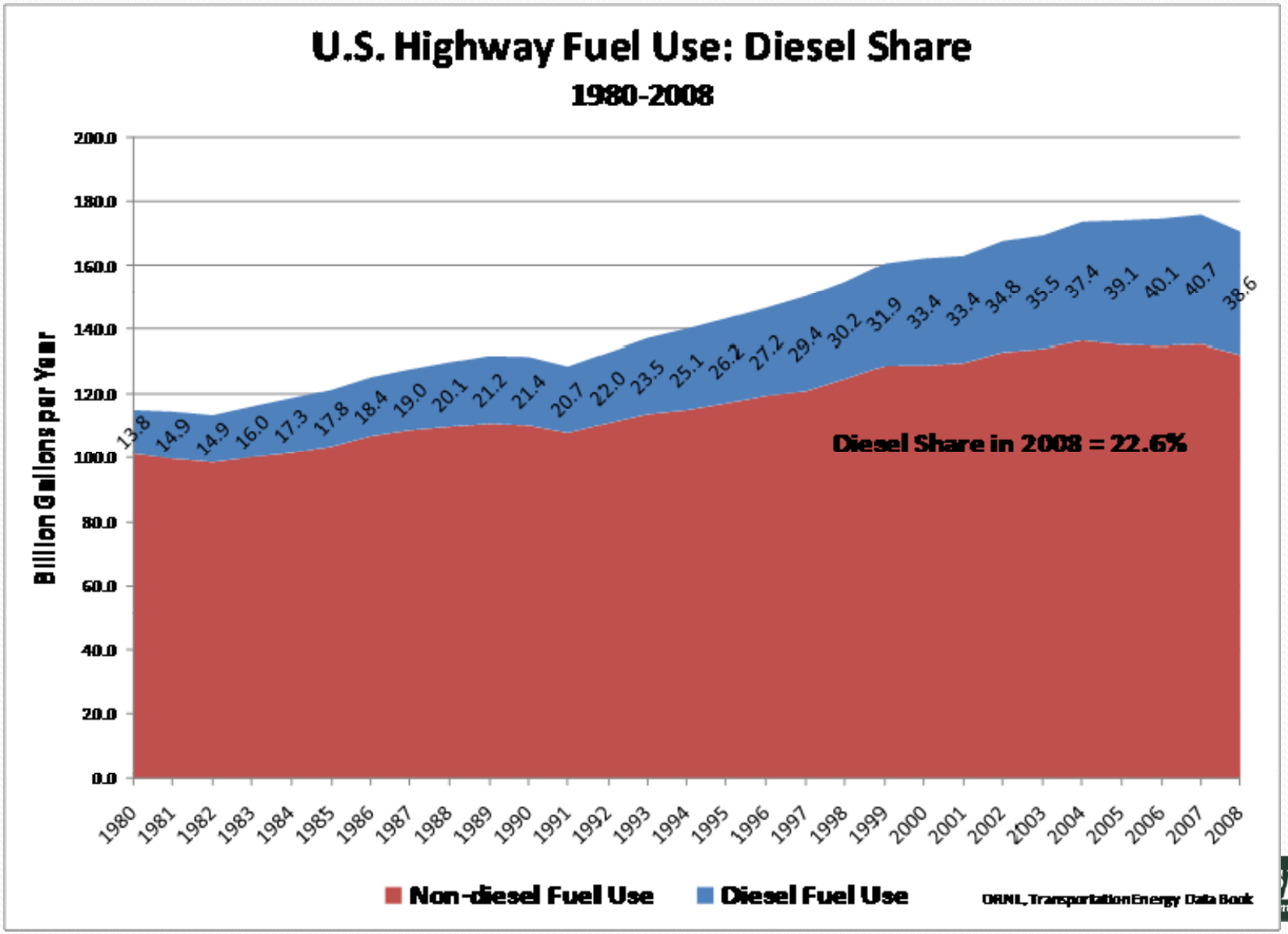
Bureau of Transportation Statistics, Commodity Flow Surveys

Diesel's Advantages

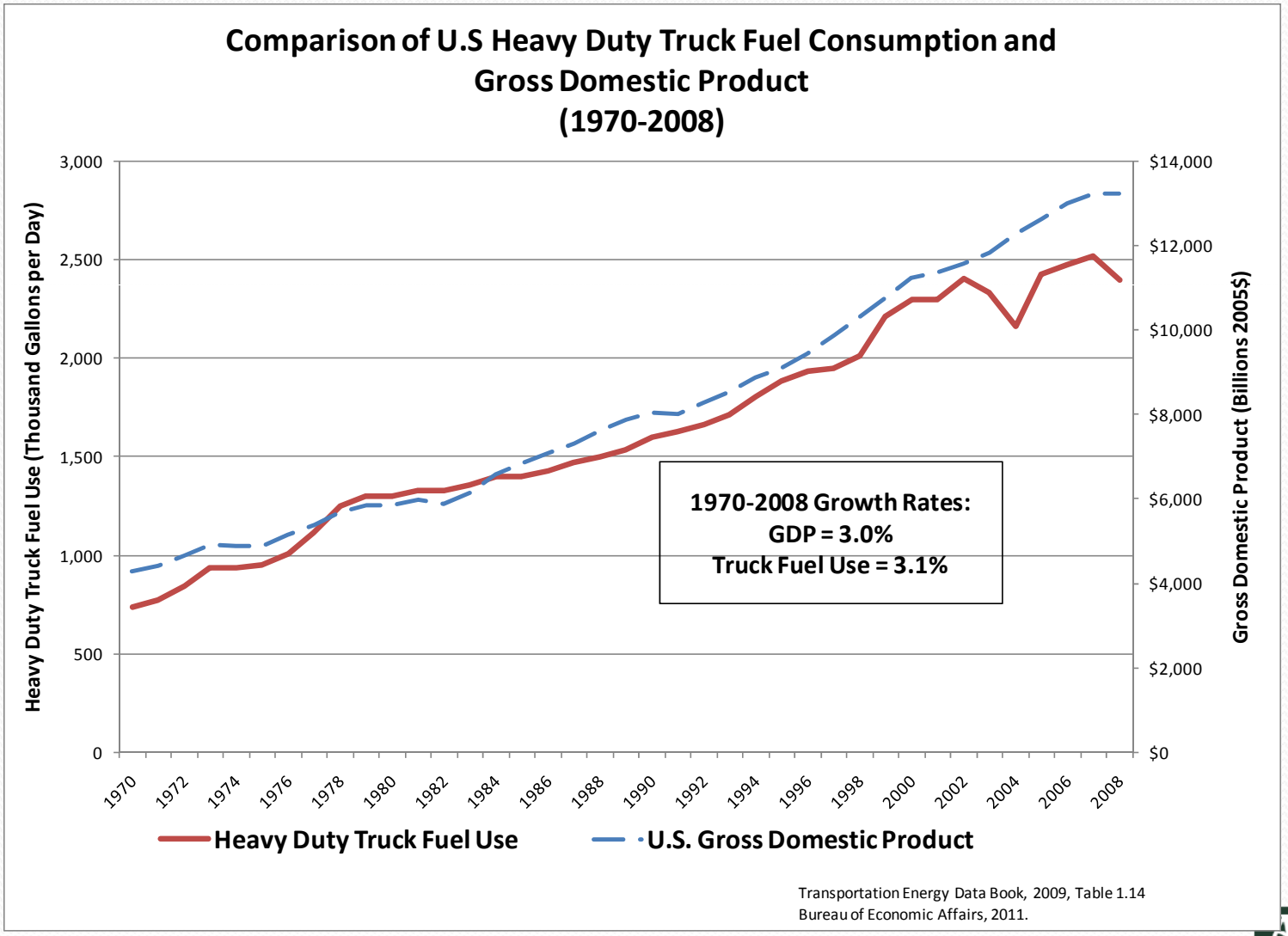
- **Energy efficient** -- 12 % more btu's/gallon than gasoline; higher thermal efficiency of engine– 30-40 % advantage
- **Power output** – high torque necessary to move heavy loads at safe speeds
- **Durability and reliability**
- Portability
- Fuel handling characteristics – less flammable than gasoline, less explosive characteristics than gaseous fuels
- Fuel flexibility – renewable fuels

Aspen Environmental Group

Diesel Share of Highway Fuel Use Has Grown 50% Since 1980



Diesel Fuel Use and GDP Growth Highly Correlated



Transportation Energy Data Book, 2009, Table 1.14
Bureau of Economic Affairs, 2011.

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Highlights of Diesel Importance to Specific Sectors

- 90% of agriculture's $1.2 trillion in shipments used diesel vehicles
- 98.5% of construction and mining fuel use is diesel
- 85% of transit vehicles and 49% of transit passenger-miles were diesel powered
- 83% of Army and Marine vehicles and engines are diesel powered

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Many Public Sector Functions Rely on Diesel

- Virtually all emergency vehicles, such as ambulances, fire engines and tow trucks use diesel engines
- Hospitals, data centers, air traffic control towers, pipelines and other critical service sectors often rely on diesel generators for emergency standby power
- National defense relies on diesel to move material, munitions and weapons, both between theatres and on the battlefield
- Non-rail transit mostly diesel powered

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How can we reduce fuel consumption and GHG emissions from Freight Movement?

- How the truck is **operated (all)**
  - drive less, idle less, limit speed, right-sizing vehicle to freight demand, logistics
- **How the truck is designed & equipped (new and old trucks)**
  - Engine/powertrain choices and efficiency
  - Reduce Rolling resistance – tires
  - Improve aerodynamics
- **How the truck is fueled (new and old)**
  - Lower carbon fuels (biodiesel, renewable diesel fuel)
  - Natural Gas,(CNG) LNG

Opportunity for efficiency improvements is significant: *small changes = big results*

- **Class 8 trucks** use 80% of all commercial trucking industry fuel – 28% of all fuel usage.

  From 1970-2007 the number of trucks more than doubled while mileage increased 3.9%.
- Heavy-duty trucks transport more than 70% of all U.S. goods purchased.
- 80% of communities are served exclusively by truck.

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Drivers impacting engine and fuel choices for the future

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Trucks of the Future will be 6-23 % more fuel efficient (2014-2018)

- New EPA/NHTSA truck rules highlights *MY 2014-2018*
- First ever Medium- & Heavy-Duty Truck Fuel Economy Standards *(applies only to new trucks)*
- Will reduce oil imports, fuel consumption, CO2 emissions, and operating costs for thousands of businesses
- Covers three distinct classes of vehicles – pick up trucks and vans, vocational vehicles and long-haul trucks

SUMMARY OF NEW RULE

- Anticipates 6- 23% percent fuel savings by MY 2018 *(more fuel savings from larger trucks*)
- Technology Neutral (Engines, fuels etc.)
- Accelerates the introduction of “off the shelf” technologies
  - Net effects – more hybrids in medium size trucks, more standardized idle limiting controls, light-weighting,
- * Does not address trailers

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Costs and benefits of new EPA/NHTSA Rule

	Final Rule
Percent Reductions (2018)	Tractors: 10-23% Vocational Vehicles: 6-9% Pickup Trucks & Vans: 12-17%
Vehicle cost (2018)	Tractors: $6,220 Vocational Vehicles: $380 Pickup Trucks & Vans: $1,050
Fuel Savings (2014-2018 lifetime)	530 million barrels oil
CO2eq Reduction (2014-2018 lifetime, Upstream + Downstream)	270 MMT
Costs*	$8.1 billion
Benefits*	$57 billion
Net Benefits*	$49 billion

New Generation Diesel Engines Deliver greater Fuel efficiency in long haul trucking

Typical Long Haul …

46,000	Payload (lbs)
23	Payload (tons)
150,000	Miles/year
6.0	Miles/gallon
0.26	Gallons/ton/mile
25,000	Gallons/truck/year
$100,000	Fuel cost per year *

2011 clean diesel engine …

+5%	Improved fuel efficiency
1250	Gallons saved/year
14	Fewer tons CO_2 year
$5000	Fuel savings per year *

** Assumes $4/gallon*

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Transportation Fuels & the future: diversity, low-carbon

Amyris diesel fuel (clear) in front; petroleum diesel (yellow) in the back

- Diesel (Ultra-low sulfur diesel fuel) remains the primary fuel powering commercial vehicles
- Blends of diesel and biofuels are available today and more are coming – EPA RFS 2 standard (*119 Million gallons of biodiesel produced last month; 1 Billion this year)*
  - Basic Biodiesel – (Fatty Acid Methyl Ester) – from soy, canola, palm, rapeseed, peanut, etc.
  - Second Generation Renewable Biofuels –
    - Engineered yeast molecules, cellulosic production, algae farms
- Key questions: Cost!

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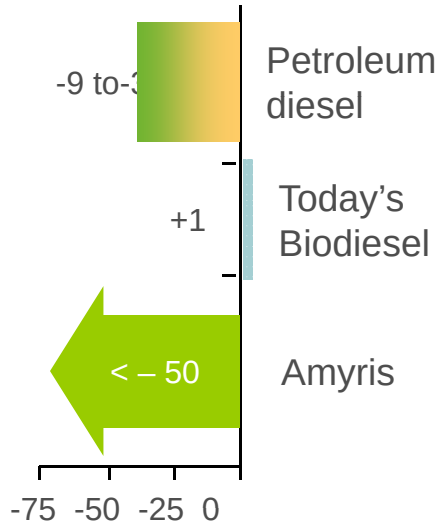
Second Generation Renewable Fuels have great potential: Amyris Renewable Diesel *Approved by EPA for 35% Blends*

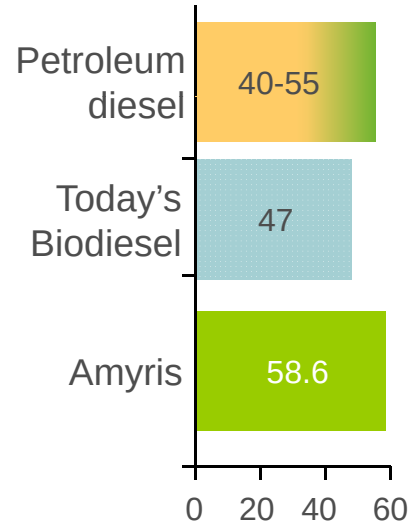
Validated by external labs as a "best-in-class" product, meeting ASTM D975 fuel properties with zero sulfur.

Cloud Point
degrees Celsius



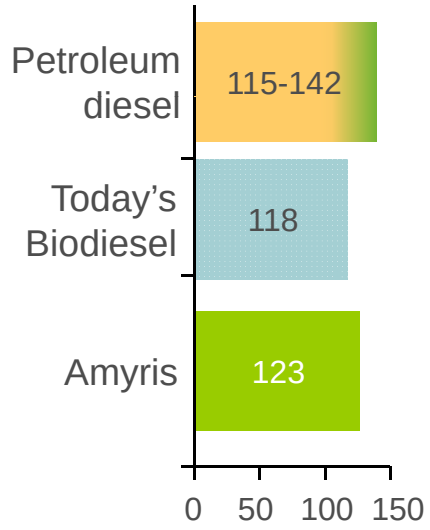
Temperature below which wax in diesel form a cloudy appearance. Solidified waxes thickens the oil and clogs fuel filters and injectors in engines

Cetane Number



Measure of fuel's ignition delay – higher cetane number has lower ignition delay.

Energy Density
1000 BTU/gal



Amount of energy stored per unit volume – directly impacts miles per gallon (km per liter)

Amyris diesel will be used in blends with conventional fuels; values shown for Amyris diesel is for biomass derived blending component.

AMYRIS

FUELS -- 2

- Plug-in electric (battery) vehicles will gain some market share in local pick-up and delivery trucks
- Hydrogen, Fuel Cells, unlikely to reach commercial scale for transport vehicles.

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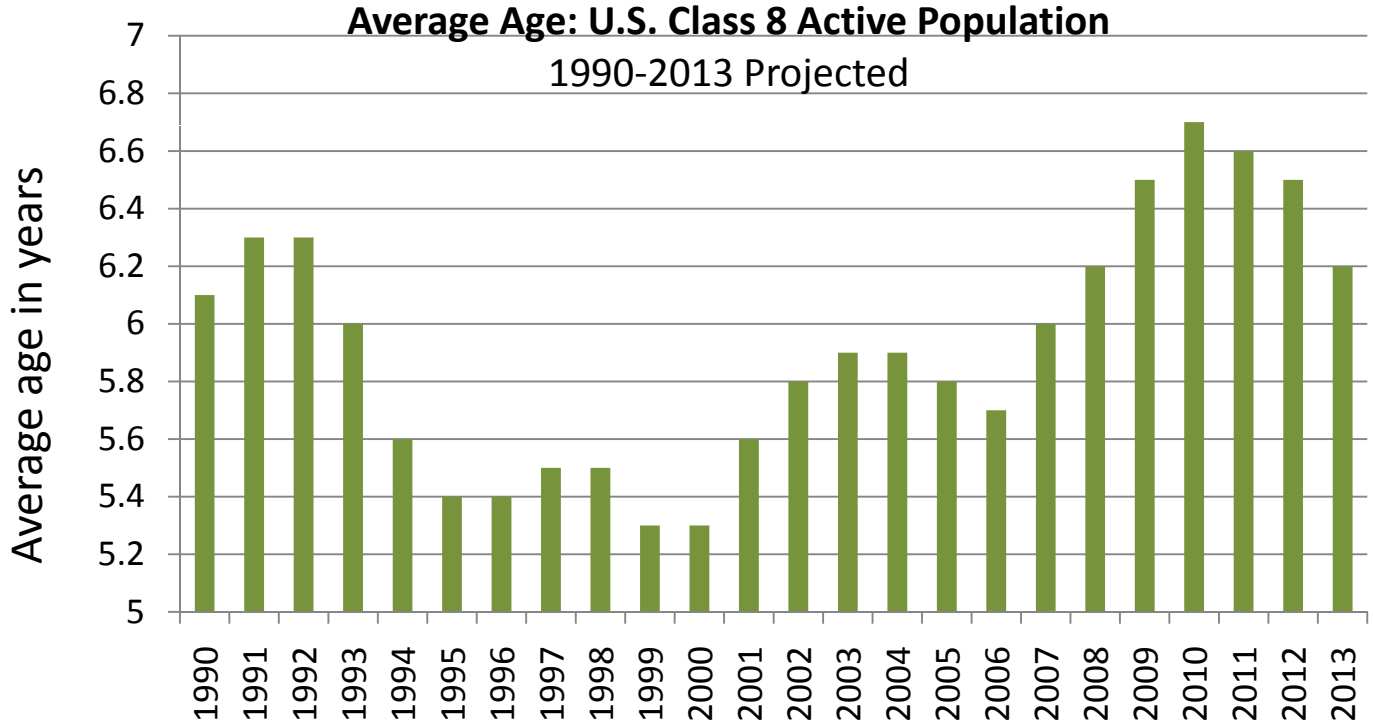
WHAT ABOUT NATURAL GAS?

- Compressed natural gas is quite feasible for local operations, but has inadequate power density for long-haul
  - Tanks too large and heavy for long distances
- Liquid natural gas is feasible for long haul if fueling infrastructure is assured
  - Can't invest heavily without assured fuel supply
  - Clear commitment to infrastructure and supply needed to drive investment decisions
- Cost- today fuel cost per gallon equivalent is lower than diesel – BUT highly dependent on cost, access to Marcellus shale and other deposits
- Infrastructure costs are substantial – pipeline upgrades, compressors etc.

Increasing Age of U.S. Truck Fleet delays fuel savings and emissions gains from new technology



Source: ACT Research Co., LLC

Older trucks = Higher fuel consumption & Higher Emissions

What Drives Truck Buyers to Buy?

Fuel Economy

- **Largest variable cost of operation**

Weight

- **More freight, enhanced revenue**

Price

- **Must make good business sense**
- **Alternative: Older, less environmentally-friendly, less fuel efficient equipment**

Reduce Idle time by 70%

Speed limiters (60mph)

Right-sizing vehicle to match freight needs

Light-weighting, engine downsizing 6cyl-4cyl

Summary

- **Diesel remains the mainstream goods movement technology;** *it will use more low-carbon biodiesel fuels in the future*
- **Today's NEW Clean Diesel trucks**
  - are near zero emissions; as good or better than CNG
  - are achieving 5-6% increases in fuel economy
  - (*Higher fuel economy is lower GHG/CO2 emissions)*
- **Tomorrow's New Clean Diesel trucks will do better.**
- **Niche penetration of Electric, Fuel Cell, Natural Gas fuels in commercial trucks**
  - Lower fuel costs, diversify fuel sources

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THANK YOU

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