

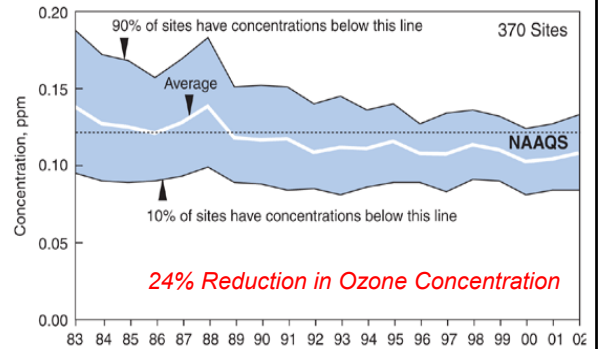
Diesel Emission Control in the United States



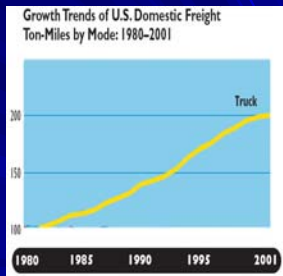
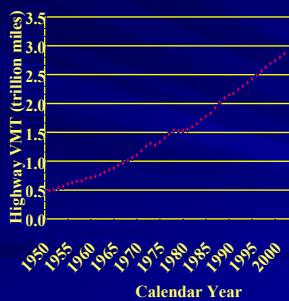
Joseph McDonald

Office of Transportation and Air Quality
U.S. Environmental Protection Agency

Ambient Air Quality-- Making Progress

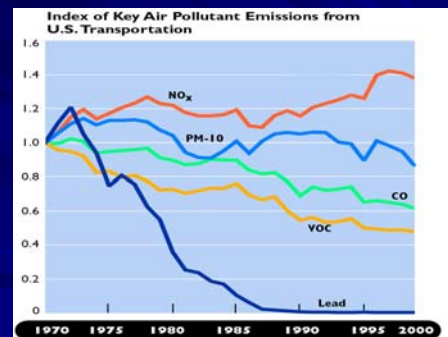


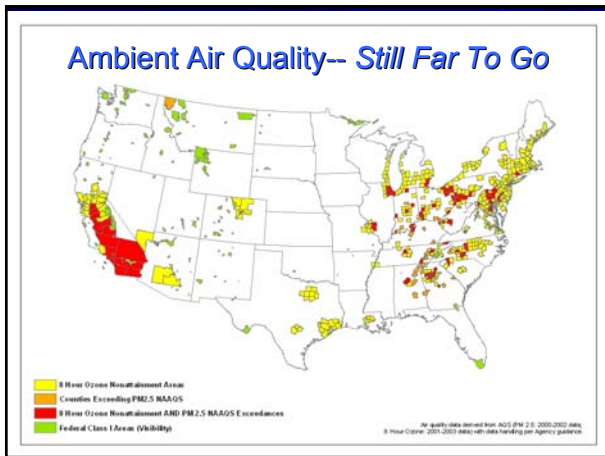
Growth In Transportation



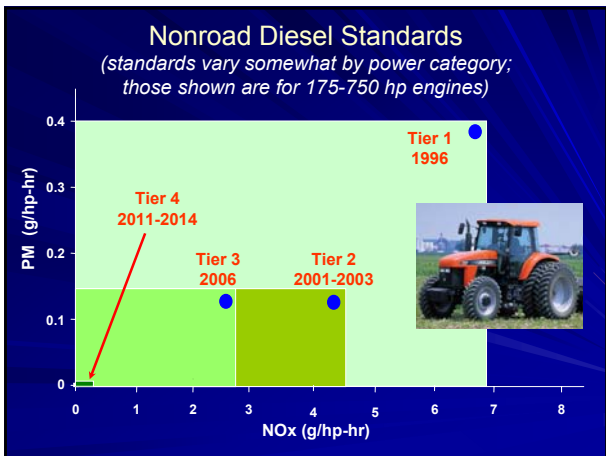
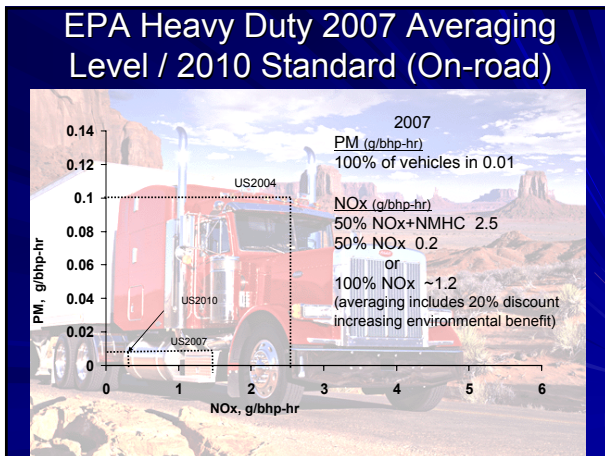
Source: U.S. Department of Transportation - Bureau of Transportation Statistics

Emission Trends



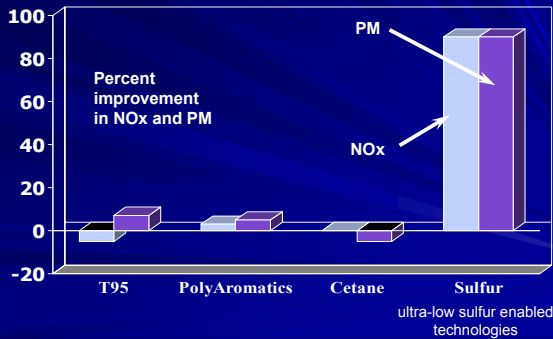


- ### EPA Clean Fuel & Vehicle Programs
- Tier 2 Standards (1999 rulemaking)
 - Gasoline sulfur control (30 ppm average)
 - Stringent light-duty vehicle standards (beginning in 2004)
 - Same standards for light trucks and cars
 - Same standards for gasoline and diesel
 - Heavy-Duty 2007 Standards (2000 rulemaking)
 - Diesel sulfur control (15 ppm maximum, beginning 2006)
 - Stringent heavy-duty gasoline & diesel vehicle standards
 - PM filter forcing standards, NOx catalysts based standards
 - Nonroad Tier 4 Standards (2004 rulemaking)
 - Diesel sulfur control (2 steps - 500 ppm in 2007, 15 ppm in 2010)
 - Stringent emission standards, based on on-highway standards
 - Diesel Retrofit (ongoing)
 - Ultra-low sulfur diesel fuel enables diesel PM retrofits
 - Realize substantial air quality and health benefits earlier
 - Locomotive and Marine Diesel Standards (rulemaking in process)
 - Marine diesel sulfur control (15 ppm maximum) in 2012
 - Considering requiring same technologies as on-highway and nonroad
 - Proposed rulemaking in 2005



Why Focus on Ultra-Low Sulfur?

Some Data On Fuel Effects



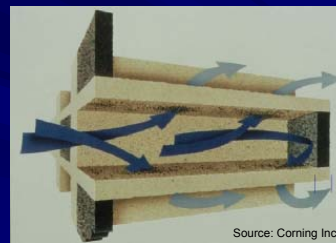
Why Ultra-Low Sulfur Fuels?

- Sulfur is a catalyst poison, harming catalyst function
- Removing sulfur, much like removing lead from gasoline, allows for maximum catalyst efficiency
 - All advanced catalyst technologies benefit from ultra-low sulfur fuel
- Reductions in fuel sulfur give immediate PM reductions
- Diesel (Highway and Nonroad) Diesel
 - Enables PM filters that can eliminate 99% of carbonaceous PM
 - Significant reductions of in-use PM due to near elimination of sulfate PM
 - Enables advanced NOx catalysts giving 90+% reductions
 - Enables diesel PM retrofit technologies
- Tier 2 Gasoline
 - New Tier 2 vehicles have near zero running emissions
 - Existing vehicles see significant improvement from the new fuel
 - Catalysts recover function lost due to sulfur in existing fuel

Advanced Diesel Exhaust Emission Control Technology

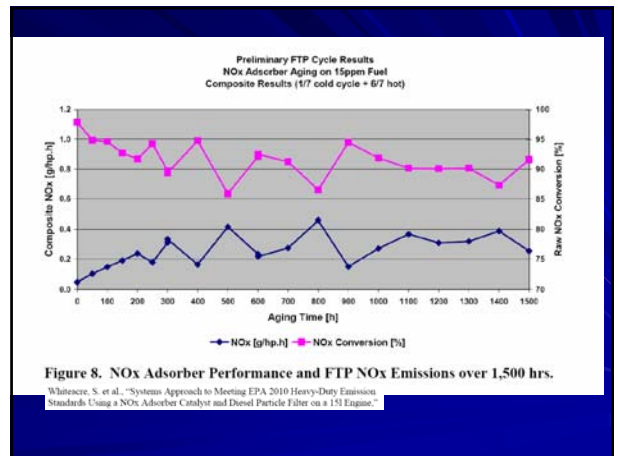
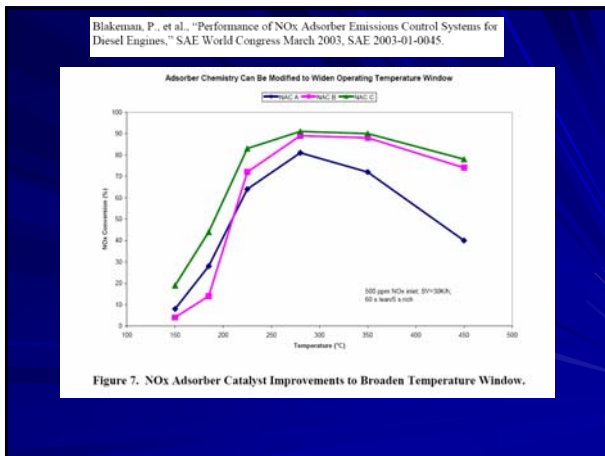
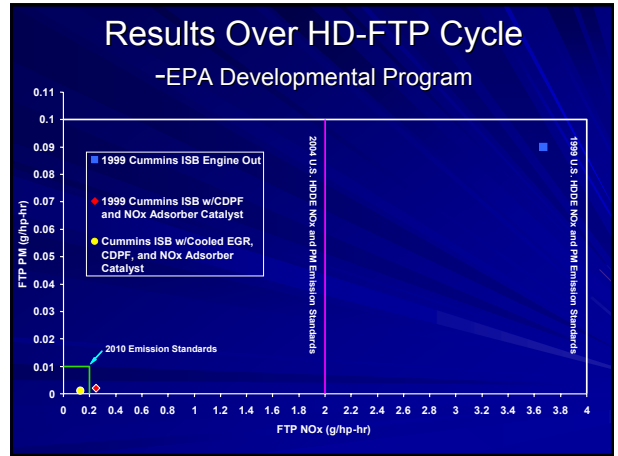
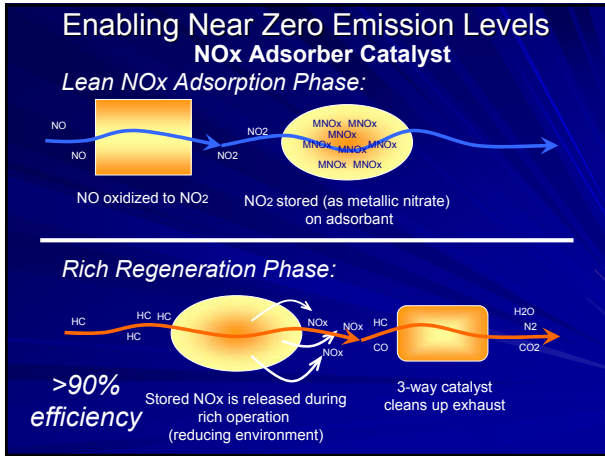
- Advanced exhaust emission control systems
 - PM traps
 - Applied directly to the wall-flow trap substrate (Toyota DPNR, others)
 - Applied to flow-through substrates (other systems)
 - NOx adsorption catalyst coatings
- DeNOx, DeSOx and forced PM regeneration
 - In-cylinder
 - In-exhaust
 - Combinations of both

Enabling Near Zero Emission Levels



Catalyzed Diesel Particulate Filters (CDPFs) can eliminate 99% of solid particles (soot & metals) can eliminate >90% of semi-volatile hydrocarbons





Caterpillar Presentation 2003 DEER Conference

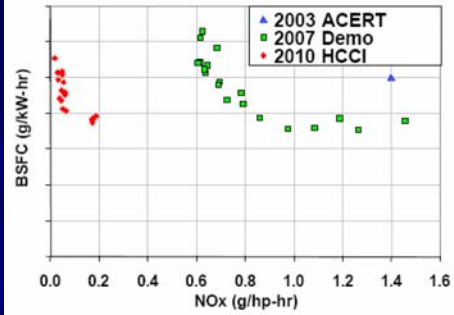
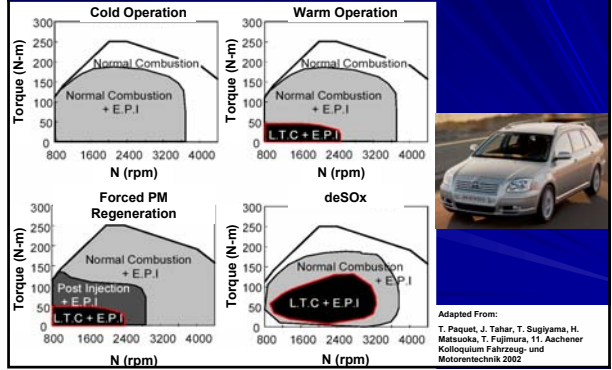


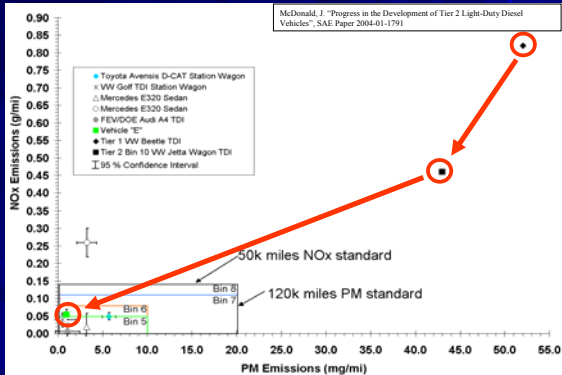
Figure 17. Emission and Fuel Economy Trade-Offs for Future Technology Engines.

Operating Modes (Toyota Avensis D-CAT)

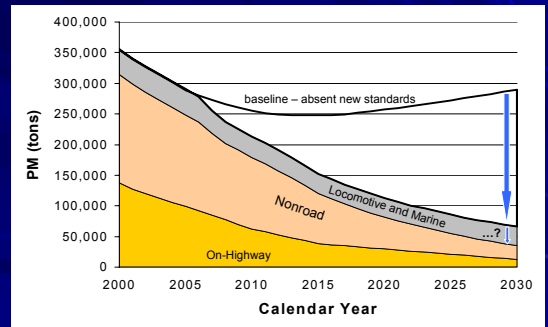


Adapted From:
 T. Paquet, J. Tahar, T. Supiyama, H. Matsuo, T. Fujimura, 11. Aachener Kolloquium Fahrzeug- und Motortechnik 2002

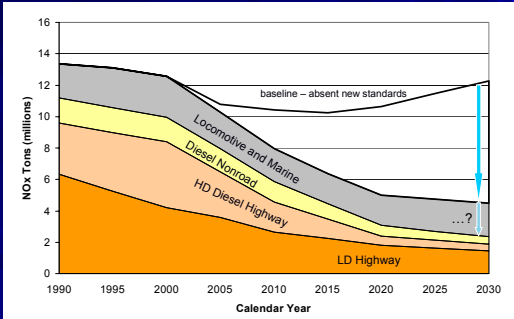
EPA Presentation 2004 SAE Congress



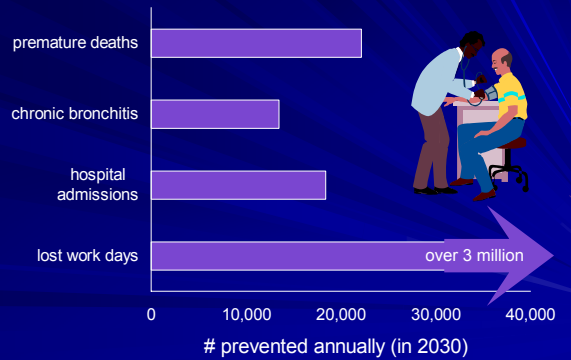
Clean Fuel and Vehicle Programs Diesel PM Reductions



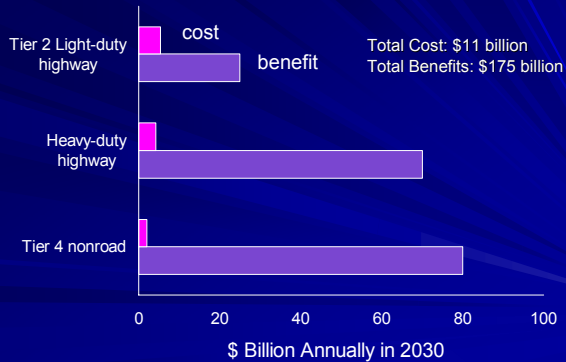
Clean Fuel and Vehicle Programs NOx Reductions



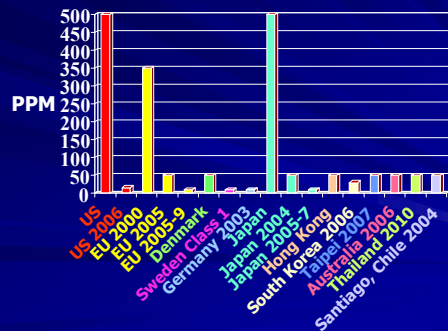
Benefits of Clean Fuel and Vehicle Programs



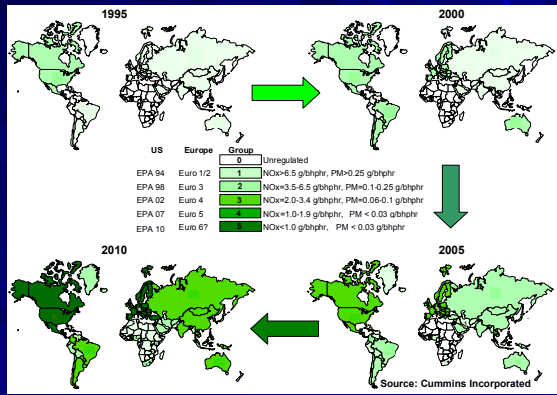
Costs & Benefits of Clean Fuels and Vehicles



Air Quality Needs Driving World to Ultra-Low Sulfur Diesel



Engine Standards Follow Ultra-Low Sulfur Fuel



Clean Fuels

It All Starts with Clean Fuels

Clean Vehicles

Clean Air

- Around the world, people are realizing the substantial public health hazards posed by diesel & gasoline vehicles
- The solution is in clean fuels and clean vehicles
 - remove the sulfur to enable PM and NOx catalysts
- Clean fuels also open the door for retrofits
 - to accelerate benefits and prove-out new technologies

Thank you



