

# Overview of the DOE Heavy Vehicle Technologies R&D Program

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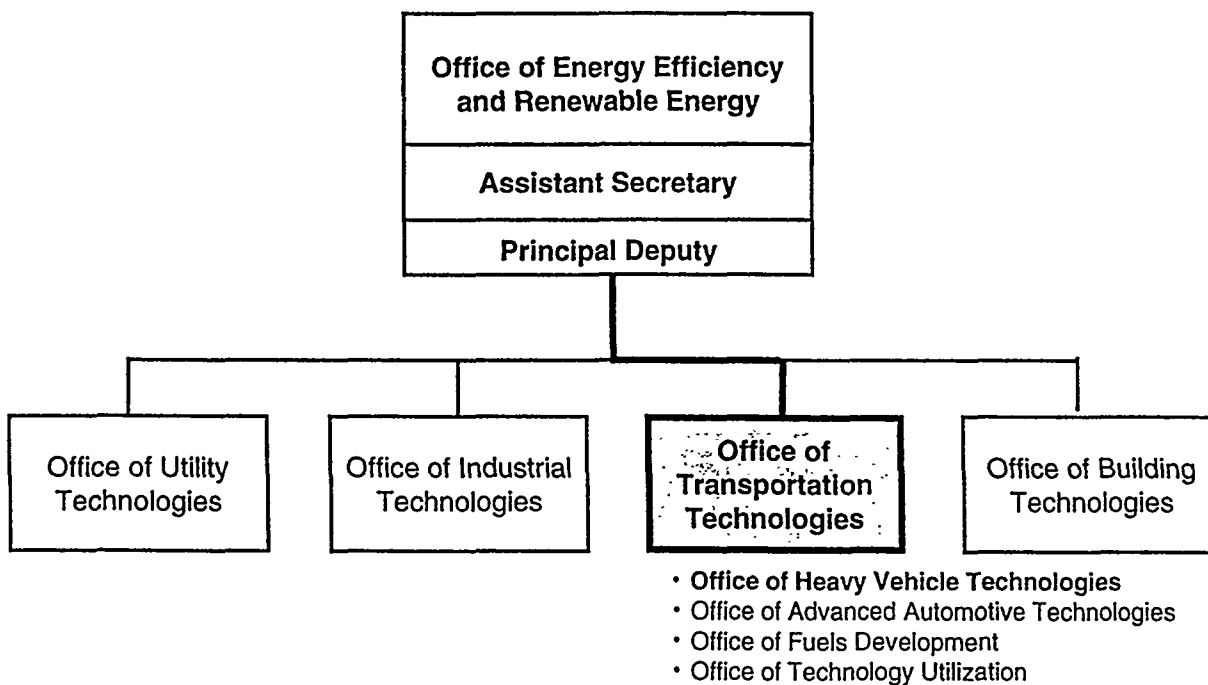
Presented at the  
*Workshop on Low Emission Diesel Engine Oils*  
Scottsdale, AZ  
January 30 to February 1, 2000



## **OHVT Mission**

*To conduct, in collaboration with our heavy vehicle industry partners and their suppliers, a customer-focused national program to research and develop technologies that will enable trucks and other heavy vehicles to be more energy efficient and able to use alternative fuels while simultaneously reducing emissions.*


## DOE Office of Energy Efficiency and Renewable Energy



# Office of Heavy Vehicle Technologies

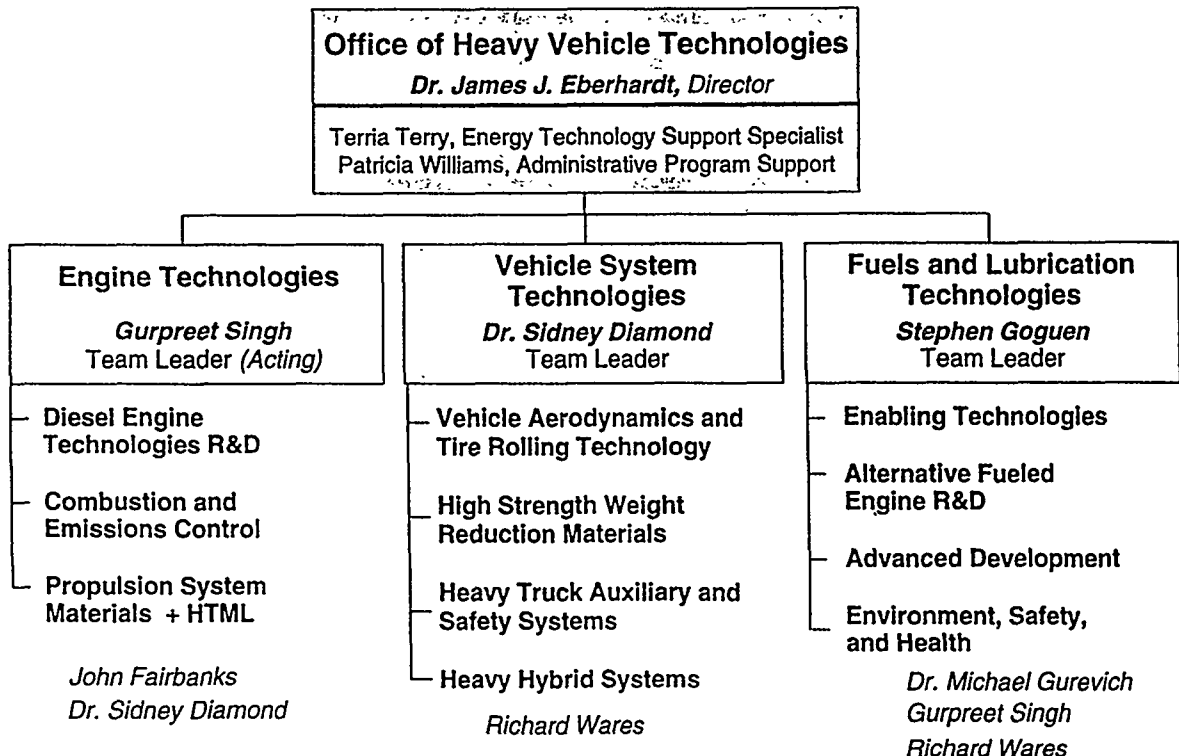


- ◆ The U.S. Department of Energy - Secretary
  - ◆ Efficiency and Renewables - Deputy Assistant Secretary, Transportation Technologies
    - ◆ **Office of Heavy Vehicle Technologies**
      - ◆ Created in the DOE/Office of Transportation Technologies restructuring (March 1996)
      - ◆ Focuses research and development on critical areas identified with heavy vehicle customers



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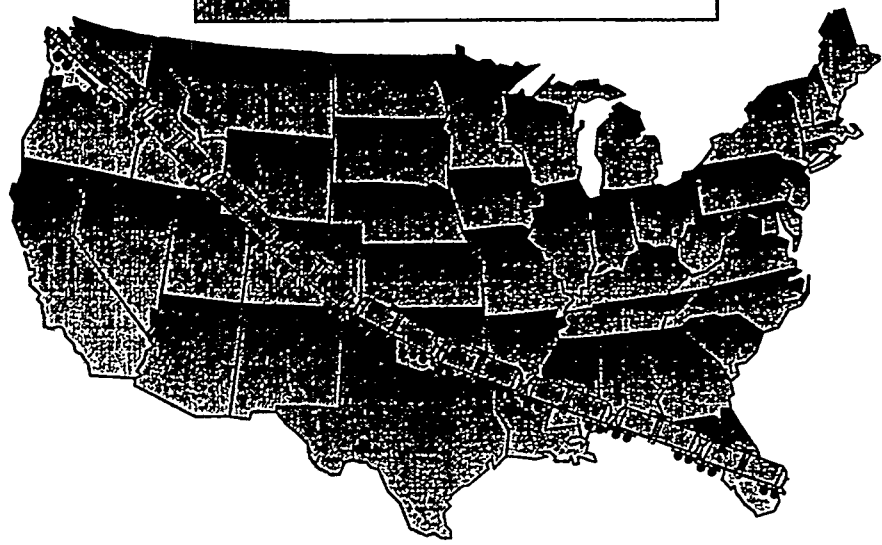
## Office of Heavy Vehicle Technologies Program Coordination Structure



# The Magnitude of Our Energy Problem



	1973	1997
U.S.	74 Quads	91 Quads
World	225 Quads	365 Quads

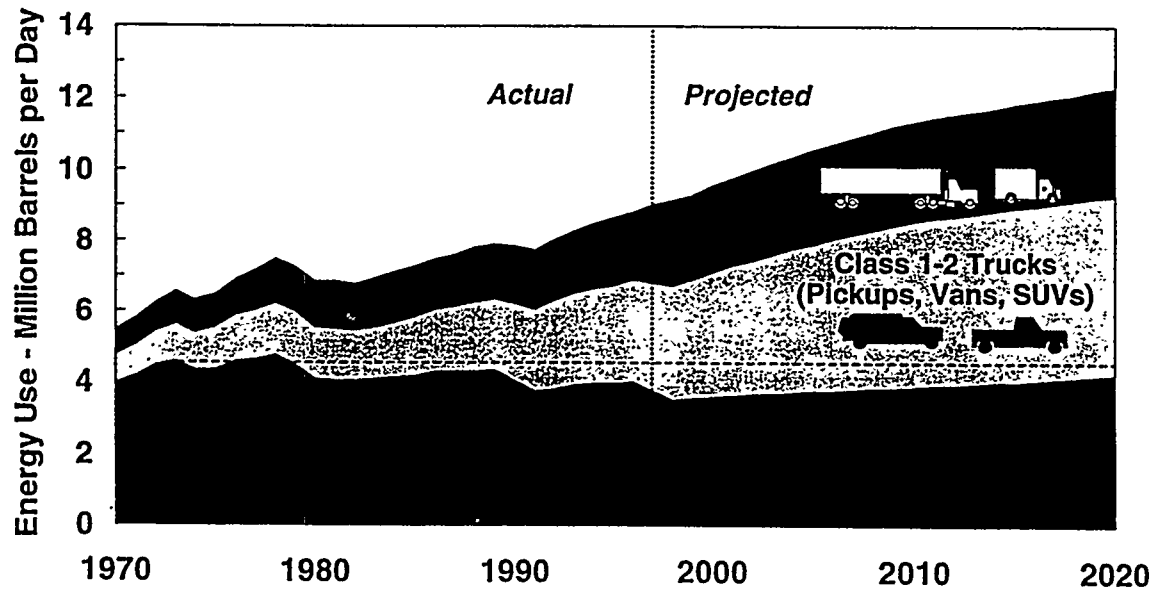


1 Quad of energy is equivalent to 340,000 tank cars of crude oil stretched from Miami to Seattle (3,300 miles).

## Rationale for a Heavy Vehicle Technologies R&D Program

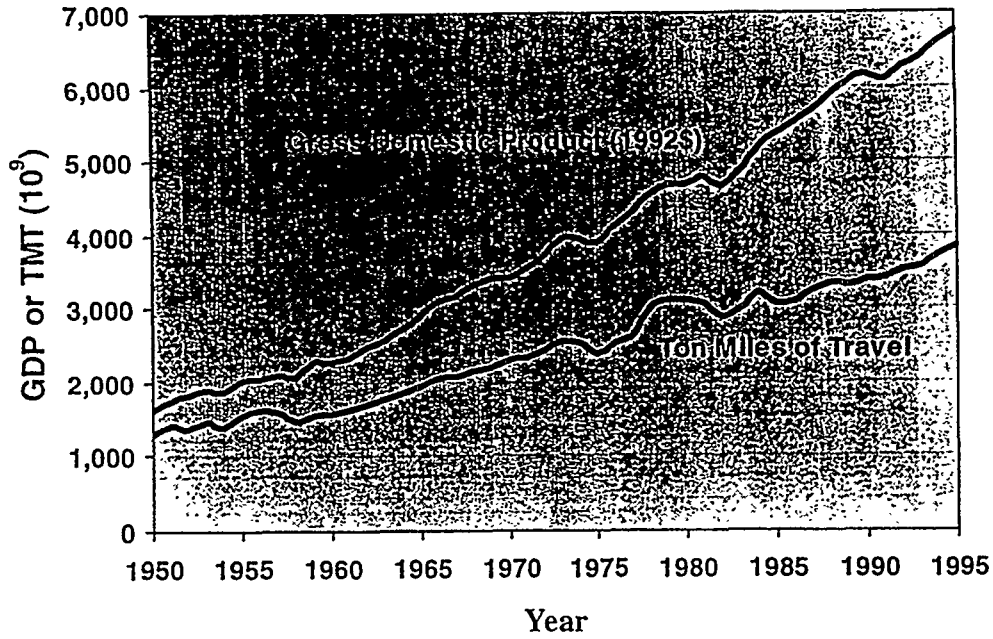


Since the 1973 Oil Embargo Essentially All of the Increase in U.S. Highway Fuel Consumption has been due to Trucks

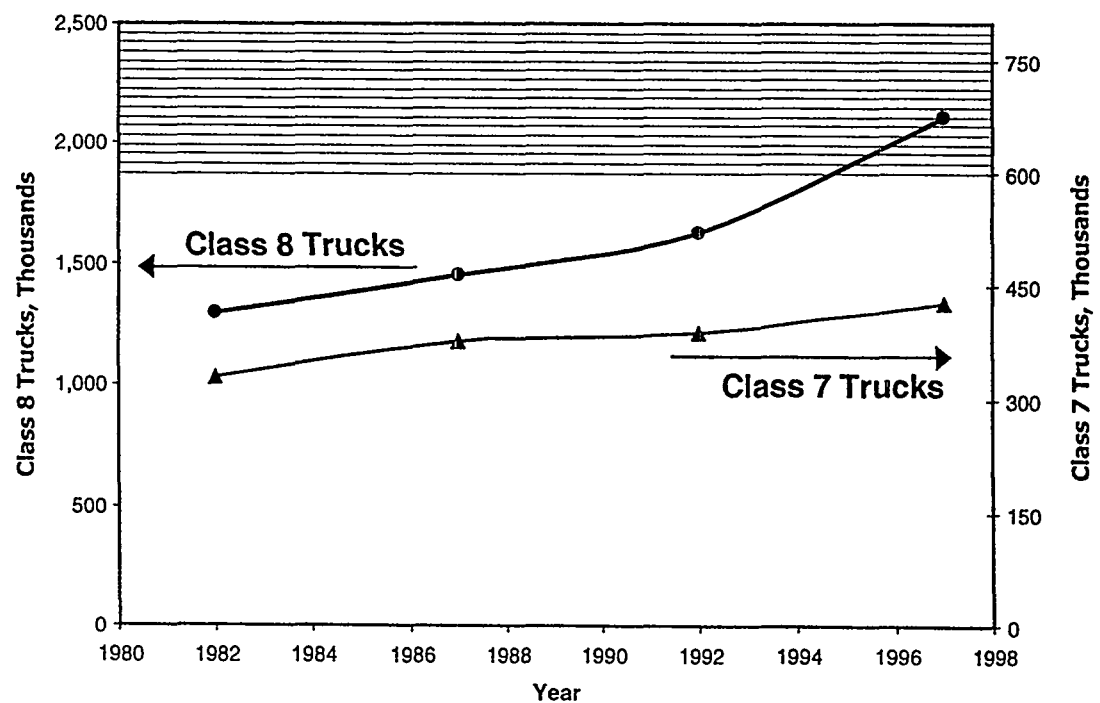


Source: EIA Annual Energy Outlook, 1999  
Federal Highway Administration, Highway Statistics

# A Healthy National Economy Depends Upon Efficient Heavy Vehicle Transportation



## Increasing Use of Class 7 and 8 Trucks



Source: 1982, 1987, 1992 Truck Inventory and Use Survey, 1997 Vehicle Inventory and Use Survey, U.S. Census Bureau

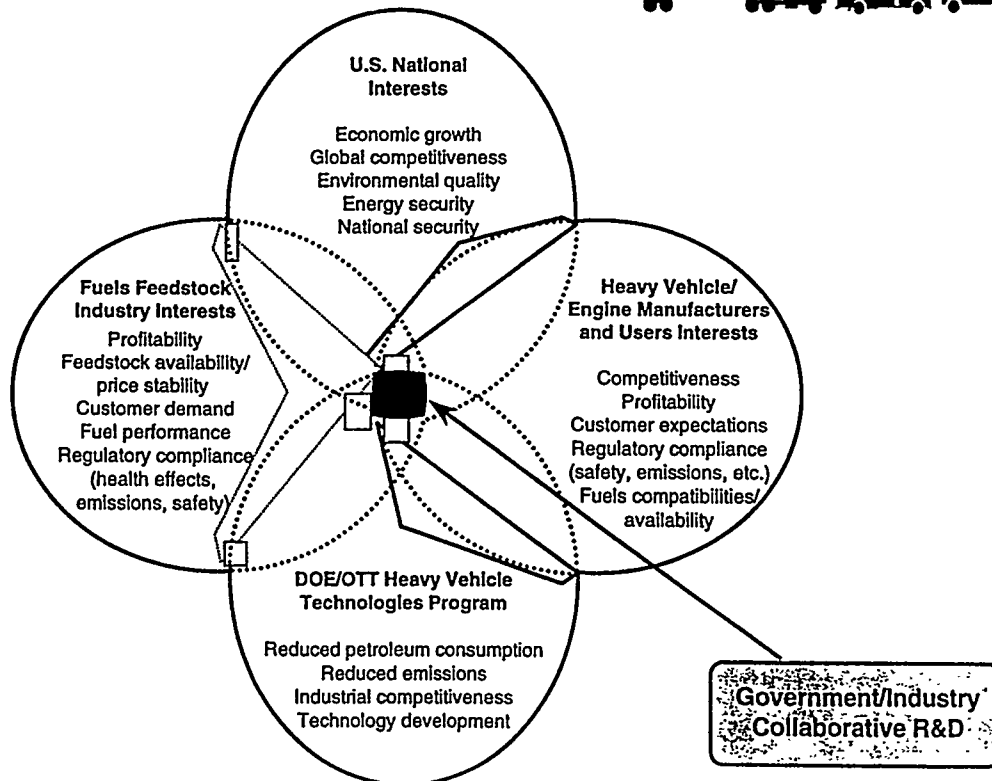
# OHVT Customers/Stakeholders



OHVT program targets joint Industry/Government needs identified with customers and stakeholders

- ◆ U.S. Diesel engine manufacturers
- ◆ Heavy vehicle manufacturers
- ◆ U.S. automakers (truck divisions)
- ◆ Component manufacturers
- ◆ Fleet operators/owners
- ◆ Industry trade organizations
- ◆ Fuel suppliers
- ◆ Materials suppliers
- ◆ Universities/research organizations

## DOE/Industry Collaborative R&D Efforts Target Common Interests



# OHVT Plans Focus on Critical R&D Areas for All Truck Classes

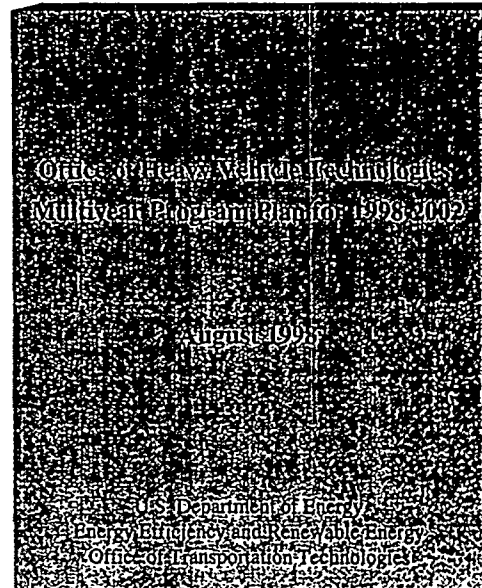


## OHVT Technology Roadmap

Office of Heavy Vehicle Technologies (OHVT)  
Office of Transportation Technologies

October 1997

<http://www.osti.gov/roadmap.pdf>



<http://www.osti.gov/multiyr.pdf>

## OHVT Technology Roadmap Development



### *Industry stakeholders provide input to Technology Roadmap*

- ◆ Initial draft developed by DOE and the National Laboratories as recommended by industry stakeholders attending the initial OHVT customer-focus workshop.
- ◆ **OHVT Executive Steering Committee Meeting** held in conjunction with SAE Truck and Bus Show (October 1996).
  - ◆ **Draft OHVT Technology Roadmap** presented to industry stakeholders for review.
- ◆ Additional **targeted workshops** and **one-on-one meetings** with industry stakeholders provided feedback and comments.
- ◆ Final version released (October 1997).
- ◆ Technology Roadmap updated/revised by OHVT Team (May 1999).
- ◆ Revised OHVT Technology Roadmap presented to industry stakeholders at the 1999 SAE International Truck and Bus Meeting and Exposition (November 1999).

### OHVT Technology Roadmap

Office of Heavy Vehicle Technologies (OHVT)  
Office of Transportation Technologies





November 1999

# OHVT Technology Roadmap



**OHVT  
Technology Roadmap**

Office of Heavy Vehicle Technologies (OHVT)  
Office of Transportation Technologies



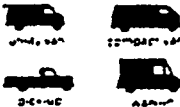


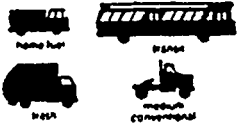


November 1999

## *R&D needs of three groups of trucks are addressed*

- ◆ Class 7 and 8, heavy-duty on-highway trucks
- ◆ Class 3-6, medium duty trucks such as urban delivery vans and transit buses.
- ◆ Class 1 and 2 light trucks (pickups, vans, and sport utility vehicles)

## Truck Classification (by Gross Vehicle Weight)



	<p><b>CLASS 1</b> 6,000 lbs. &amp; Less</p>		<p><b>CLASS 5</b> 16,001-19,500 lbs.</p>
	<p><b>CLASS 2</b> 6,001-10,000 lbs.</p>		<p><b>CLASS 6</b> 19,501-26,000 lbs.</p>
	<p><b>CLASS 3</b> 10,001-14,000 lbs.</p>		<p><b>CLASS 7</b> 26,001-33,000 lbs.</p>
	<p><b>CLASS 4</b> 14,001-16,000 lbs.</p>		<p><b>CLASS 8</b> 33,001 lbs. &amp; Over</p>

# DOE/OHVT Advanced Truck Technologies R&D Goals



## Heavy (Class 7-8) Trucks

To develop by 2004, the enabling technologies needed to achieve a fuel efficiency of at least **10 miles per gallon (at 65 miles per hour)** and **meet** emissions standards prevailing in 2004, using petroleum-based diesel fuel.

## Medium (Class 3-6) Trucks

By 2004, to develop and demonstrate commercially viable vehicles that achieve, on an urban driving cycle, at least **double the fuel economy** of comparable current (1999) vehicles, and as a *research goal*, reduce criteria pollutant emissions to at **least 30 percent below** EPA standards prevailing in 2004.

## Light (Class 1-2) Trucks

To develop by 2004 the enabling technologies for clean diesel engines to be competitive with and **at least 35-percent more fuel efficient** than equivalent gasoline engines for light trucks, while meeting Federal and state emissions standards prevailing in 2004.

## OHVT Technology Roadmap



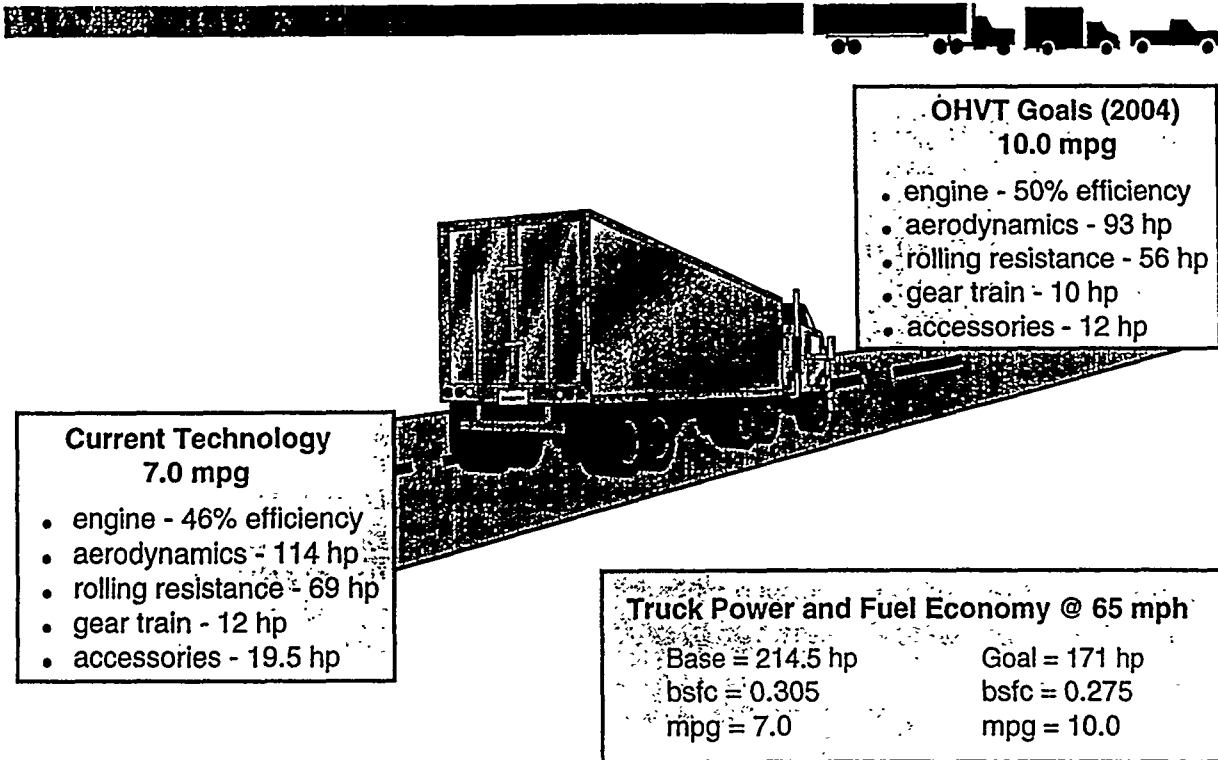
### Technical Plan -- Class 7 & 8

#### *Technology Thrust Areas*

- ◆ Engine Efficiency
- ◆ Power Requirements (@65 mph)
- ◆ Emissions
- ◆ Fuels and Lubricants



# Heavy (Class 7-8) Truck Technologies R&D



## October 1998 EPA/DOJ Consent Decree with Heavy-Duty Engine Manufacturers

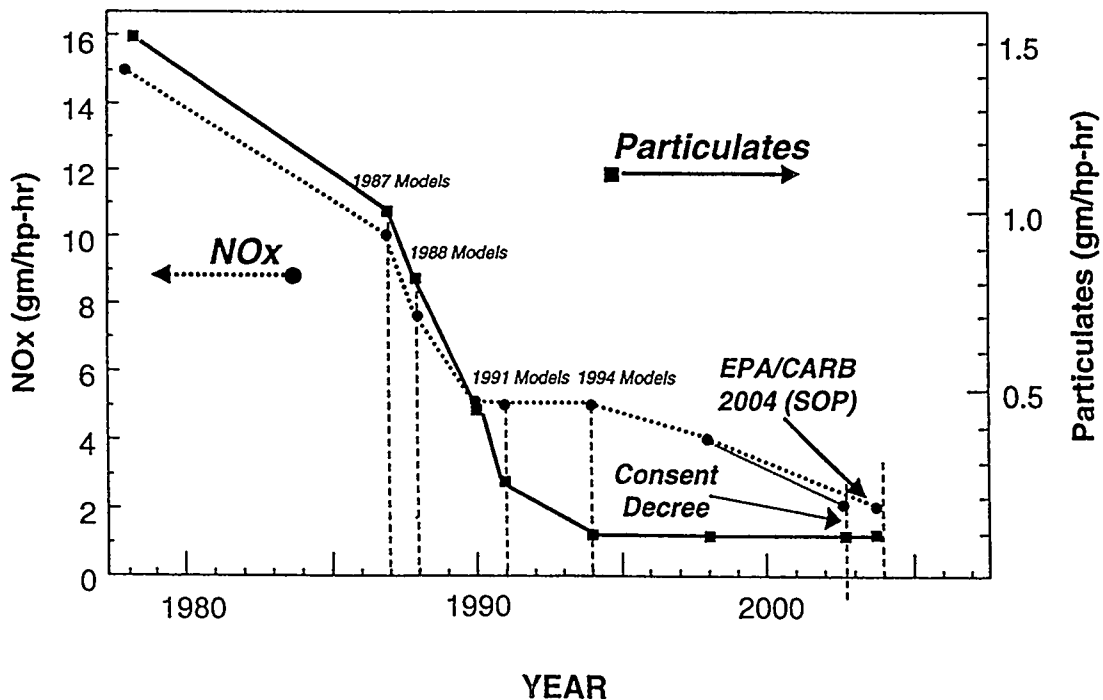
- ◆ EPA alleges use of “defeat devices” by manufacturers to control NO<sub>x</sub> during certification.
- ◆ Manufacturers deny allegations and claim full compliance with emissions limits.
- ◆ Manufacturers cannot use current “injection timing strategies.”
- ◆ EPA 2004 heavy-duty emissions regulation must be met by October 1, 2002.
- ◆ Manufacturers must develop new technologies to meet emissions levels.

# Impact of EPA/DOJ Consent Decree on Heavy-Duty Engines



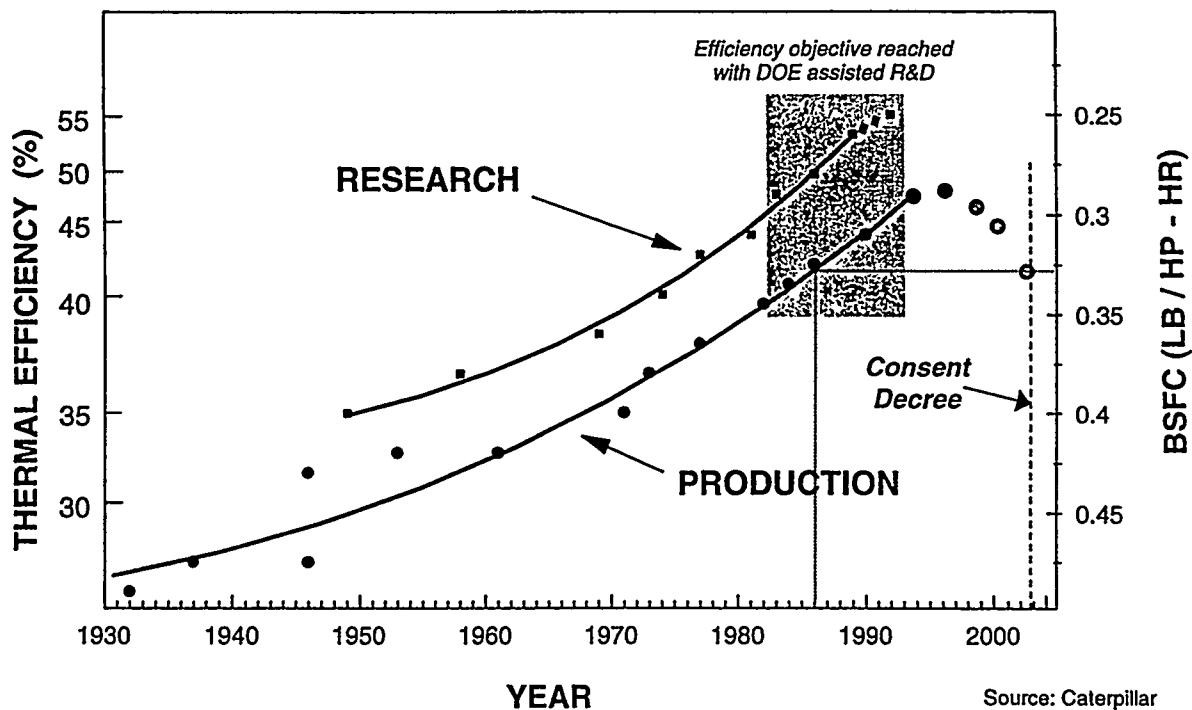
- ◆ Efficiency will be sacrificed (about 10 percent penalty) to meet emissions regulations. This could well mean a 0.5 to 1.0 mpg fuel economy penalty for a Class 8 truck.
- ◆ New emission control technologies are required to achieve emissions and maintain current efficiency.
- ◆ Improved fuel quality (very low sulfur) may well be necessary for some control technologies to be effective.

## Decreasing Diesel Engine Emissions



Source: Cummins, modified by DOE

# Increasing Diesel Cycle Engine Efficiency



## Potential Impact of EPA/DOJ Consent Decree on Heavy-Duty Engine Lube Oil

- ◆ Sulfur/phosphate content of lube oil are real issues
  - Near-zero sulfur/phosphate lube oil may well be necessary for effective emissions control if exhaust aftertreatment is required (e.g., lean-NOx catalysts).
- ◆ Durability issues
  - Change in lubricity?
  - Impact on seals?
  - Impact on fuel injectors?

## Workshop on Low Emission Diesel Engine Oils



### Purpose

To craft a shared vision for Industry-Government (DOE) R&D collaboration in diesel engine oils to minimize emissions, while maintaining or enhancing engine performance.

## R&D Needs for Low Emission Diesel Engine Oils



*Within the context of improving energy efficiency and reducing emissions of the vehicle as a system*

what are the high priority R&D opportunities in diesel engine lubricating oils for Industry/Government collaboration?

# OHVT Budget by Activities



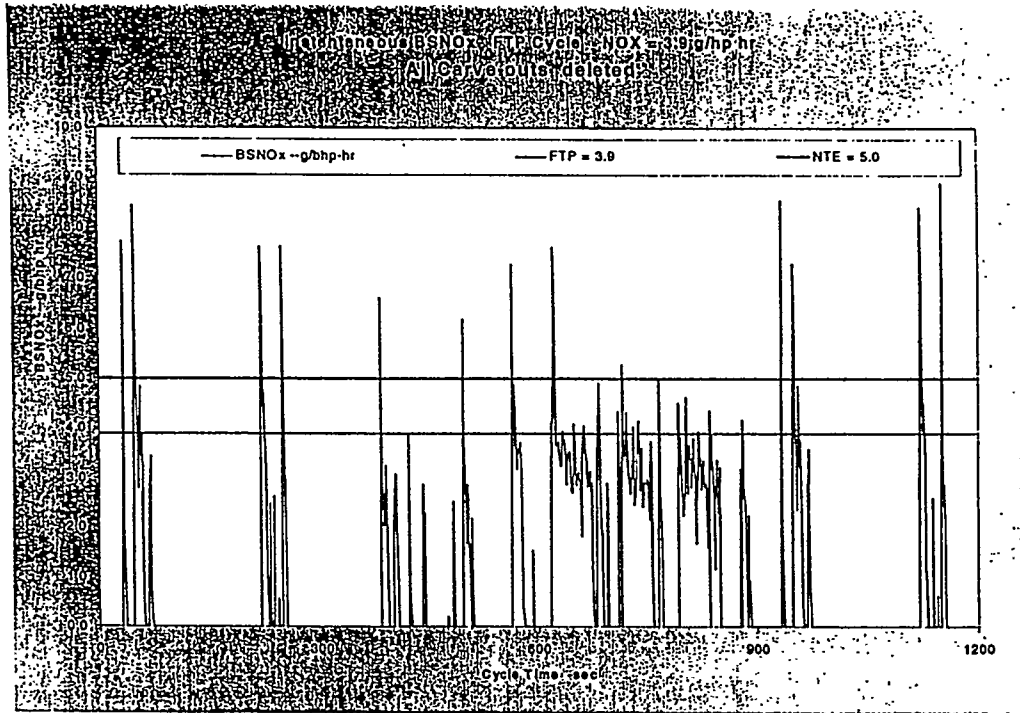
	FY 1996	FY 1997	FY1998	FY1999	FY2000
<b>Appropriation (In Millions)</b>					
<b>Vehicle Technologies R&amp;D</b>					
<b>Advanced Combustion Engine R&amp;D</b>					
◆ Combustion and Aftertreatment R&D	1.95	1.5	1.8	3.4	3.147
◆ Light Truck Engine	--	5.6	9.4	14.8	18.0
◆ Heavy Truck Engine	3.45	--	--	--	5.0
<b>Heavy Vehicle Systems R&amp;D</b>					
◆ Hybrid Systems R&D	--	--	1.7	1.5	3.0
◆ Heavy Vehicle Propulsion Systems	--	--	--	--	4.0
<b>Fuels Utilization R&amp;D</b>					
<b>Advanced Petroleum Based Fuels</b>					
◆ Heavy Trucks	0.0	0.0	2.4	2.7	4.0
<b>Alternative Fuels</b>					
◆ Heavy Trucks	9.3	12.4	3.765	3.27	4.3
◆ Medium Trucks	0.0	0.0	6.31	4.7	4.3
◆ Fueling Infrastructure	0.0	0.0	0.0	0.2	2.0
<b>Transportation Materials Technologies</b>					
<b>Propulsion Materials Technology</b>					
◆ Heavy Vehicle Propulsion System Materials	8.0	5.0	4.95	5.3	6.05
<b>Lightweight Materials Technology</b>					
◆ High Strength Weight Reduction Materials	2.5	2.8	3.1	4.2	5.95
High Temperature Materials Laboratory	5.2	4.7	5.2	5.5	8.5
<b>TOTAL Heavy Vehicle Technologies</b>	<b>30.4</b>	<b>32.0</b>	<b>38.625</b>	<b>45.57</b>	<b>68.247</b>

## Summary



- ◆ Commercial truck highway transportation energy use continues to grow both in the U.S. and the world.
- ◆ EPA/DOJ Consent Decree may exact unacceptably high fuel consumption penalties for heavy-duty truck owners and operators.
- ◆ There are some serious engine lubricating oil concerns as emissions control strategies tend toward catalytic exhaust aftertreatment.
- ◆ An early consensus on high priority opportunities for Government/industry collaboration in diesel engine lubricating oil R&D could lead to more timely solutions to heavy vehicle emissions and fuel efficiency challenges.

# Flat Emissions Map



## Compliance Over Wider Range of Engine Operating Conditions

