Diesel Engines: Environmental Impact and Control

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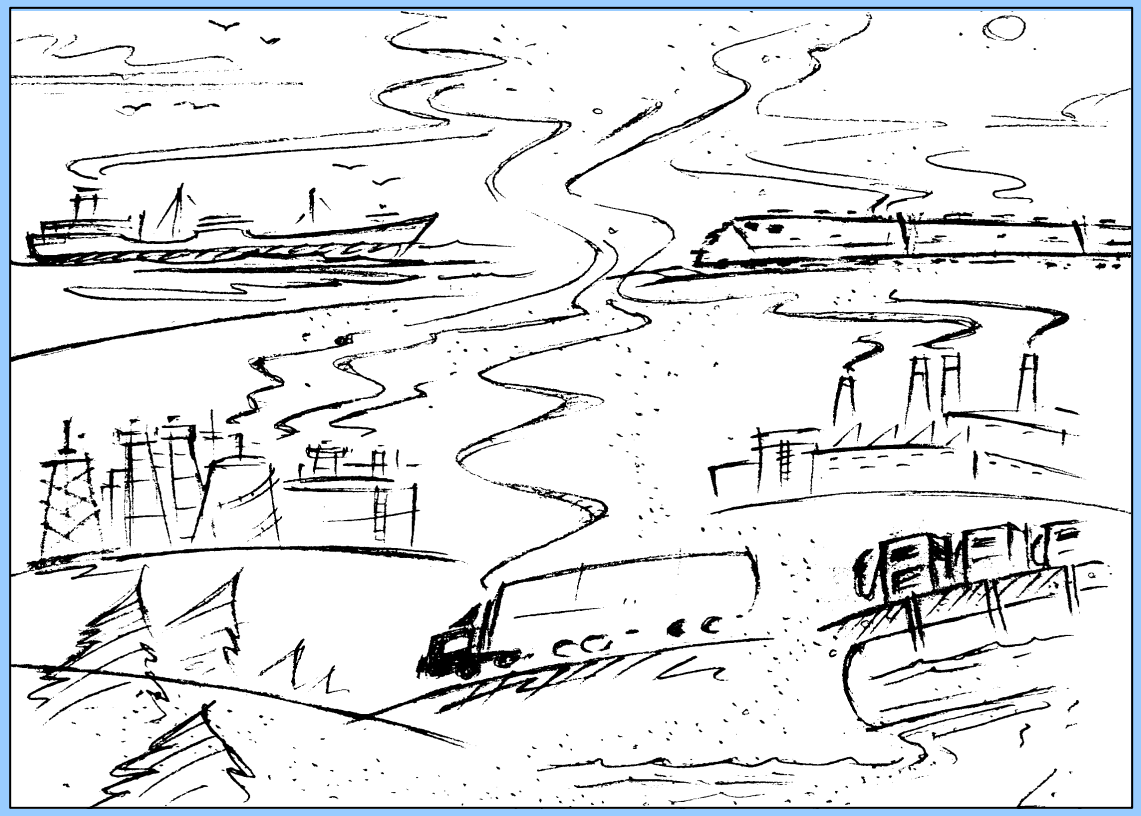
California Air Resources Board

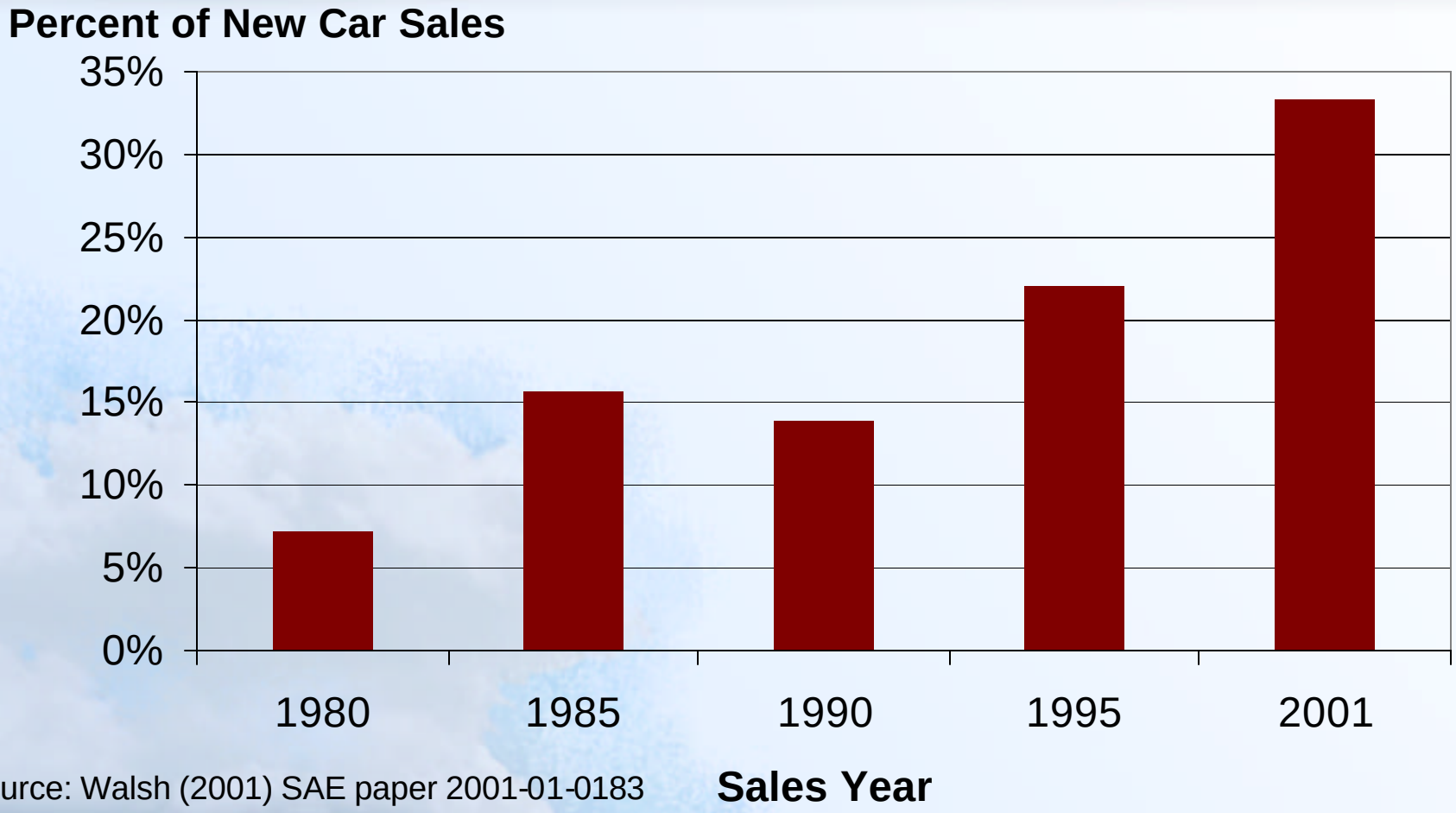


DEER Conference 2002

Diesels are an Important Part of the World's Economy

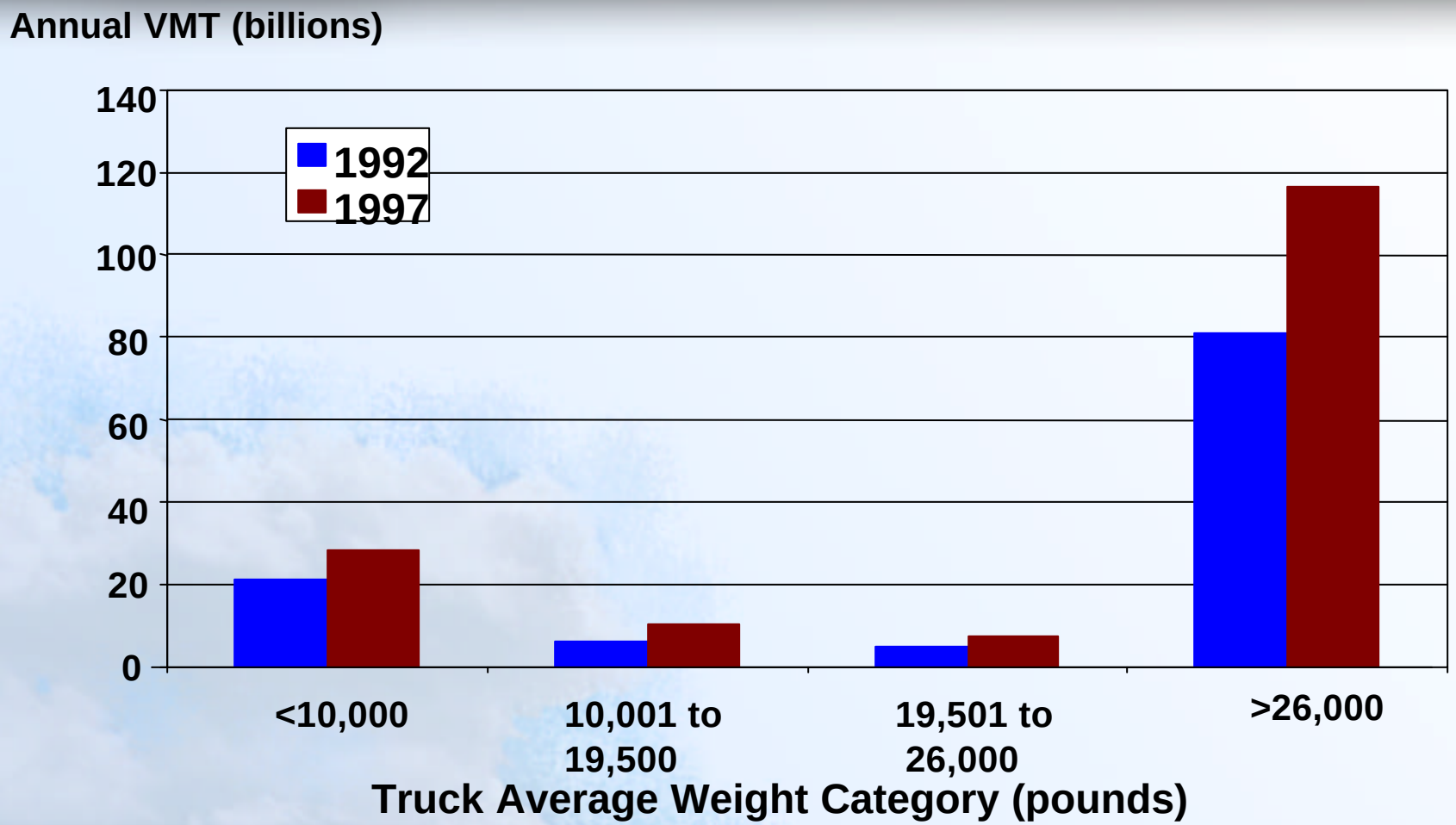
- Land and sea transport
- Electrical power
- Farming, industrial, and construction activities

Diesels Make Up One-Third of Passenger Car Sales in Europe



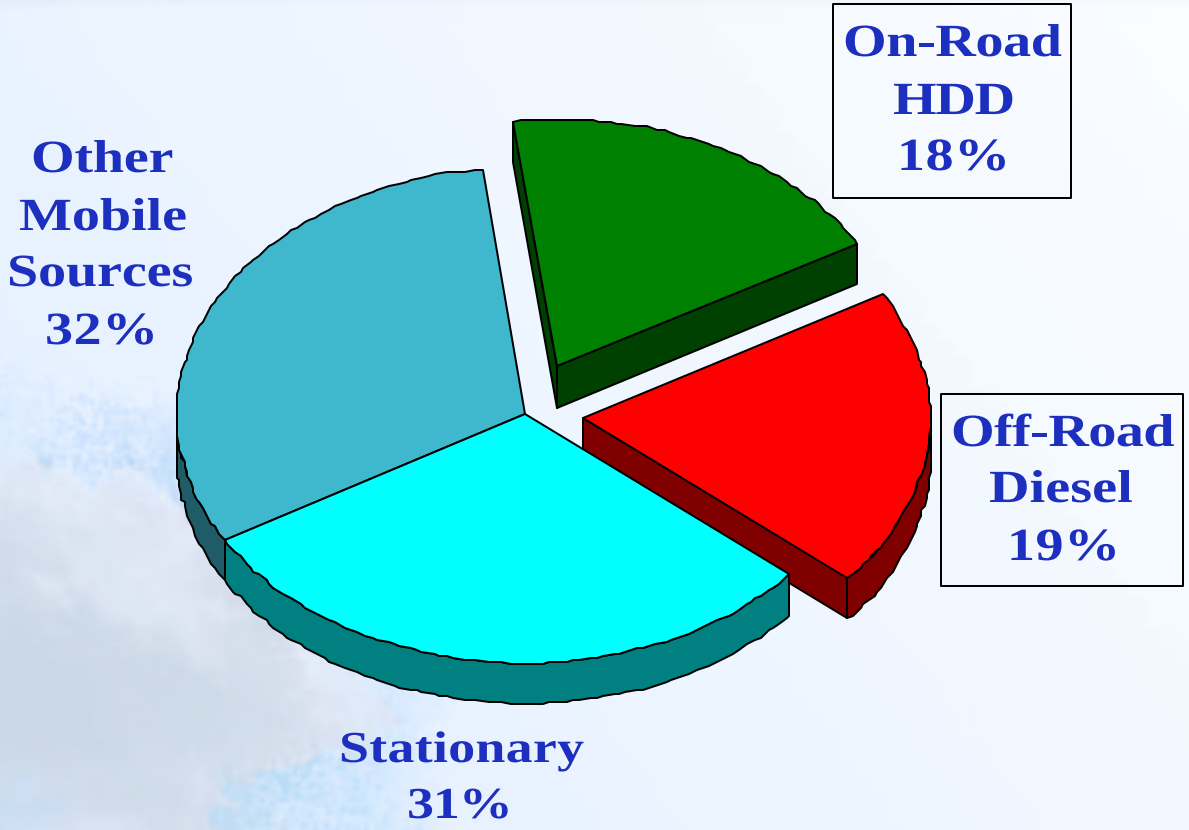
Source: Walsh (2001) SAE paper 2001-01-0183

Diesel Truck VMT is Growing in the U.S.



Source: U.S. Department of Commerce

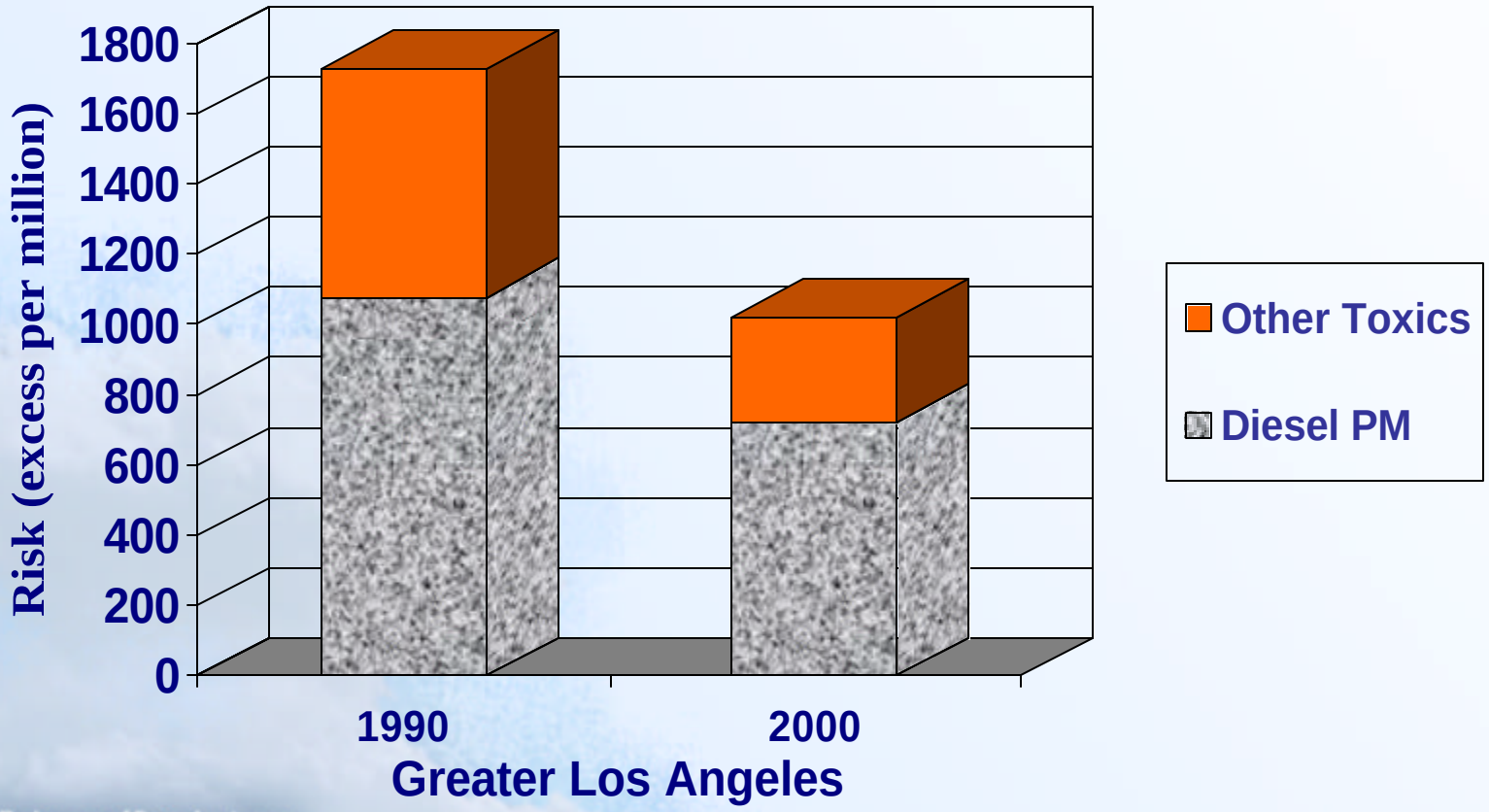
Diesel Will be a Major Source of NO_X in California



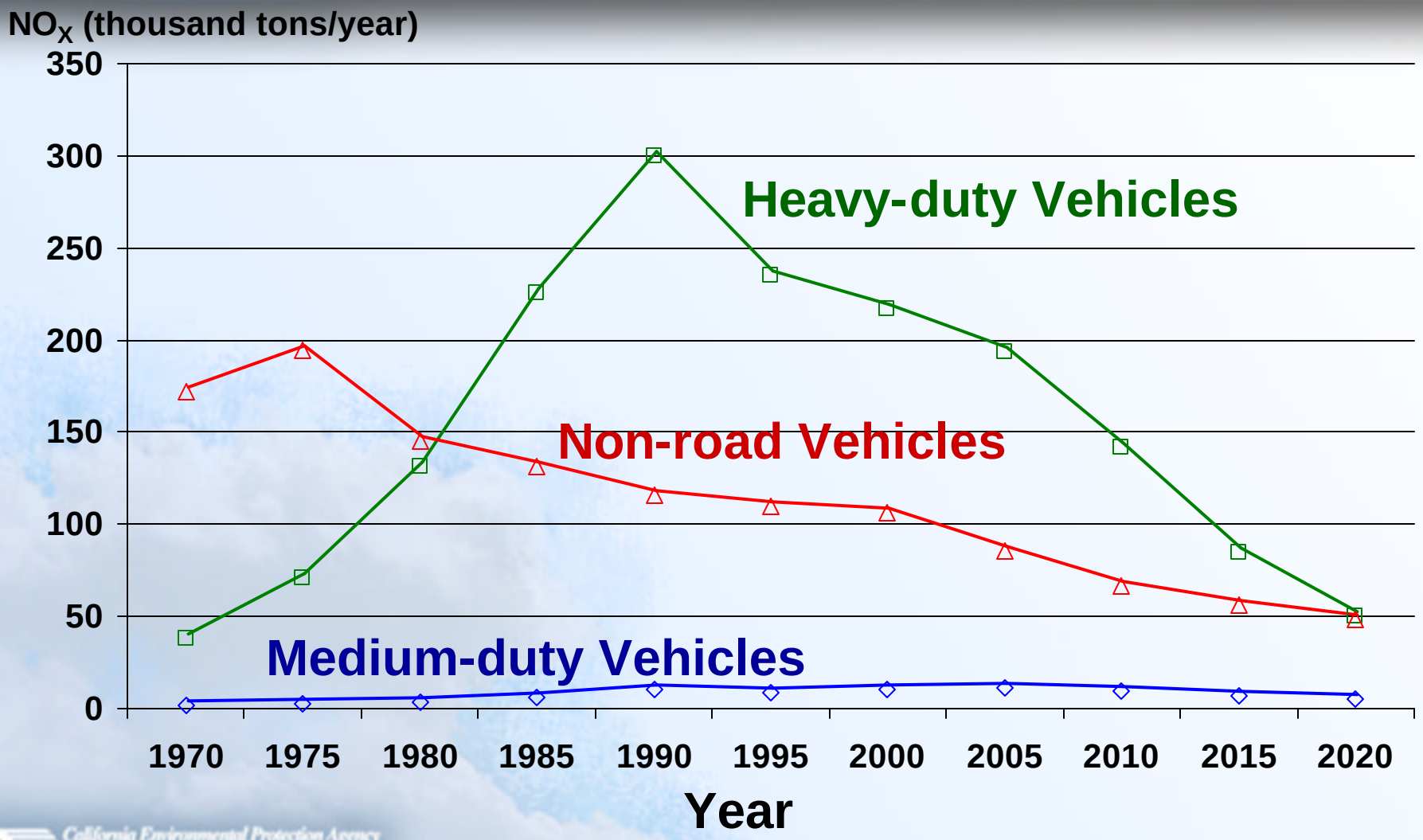
California in 2010

Source: EMFAC2001 v2.082

Diesel is a Majority of Air Toxic Risk in Los Angeles

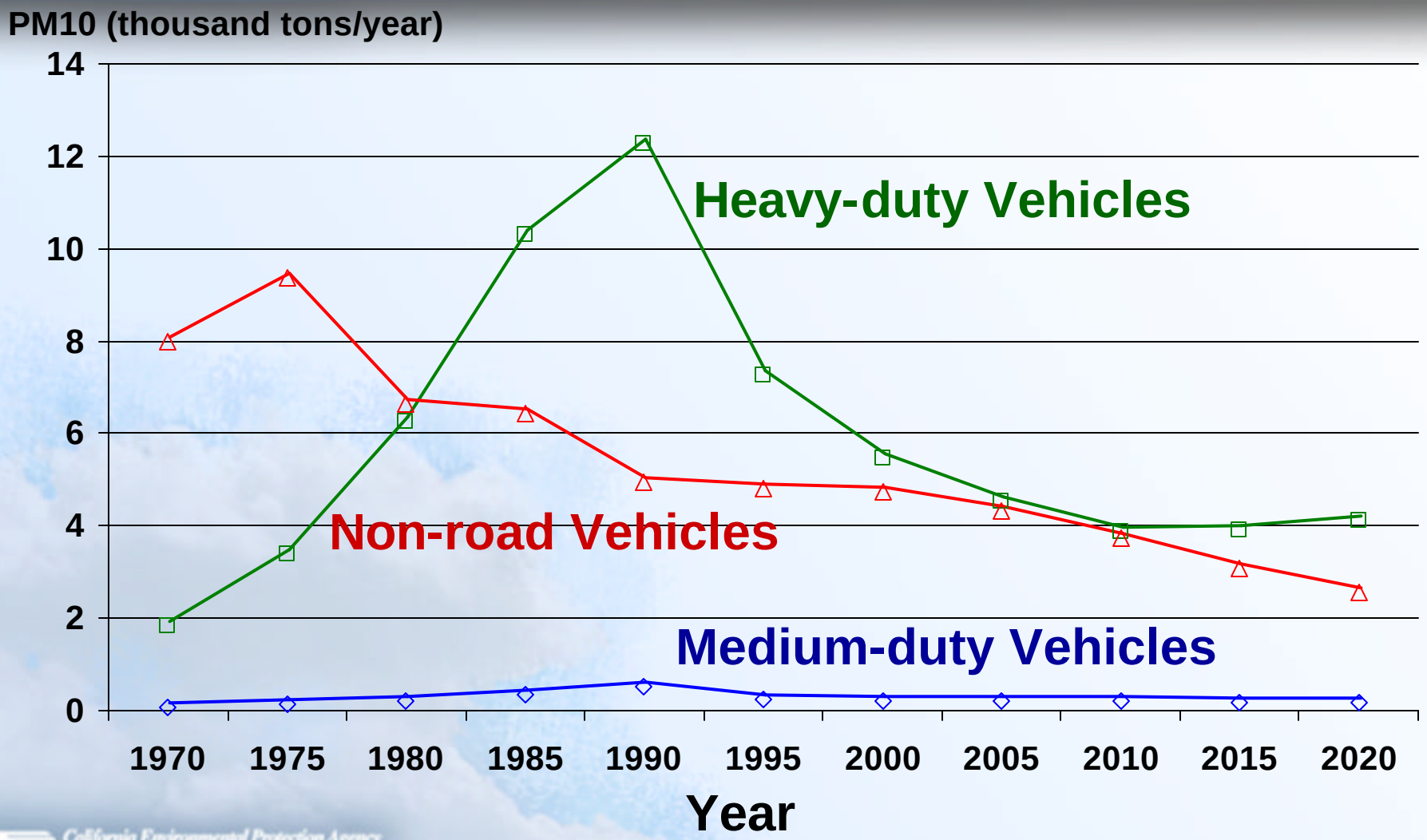


CA Diesel Vehicle NO_X Inventory



ARB EMFAC 2001 v2.08

CA Diesel Vehicle PM10 Inventory

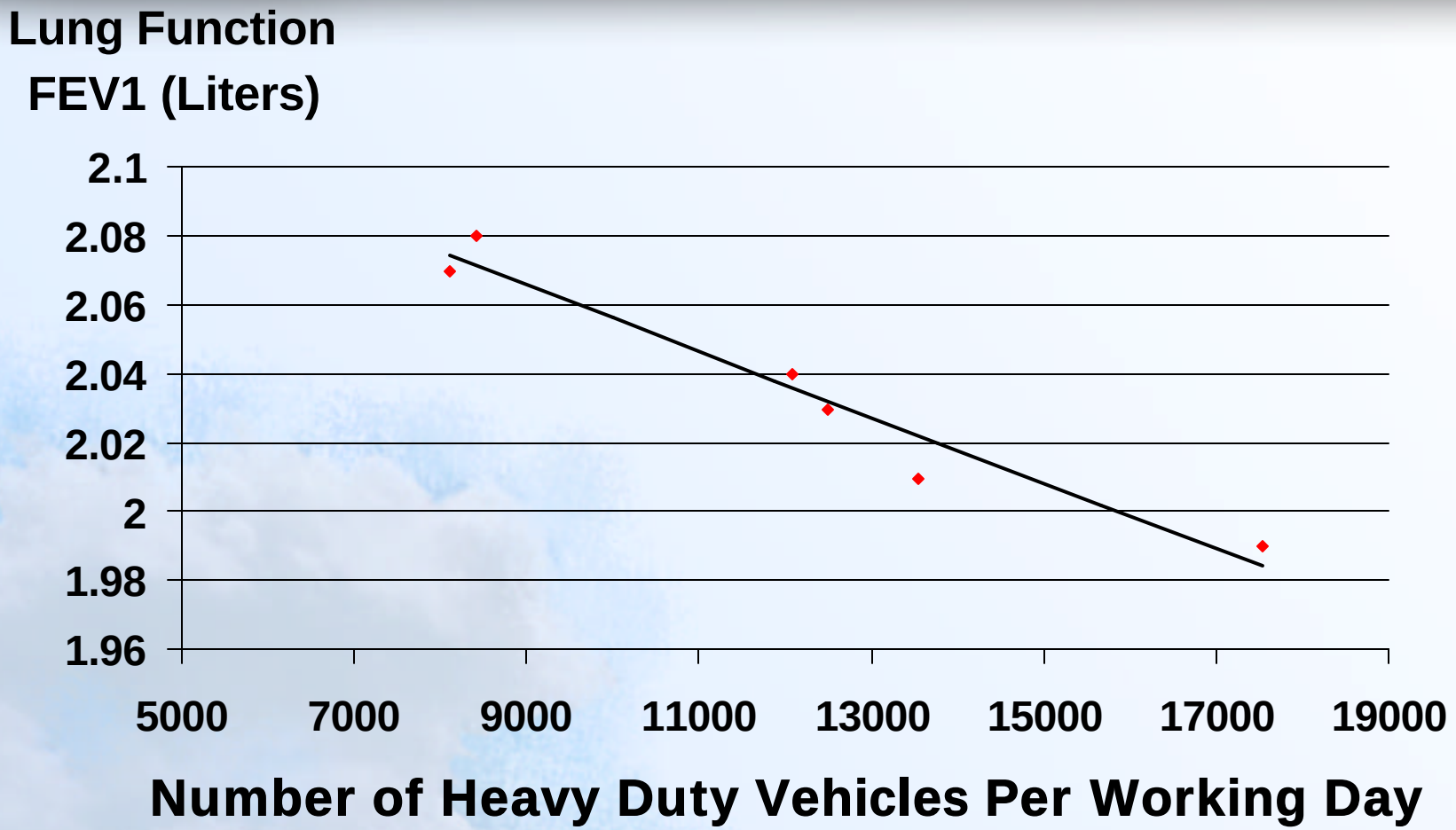


ARB EMFAC 2001 v2.08

Cancer Effects of Diesel

- Increased lung cancer incidence supported by 30+ population studies.
- WHO, U.S. EPA, NIOSH, and HEI acknowledge the cancer potential in humans.
- ARB identified diesel exhaust PM as TAC.
- Unit Risk Range: 130 - 2,400 per million.

Association Between Lung Function of Children Living <300 Meters From Motorway and Intensity of Cargo Traffic



Source: Brunekreef B, et al, Air Pollution from truck traffic and lung function in children living near motorways

Diesel Contributes to Water and Soil Pollution

Fuel spills and leaks.

Deposition to water bodies and soils.

Emissions From Diesels Can be Reduced

New Engines

- Engine improvements /
- electronic controls
- Post-combustion clean-up
- Alternatives to diesel

Fuels

- Cleaner diesel
- Alternatives

Current fleet

- Proper maintenance
- Retrofit

Engine Technologies That Reduce Diesel Emissions

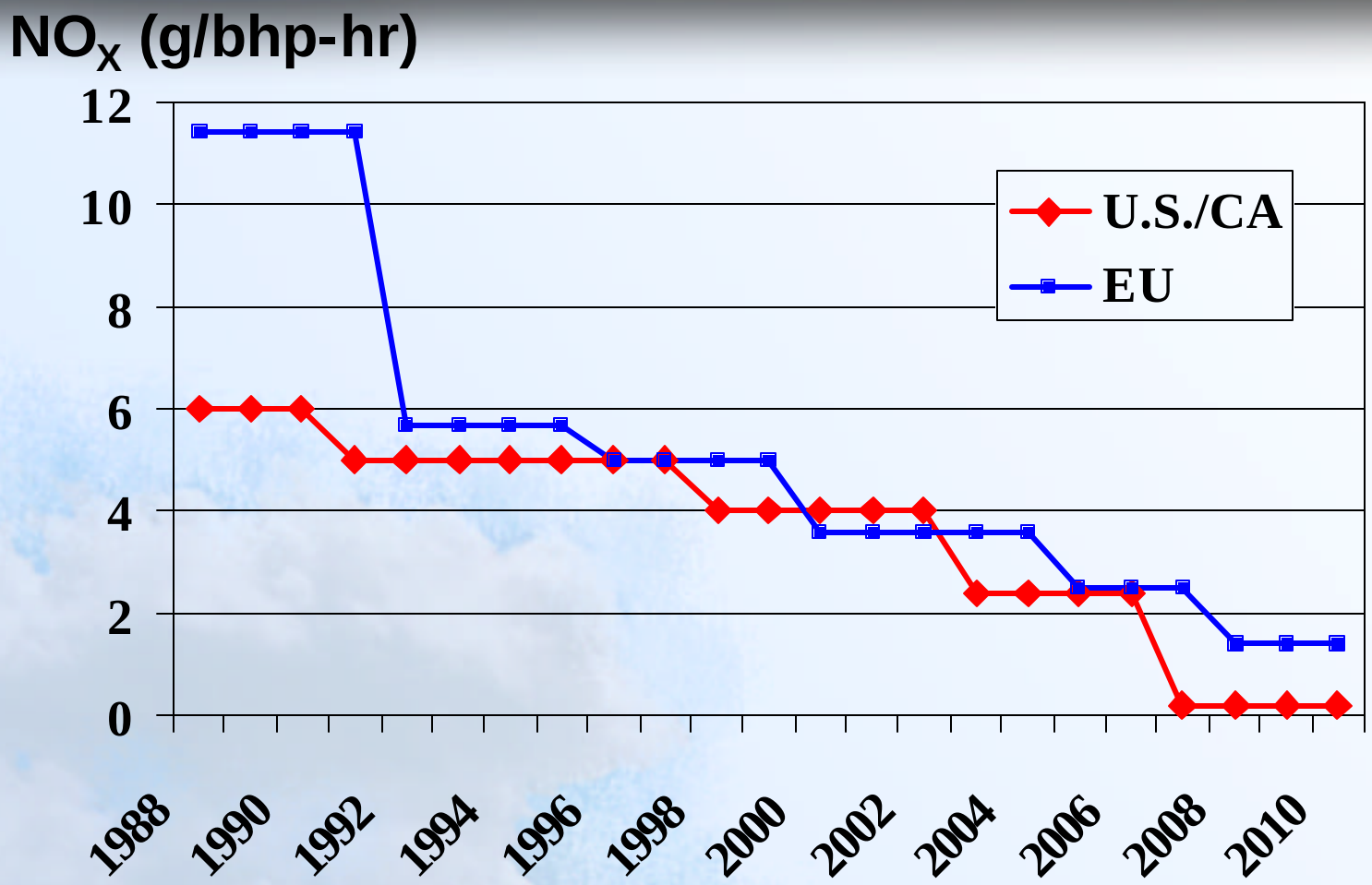
In-Cylinder

- Air Handling
- Fuel Handling
- Electronic control

Aftertreatment

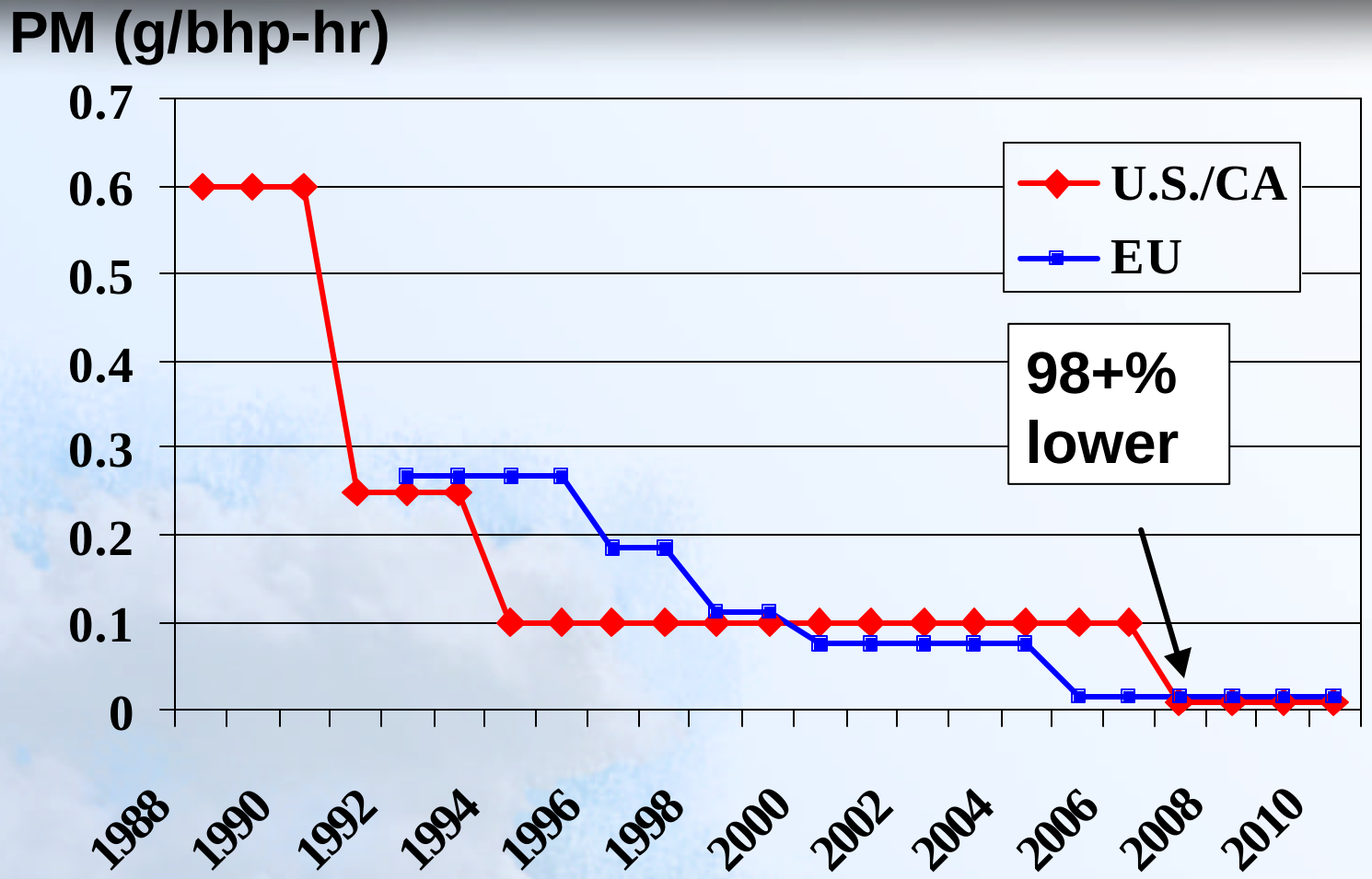
- PM Traps
- NOx Catalysts

Stringent NOx Standards Exist for New On-Road Engines



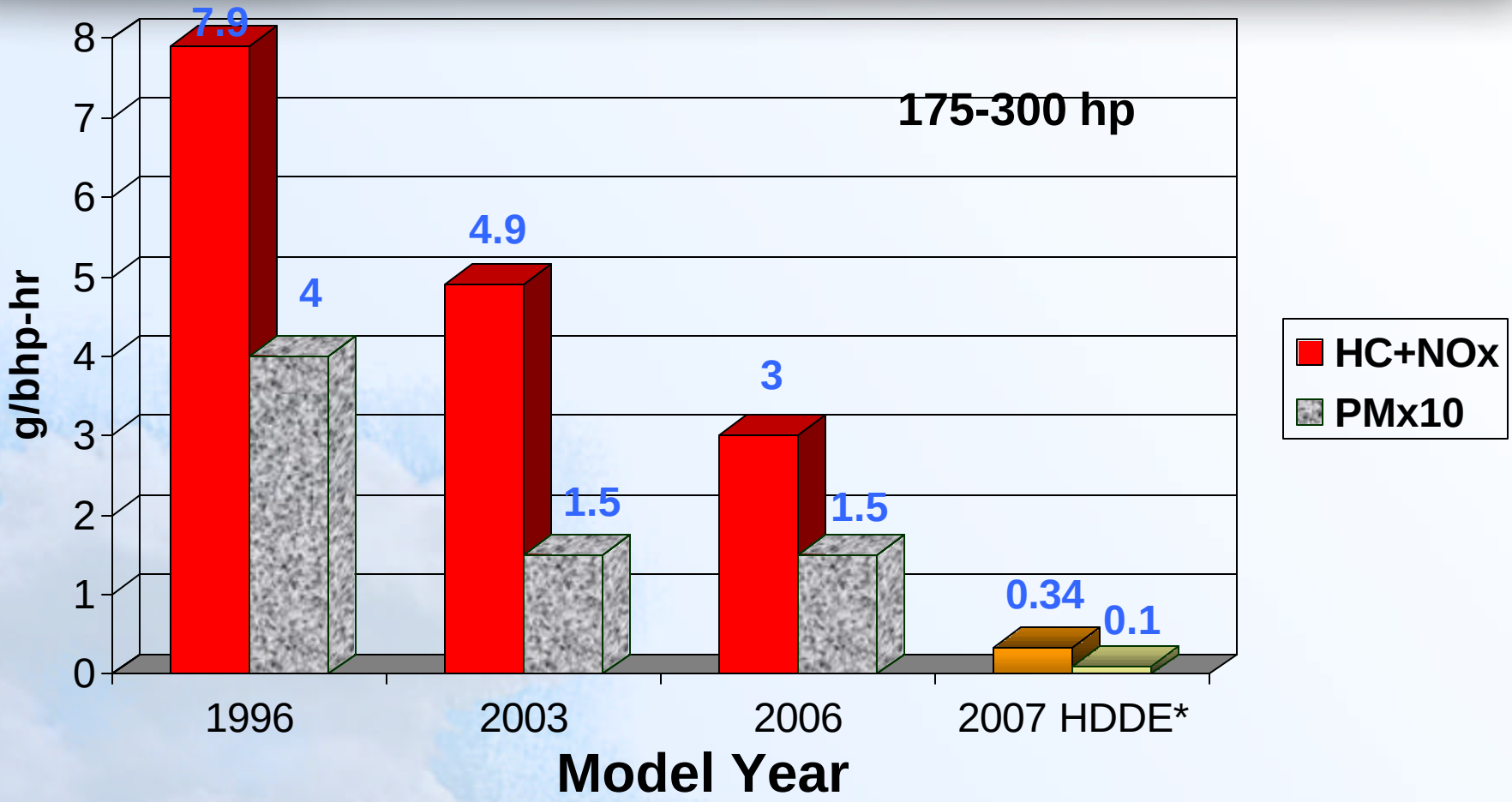
Source: DieselNet. *Emissions Standards: European Union*, 2001.

Stringent PM Standards Exist for New On-Road Engines



Source: DieselNet. *Emissions Standards: European Union*, 2001.

More Stringent Emission Standards For New Off-road Engines Needed



*2007 HDDE Standards are 0.2 g/bhp-hr NOx and 0.14 g/bhp-hr NMHC

Diesel Fuels

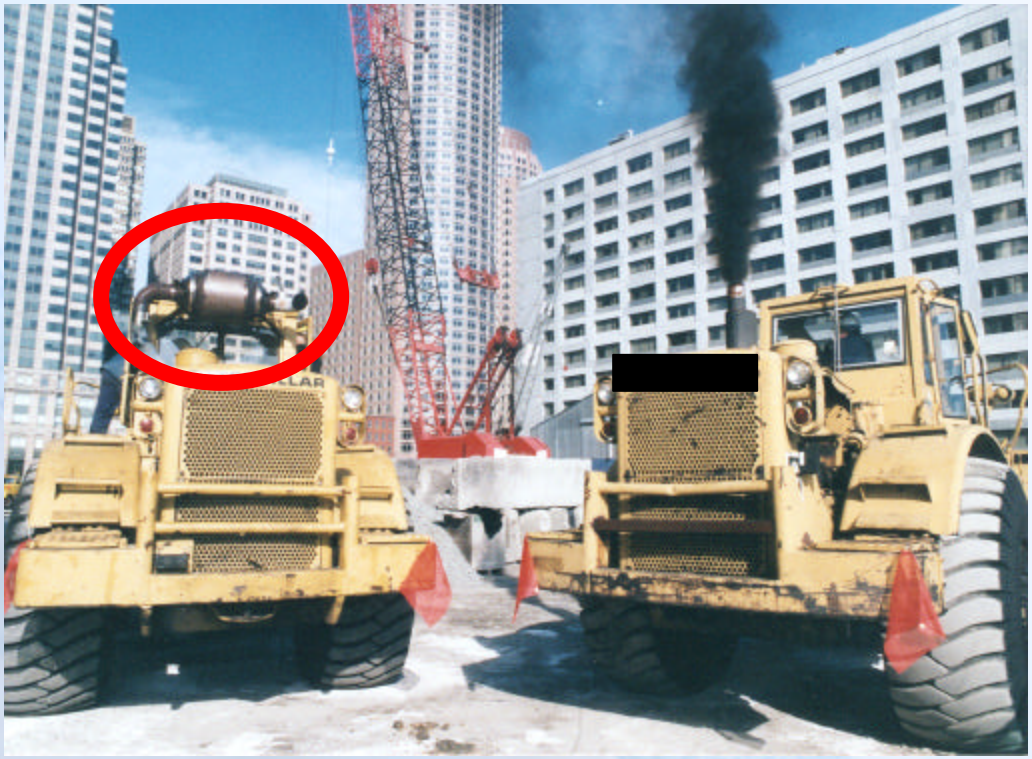
Low Sulfur Fuel

- Needed for aftertreatment
- U.S. - 15 ppm (on-road) by mid-2006
- CA/TX - 15 ppm (on and off-road) by mid-2006
- EU - 50 ppm by 2005 (possibly 10 ppm)

Alternative Diesel Fuels

- Fischer Tropsch - zero sulfur and aromatics
- Water emulsions - reduce PM and NO_X

California Diesel PM Risk Reduction Plan Sets Aggressive Goals



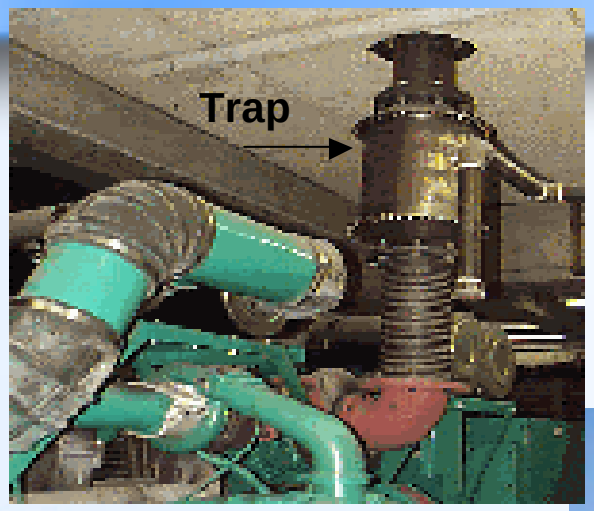
75% risk reduction by 2010.

Retrofit on- and off-road diesel engines with filters (80% of plan's benefit).

Maintaining Low Emissions In-use Through Enforcement

- Roadside smoke inspections.
- Reduced smoky trucks from 30% to 8%.
- Expand to include NO_X and PM.
- Manufacturer-run in-use compliance program.

Diesel PM Traps Can Be Effective



Alternative Fuels Can Reduce Emissions

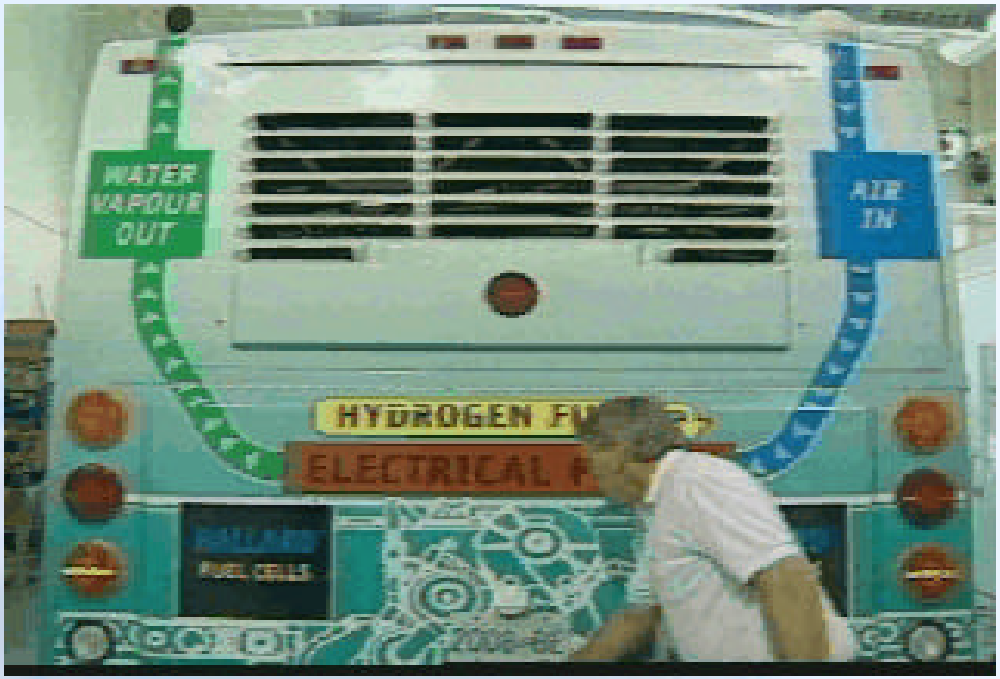
Natural Gas

- Lower NO_X and PM.
- Nanoparticle formation being investigated.

Methanol and Ethanol

- Poor durability and frequent overhauls.

Fuel Cells Have Promise



Ultimate replacement for diesel engines:

- **Zero Emissions**
- **High efficiency**
- **Cost reduction needed**

Initial transit buses in 2003.

Near-term promise as truck APU.

Progress Means Continued Regulation and Monitoring

- Environmental regulations result in reduced emissions.
- Equal focus on off-road engines and fuels needed.
- Monitoring of in-use emission performance must continue.

Summary

- Diesels are a key power source.
- Diesels are significant contributors to air pollution.
- Diesel exhaust is linked to cancer.
- Regulations are in place for new on-road diesels.
- Comparable regulations are needed for off-road, including cleaner fuel.

Summary (cont'd)

- Technology is advancing to meet these challenges.
- Existing engines need to be cleaned up.
- Retrofit and replacement programs are being developed.