

The Rapid Growth of Goods Movement-Related Emissions Worldwide: Trends, Health Effects and Needed Policy Responses

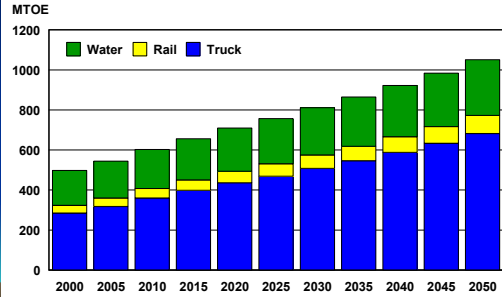


Healthy Regions, Healthy People

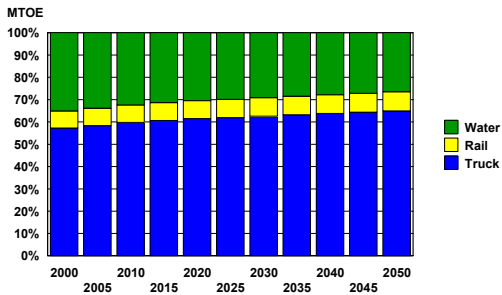
October 17, 2005

Michael P. Walsh
International Consultant

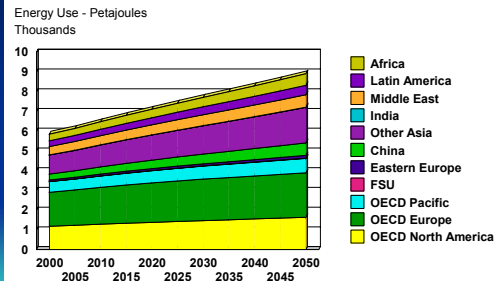
Global Freight Energy Use

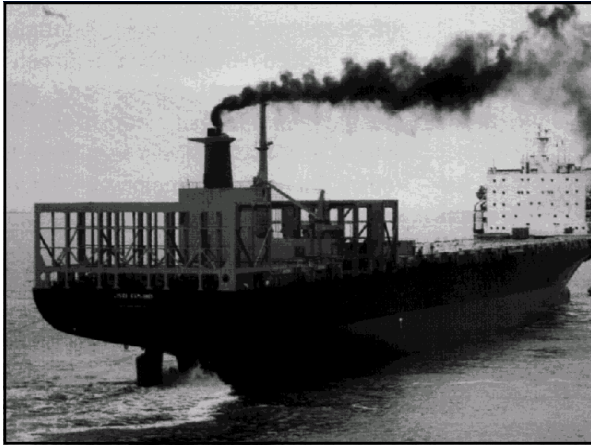


Global Freight Energy Use

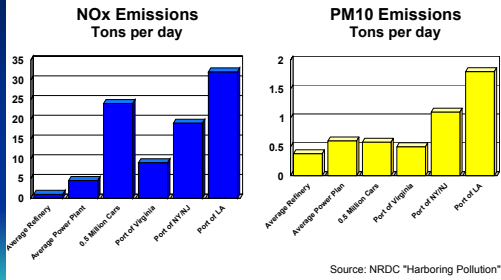


International Water Borne Travel (Bunker Fuel)

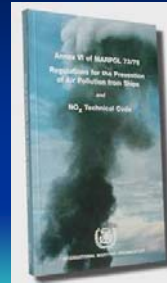




Pollution From Ports Compared To Other Sources

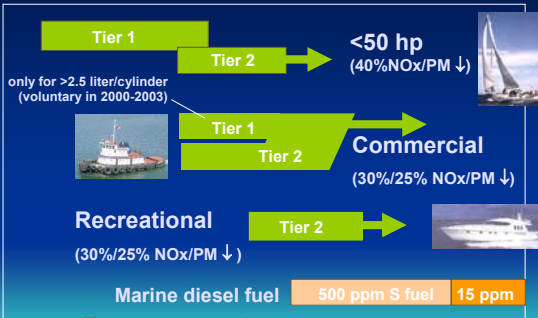


MARPOL Agreement



- Annex VI Entered Into Force on 19 May
- Global cap of 4.5% Sulfur
- Special SOx Control Areas Limited to 1.5% or SOx limits
 - Baltic Sea
 - North Sea
- Ozone Depleting Substances
- NOx Limits
- Restricts PCB Incineration

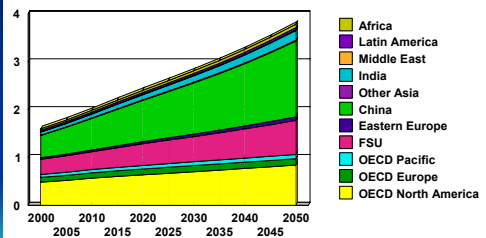
Key Elements of Current Marine Diesel Program (only applies to U.S. vessels)



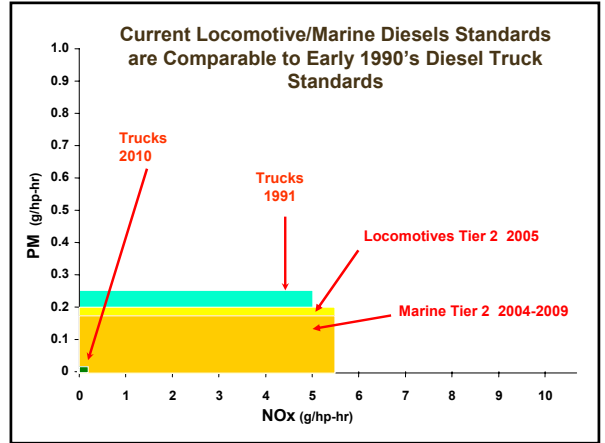
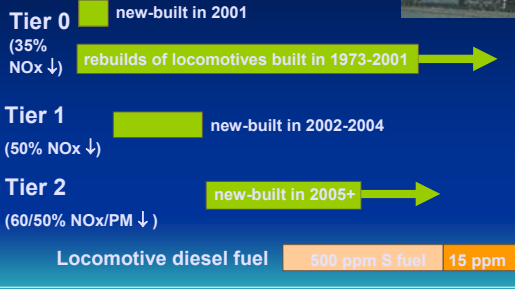
1998 2000 2002 2004 2006 2008 2010 2012 2014

Rail Freight Movement

Energy Use - Petajoules Thousands



Key Elements of Current Locomotive Program (only applies to U.S. railroads)

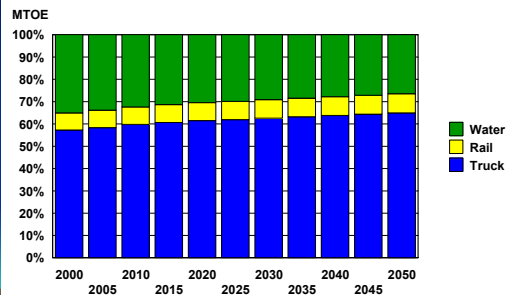


EPA Regulatory Development Priority - Diesel Locomotive & Marine Engines

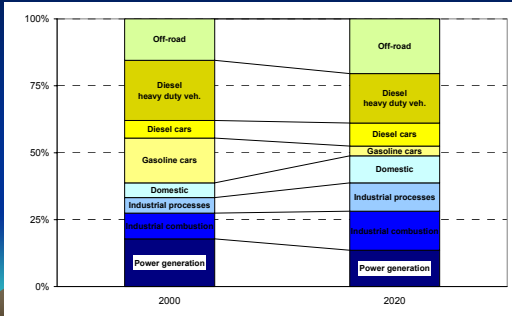


EPA requires 15ppm sulfur in fuel for loco/marine in 2012
EPA Engine proposal targeted for the spring of 2006

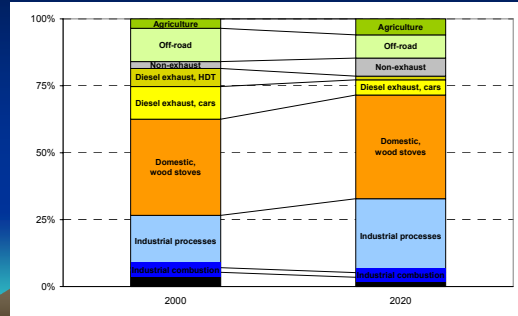
Global Freight Energy Use



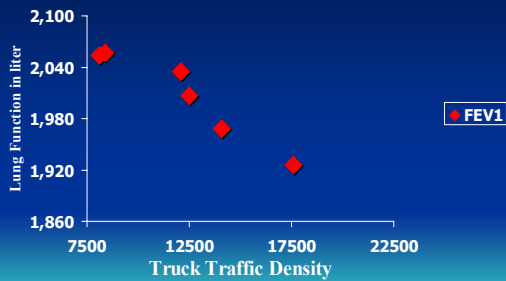
NO_x emissions EU-25



Contribution to primary PM_{2.5} emissions EU-15

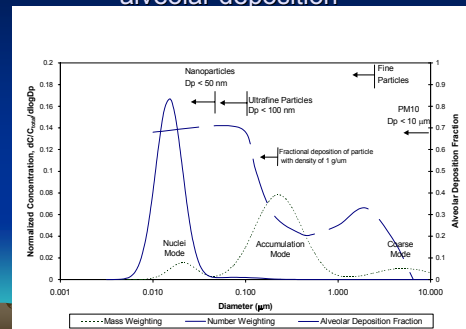


Proximity To Truck Traffic Linked To Lung Function in Children

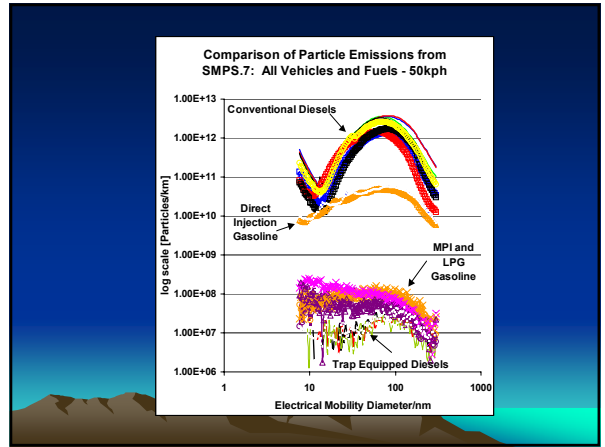
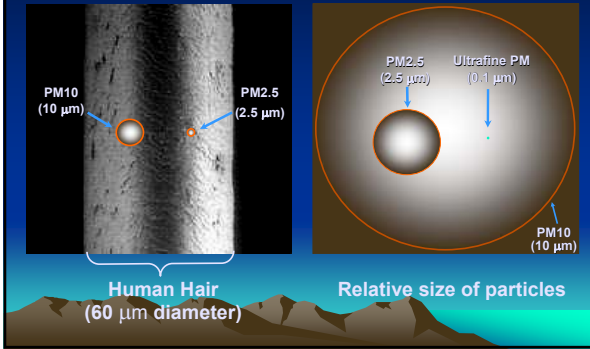


Brunekreef, Epidemiology 1997; 8: 298-303

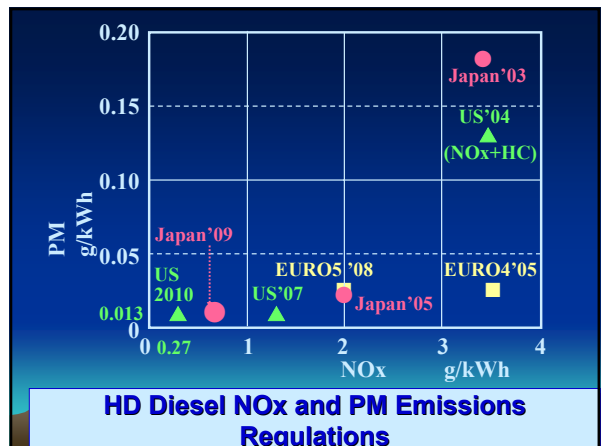
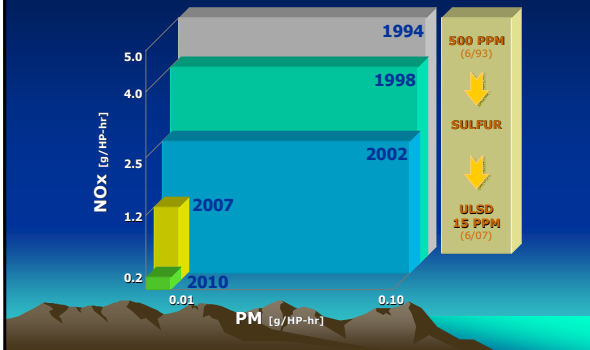
Typical engine exhaust mass and number weighted size distributions shown with alveolar deposition



Comparison of PM10, PM2.5, and Ultrafine PM



Evolution of US On-Highway Heavy Duty Standards



Linkage Between Fuel Sulfur and PM Emissions

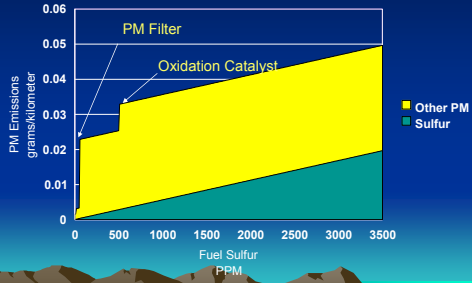
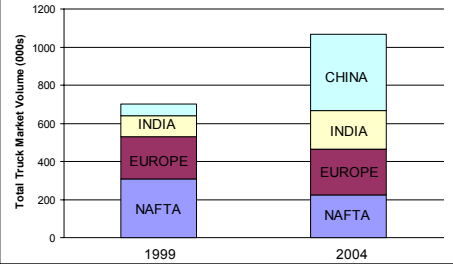
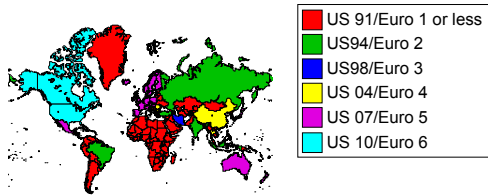


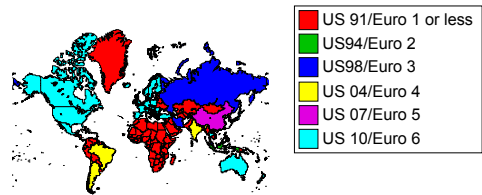
Figure 2 -- Major Commercial Truck Markets



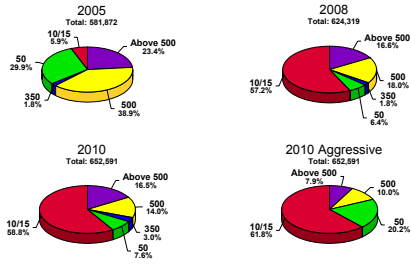
Heavy Duty Diesel PM Regulations 2010



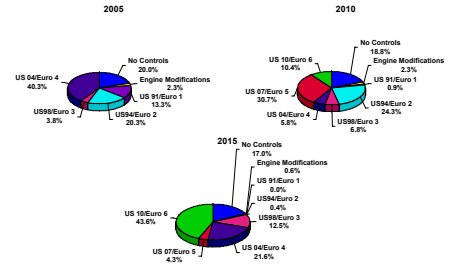
Heavy Duty Diesel PM Regulations 2015



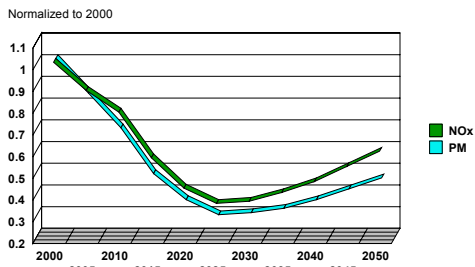
Global Distribution of On Road Diesel Fuel Sulfur Content (PPM)



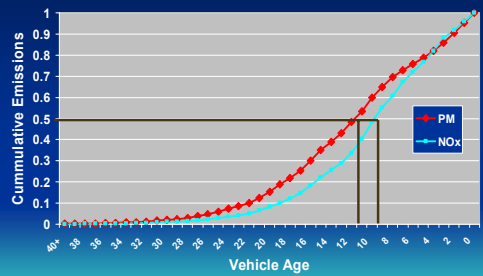
Global Distribution of Emissions Controls New Heavy Duty Diesel Trucks (000)



Heavy Duty Diesel Vehicle Emissions Trends



Cumulative Emissions By Age – Diesel Trucks



General Regulatory Approach

- Retrofit mid-aged engines
 - Filters 85% PM ↓
 - Catalysts 25% PM ↓
 - Other 50% PM ↓ typical
- Replace older engines
 - Re-power
 - New vehicle



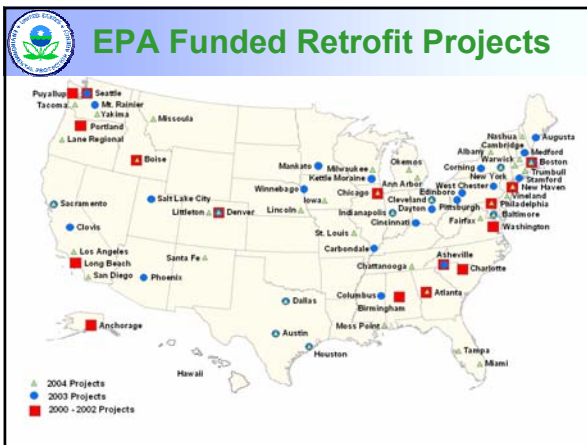
CA Verified Devices and Applications

Type	# ¹	PM↓	NOx ↓	Years ¹	On/off
Filter	5	85		1994-2004	On
Filter	3	85	25-40	1993-2003	On
Filter	1	50		1991-1993	On
Fuel	2	50	15	1996-2002	On
Ox catalyst	2	25		1973-2003	On
Ox catalyst	2	25	25-80	1991-1998	On
Filter	1	85		1996-2004	Off
Fuel+ox cat.	1	50	20	1996-2002	Off
Ox catalyst	1	25		1994-2002	Off

7/05

¹ Individual devices may have a more limited model year application

EPA Funded Retrofit Projects



Conclusions

- Emissions From Heavy Duty Diesel Are A Major Source of PM and NOx Emissions
- Standards in US/EU/Japan Converging at Very Low Levels but Differing Technology Options May Emerge
 - EU Diesel NOx Standards Will Still Likely Lag After Euro 5 and Euro 6
 - Ultrafines Still Issue Without PM Filters
- Major Challenges
 - Increasing Adoption of Low Sulfur Fuel in Developing Countries
 - Accelerating The Introduction of Euro 3, 4 and 5 in Developing Countries
 - Addressing Locomotives and Marine Vehicles
 - Retrofitting and Replacing Existing Dirty Engines