

Linkages between Stricter Emissions Standards and Fuel Quality: Cost-Benefit Analyses of Lowering Sulfur Levels in Gasoline and Diesel

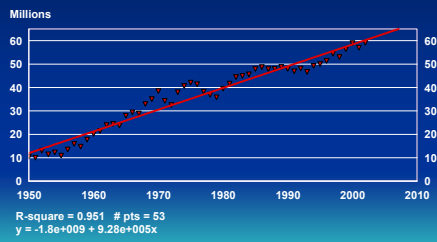


Michael P. Walsh and
Katherine Blumberg
BAQ 2004
Agra, India
December, 2004

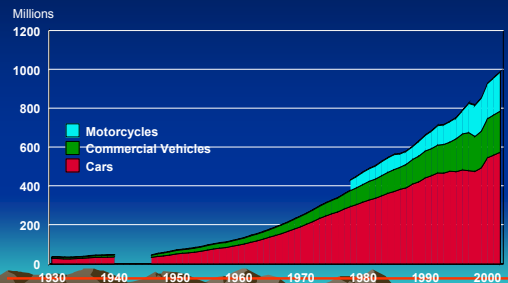
Objectives

- To Review the Status of Low Sulfur Fuels Around The World
- To Summarize the Reasons Countries Are Adopting Low Sulfur Fuels
- To Summarize Various Cost-Benefit Studies Which Have Looked at Low Sulfur Fuels and Tighter New Vehicle Standards

Global Trends In Motor Vehicle (Cars, Trucks & Buses) Production

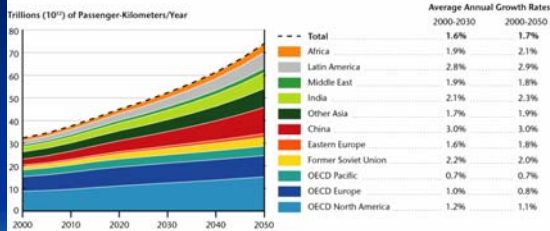


World Motor Vehicle Population



Growth Will Likely Continue With Asia Leading The Way

Personal transport activity by region



Source:
Sustainable Mobility Project calculations.

...and even more significant freight transport growth: 2,4 % /year

Most Vehicles Tend To Aggregate in Cities

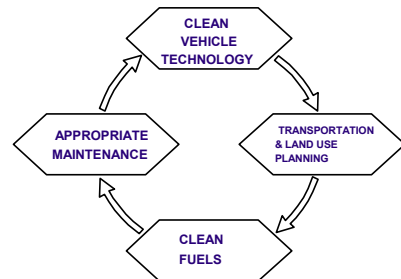


One Result: Serious Health Concerns

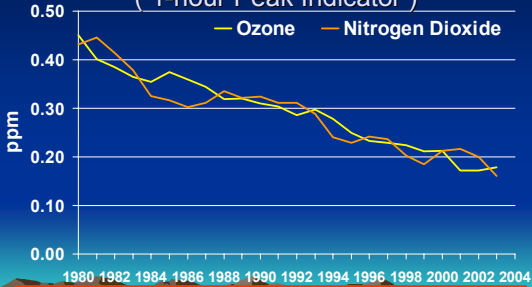
- WHO Concludes ~ 800,000 Premature Deaths Each Year From Urban PM; Most in Asia
- Numerous Studies in Europe & US Consistently Link PM With Premature Deaths, Hospital Admissions, Asthma Attacks, Etc.
- No Evidence of a Threshold
- PAPA Project Indicates Similar Effects in Asia
- Ozone Also A Serious Health Concern
- NO_x Various Toxics Also Problematic



ELEMENTS OF A COMPREHENSIVE VEHICLE POLLUTION CONTROL STRATEGY



Good Programs Can Improve Air Quality: California Trends (1-hour Peak Indicator)

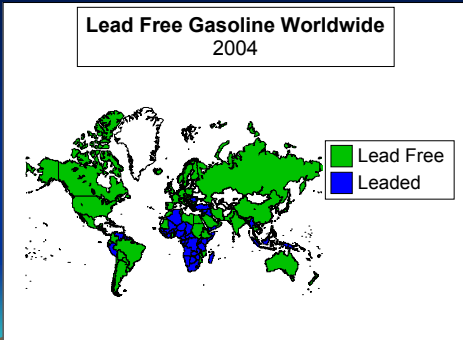


California PM10 Air Quality Trend (Maximum Annual Average of Quarters)

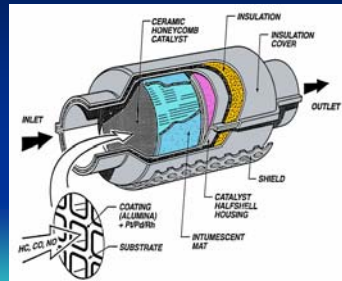


Positive Actions Are Spreading Around The World

Lead Free Gasoline Worldwide 2004



The Three-way Catalytic Converter: A Familiar Technology Re-Engineered for High Performance in Close-coupled and Underfloor Applications

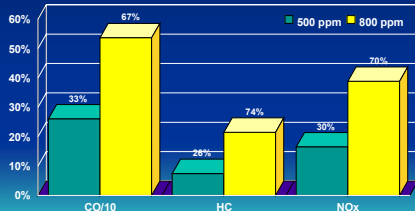


- Layered washcoat architectures and support materials with high thermal stability
- Integrated HC adsorption functions
- Mounting materials with improved durability
- High cell density ceramic or metallic substrates
- Insulation schemes for heat management

Maximum Emissions Performance Is Only Achieved With Near Zero Sulfur Fuel

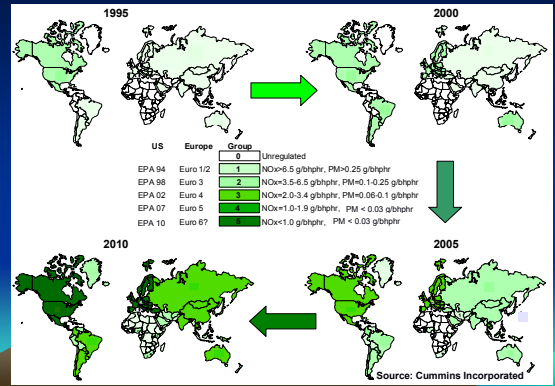
Increase in In-Use Vehicle Emissions in Bangkok Due To Sulfur in Fuel (Gasoline)

Percent Increase Compared to 150 PPM Sulfur



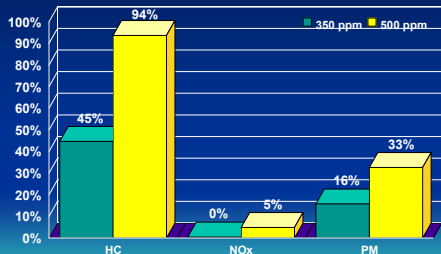
Impact on Vehicles Meeting EURO 3 Standards

Engine Standards Follow Ultra-Low Sulfur Fuel



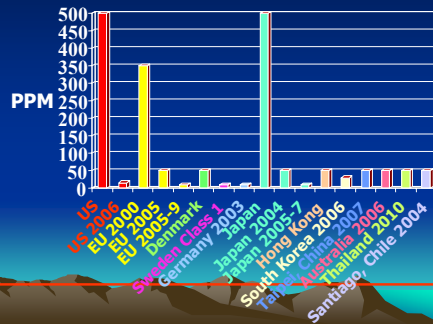
Source: Cummins Incorporated

Increase in In-Use Vehicle Emissions in Bangkok Due To Sulfur in Fuel (Diesel)

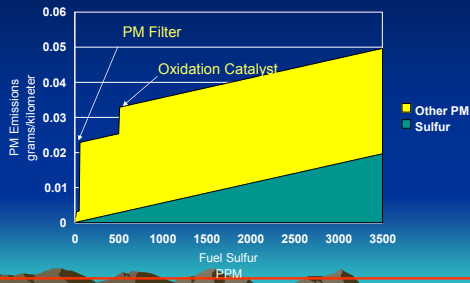


Impact on Vehicles Meeting EURO 3 Standards

Air Quality Needs Driving World to Ultra-Low Sulfur Diesel



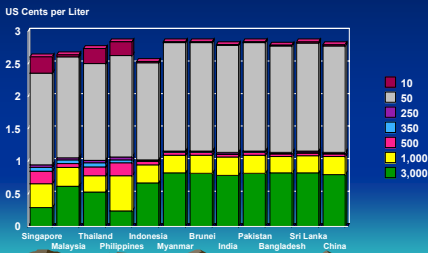
Linkage Between Fuel Sulfur and PM Emissions



Other Benefits from Sulfur Control

- Sulfur reduction reduces SO₂ emissions.
 - Less sulfate formation in the atmosphere (about 1/3 of SO₂ reacts to sulfate)
 - Reduced acid rain.
- Sulfur reduction reduces engine wear.
 - Reduction from 2500 ppm to 500 ppm reduces engine wear 10 - 20%; about 33% if starting out at 5000 ppm.
 - Greater engine wear with infrequent oil change.
- Retrofit Opportunities

Cost of Reducing Sulfur in Diesel Fuel in Asia (High Sulfur Crude)

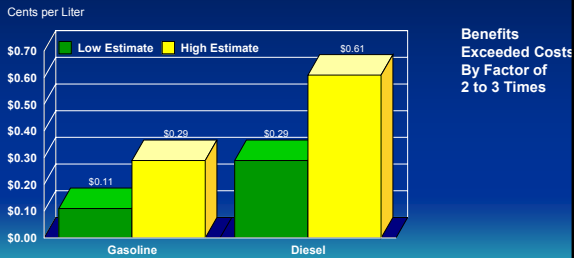


Source: Enstrat International

The Costs and Benefits of Shifting To Lower Sulfur Fuels International Experience

- European Union
- Canada
- US

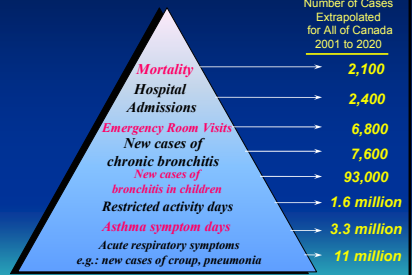
EU Estimate of Costs to Reduce Sulfur From 50 ppm to 10 ppm



Canada Health Effects Consensus Findings (Independent Expert Panel)

Reducing sulphur to 30 ppm improves the health of Canadians

Health Effects of Pollution Mixture May Be Much Greater than Particles Alone



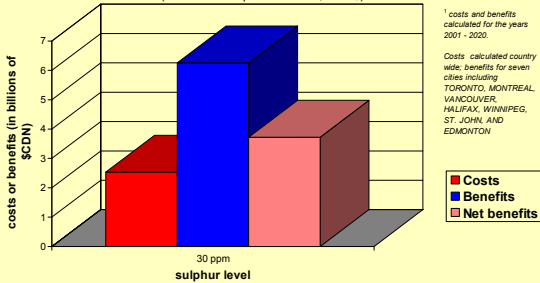
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Canadian Study of Health Impacts of Low Sulfur Gasoline

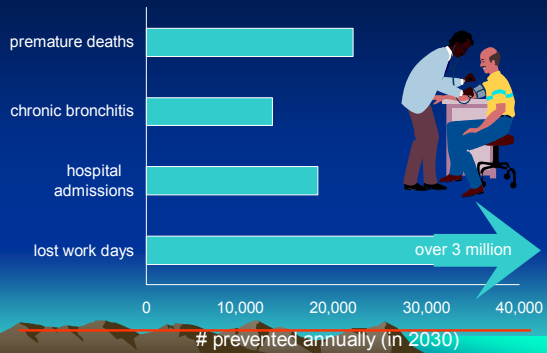
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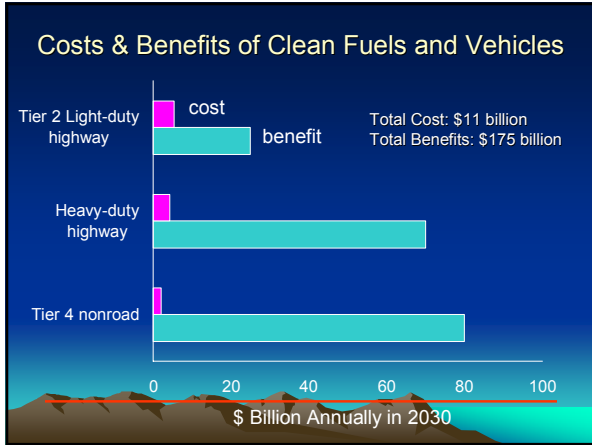
Canada

Costs and benefits of reduced-sulphur gasoline¹ (in terms of net present value; 1994\$)

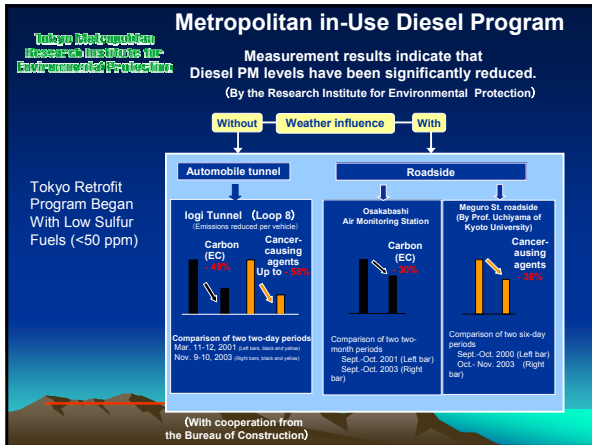


Benefits of Clean Fuel and Vehicle Programs





- ### Retrofits – Why Wait for Benefits?
- **Ultra-Low Sulfur Diesel Enables PM Retrofits**
 - Realize significant environmental benefits from existing fleet
 - Don't have to wait for new vehicle fleet to turnover
 - **Technologies addressing diesel PM emissions**
 - Diesel Oxidation Catalysts (DOCs)
 - Catalyzed Diesel Particulate Filters (CDPFs)
 - Flow Through PM Filters Emerging



- ### It All Starts with Clean Fuels
- 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 and enhance emissions controls
 - Clean fuels also open the door for retrofits to accelerate benefits and prove-out new technologies
 - **Benefits far outweigh costs**