

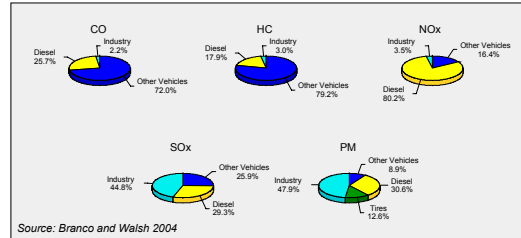
Benefits versus Costs: Low Sulfur Fuels & Tight Vehicle Standards in Brazil

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December 03, 2004 – São Paulo, Brazil



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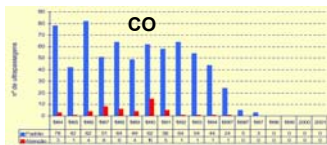
Source: Branco and Walsh 2004

- Diesels are arguably the most important source of NO_x and PM
- Other vehicles (gasoline, etc.) are the most important source of HC and CO

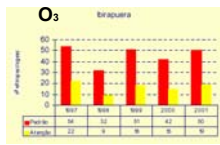
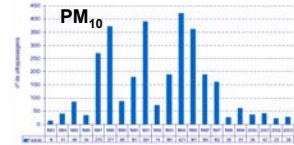


Emissions Inventory for São Paulo

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- CO has improved; standard is now generally being met
- PM₁₀ and ozone (O₃) standards continue to be violated on a regular basis
- No standard yet for fine PM (PM_{2.5})



NUMBER OF DAYS WITH POLLUTANT CONCENTRATIONS ABOVE THE AIR QUALITY STANDARDS

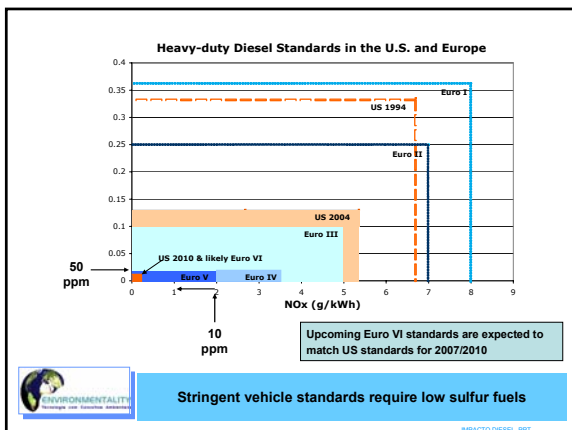
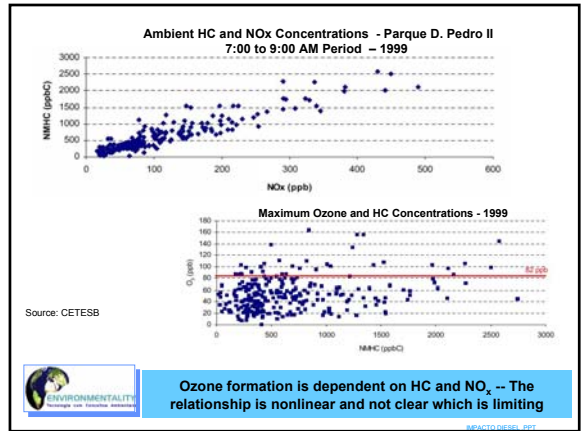
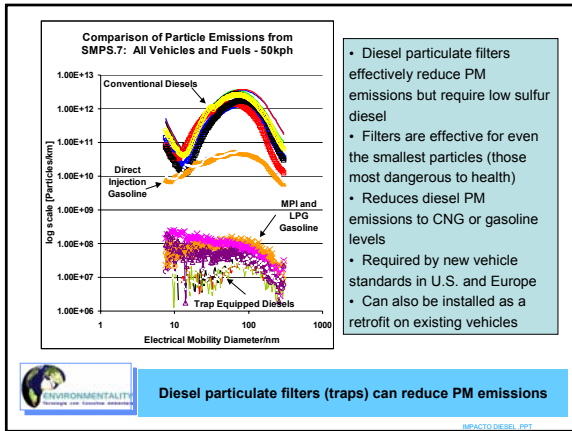
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- WHO concludes there are ~ 800,000 premature deaths worldwide each year from urban PM; Diesels are a major source
- Numerous studies in Europe & US consistently link PM with premature deaths, hospital admissions, asthma attacks, etc.
- No evidence of a PM threshold for health effects
- Ozone also a serious health concern. NO_x and HC are precursors



PM and O₃ are the most important pollutants from a health perspective

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Health benefits associated with PM reductions in the year 2030

Health Endpoint	Avoided Cases	\$/Case
Mortality	4-5 thousand	613,000
Infant mortality	2-3 hundred	613,000
Chronic bronchitis	4-6 thousand	75,000
Hospital admissions for cardiovascular causes	4-6 hundred	4,000
Hospital admissions for respiratory causes	2-4 thousand	3,000
ER visits	17-24 thousand	70
Asthma attacks	120-180 thousand	10
Children: acute bronchitis	12-17 thousand	13
Work loss & restricted activity days	3-4 million	12

Source: Analysis of avoided cases used Cifuentes et al., 2001; Values are adjusted from US EPA 2004 by purchasing power parity and mortality is further adjusted for reduced disability-adjusted life years.

Predicted health benefits from diesel PM reductions in São Paulo alone could result in annual savings of up to US\$3-4 billion in the year 2030.

São Paulo health benefits associated with expected reduction in PM concentration

Capital investments:

Petrobras predicted US\$ 1.8 billion is required to achieve CONAMA proposal (500 ppm in 2005, 50 ppm in 2009).

Using the conservative assumptions from US EPA Nonroad Diesel rule and applying a 50% mark up, we estimate that the capital investment required to achieve 10 ppm levels for sulfur and 30 ppm for gasoline will be approximately equivalent, ~ US\$2 billion.

Yesterday we were told US\$ 3 billion, this analysis assumes that amount with a 15% discount rate, a 15 year lifetime, and a 3x mark-up to account for operating costs.

Health benefits:

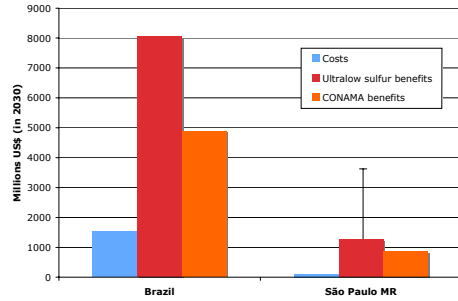
Country-wide (Derived from US EPA rural/urban averages and adjusted for Brazilian PPP): US\$ 2020/ ton NO_x, US\$ 28886/ ton PM, US\$ 3232/ ton SO_x

São Paulo MR (Derived from Santiago study specifically considering diesel emissions and adjusted for Brazilian PPP): US\$ 3345/ ton NO_x, US\$ 66632/ ton PM, US\$ 12690/ ton SO_x. Also the direct quantification of benefits as described.



Incremental costs for low sulfur fuels are reasonable

Costs and benefits of reducing sulfur for the year 2030



Initial findings suggest that benefits for ultralow sulfur diesel in Brazil are approximately 4-20 times greater than costs, with highest benefits in urban areas.

QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.

Upgrading refineries to meet low sulfur standards may require reduced investments in certain types of equipment and increased investments in other types.

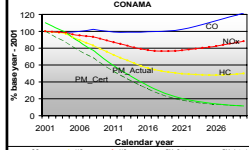
It is critical to plan for more stringent future standards while implementing current standards.

Source: World Bank 2002

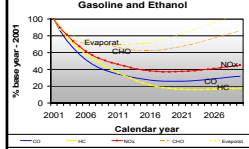


Ensure investments are not sunk as goals change.

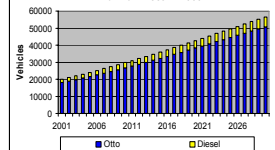
Heavy Duty Diesel Fleet Emissions CONAMA



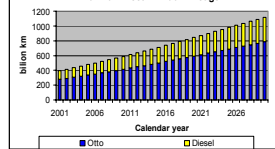
Light Duty Vehicle Fleet Emissions Gasoline and Ethanol



Brazilian Fleet x 1000



Brazilian Fleet x Annual Mileage



DIESEL AND OTTO FLEET COMPARISON CONAMA'S SCENARIO

According to EPA guidelines, 9-13 µg/m³ reduction in PM₁₀ may correspond to → **2.25 to 3.25 billion dollars per year**

Six cities study (Bangkok, Krakow, Manila, Mumbai, Santiago and Shanghai):

- Average environmental costs = US\$ 380 per ton of burned diesel fuel;
- Maximum environmental cost = US\$ 847 per ton of burned diesel fuel (Santiago);
- SPMR diesel demand = 2.7 billion liters/year → **US\$ 0.86 to 1.9 billion/year**

EPA's rule of thumb:

Pollutant	NOx	MP	SO ₂
US\$ / ton	10000	143000	16000

→ **US\$ 3.4 billion / year**

NREL and World Bank

Pollutant	CO	HC	NOx	MP	SO ₂	CO ₂
US\$ / ton	1000	2200	2500	30050	800	20

Urban costs = US\$ 822 million / year
Global costs = US\$ 206 million / year

Adopted because these values are more conservative and match to the six cities study;
Allows estimation for each pollutant separately.

ESTIMATED COSTS OF AIR POLLUTION IN THE SPMR

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Environmental Costs of Diesel Fleet-SPMR US\$ million - CONAMA

CO₂ → Greenhouse Effect – Global warming
Other contaminants → local pollution

Base line	CO	HC	NOx	PM	SO ₂	CO ₂
US\$ / ton	1000	2200	2500	30050	800	20

**ESTIMATED COSTS OF AIR POLLUTION IN THE SPMR
CONAMA'S SCENARIO**

IMPACTO DIESEL PPT

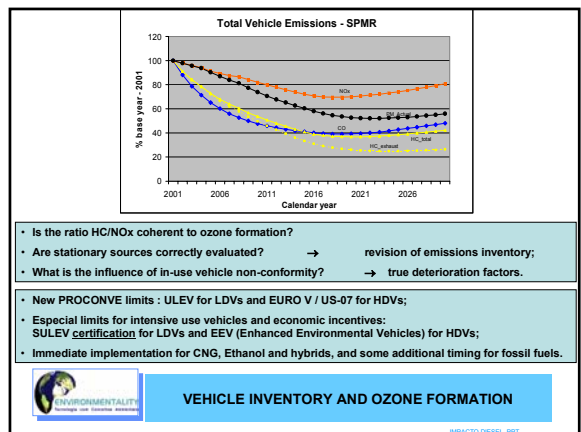
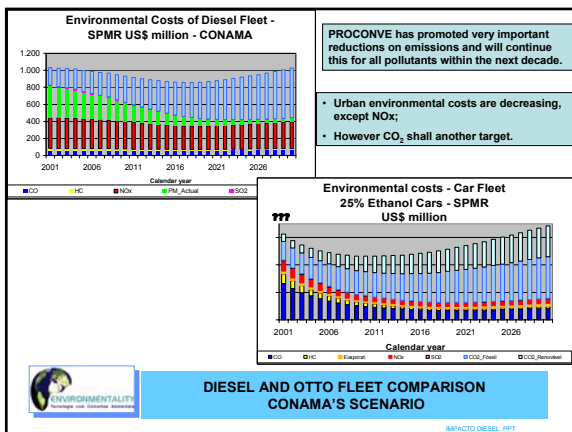
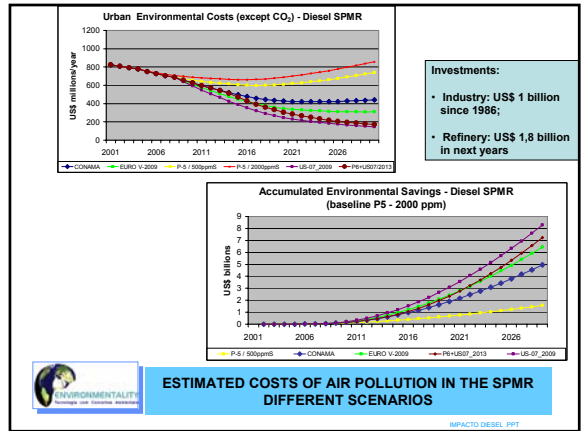
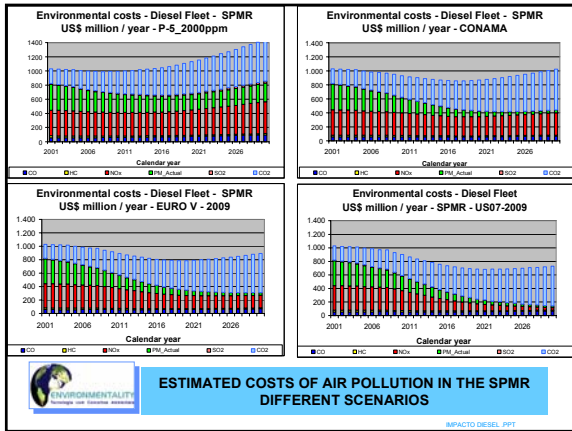
- **CONAMA:** maintaining the official timeline established by CONAMA through its Resolution 315/2002, (equivalent to EURO III) with diesel fuel containing a maximum sulfur level of 500 ppm (parts per million) beginning in 2005 (for large cities), and EURO IV standards with a maximum sulfur level of 50 ppm (for large cities) by January 1, 2009;
- **EV-09:** leapfrogging directly to EURO V (diesel fuel with a maximum sulfur level of 10 ppm) in 2009;
- **US-07_2009:** leapfrogging directly to US-07 (diesel fuel with a maximum sulfur level of 10 ppm) in 2009
- **P-5:** reducing sulfur content to 500 ppm by 2005 (the current PROCONVE P-5 phase) but holding there even beyond 2009, because without 50 ppm sulfur fuel, it will be impossible to implement EURO IV emission standards (the energy sector is lobbying heavily to adopt this timeline);
- **BAU:** maintaining the current standards and fuel quality beyond 2005 and even beyond 2009, that is, indefinitely maintaining EURO III emission standards and sulfur levels of 2000 ppm (a "business as usual" scenario) – red lines;
- **CONAMA + US-07 in 2013:** maintaining the official timeline established by CONAMA through its Resolution 315/2002, adding a new phase for US-07 standards implementation in 2015 anticipated to 2013 for urban buses

DIFFERENT SCENARIOS FOR HDV EMISSION STANDARDS

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**ANNUAL EMISSIONS OF DIESEL FLEET
DIFFERENT SCENARIOS**

IMPACTO DIESEL PPT



CONCLUSIONS and SUGGESTIONS:

- The environmental costs produced by the VEHICLE fleet in the SPMR are estimated in US\$ billions/yr, which justifies higher investments in emission reduction programs;
- 500 ppm sulfur is needed immediately to assure the PM emission conformity of model year 1998 and later vehicles in real use;
- Urban costs will remain in the present HIGH levels if sulfur content is not reduced below 50ppm by 2009 and below 10 ppm in a supplementary phase to reduce PM emission effectively;
- PROCONVE must be revised to reduce NOx and ozone precursors effectively, and request fuel consumption data to improve emission inventory, establishing targets for the vehicle efficiency to better assess the reduction of CO₂;
- Environmental and technology sectors might start immediately discussing additional targets for NOx, PM, HC and fuel consumption to be implemented in the next years, considering that the environmental savings accumulated in the SPMR until 2030 will be higher than US\$ 7 billion;
- Environmental costs produced by old diesel vehicles are comparable to their fuel expenditures. In some cases, retrofitting diesel engines may represent ambient savings that pay its investments in only a few years;



FINAL COMMENTS

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CONCLUSIONS (continued):

- The emission inventory has to be revised for all sources to better evaluate the HC/NOx ratio, compare to ozone modeling and propose new targets for these pollutant reductions;
 - Fuel economy targets must be established by the involved Ministries (MMA, MCT and MDIC) and certified through PROCONVE'S current proceedings to reduce CO₂, considering the application of carbon credits through the Clean Development Mechanism;
 - The Brazilian renewable fuel policy has to be revised to refrain CO₂ emission, to avoid the environmental cost increase up to the present levels in 2030;
- THE ADOPTED STRATEGIES FOR EMISSION REDUCTION MUST BE REVISED ACCORDING TO A LONG TERM TREND, CONSIDERING THAT ENVIRONMENTAL SAVINGS ARE MUCH MORE SIGNIFICANT THAN THE COSTS OF EMISSION CONTROL**



FINAL COMMENTS

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THANK YOU!

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