Sustainable transport, the challenge ahead

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1. BACKGROUND AND INTRODUCTION

Four trends continue to dominate the global consideration of motor vehicle pollution control issues:

- the continued growth in the world's population;
- the rising affluence of many rapidly industrializing developing countries, increasing the affordability of motor vehicles;
- the increasing number of health studies showing adverse effects at lower and lower levels of pollution; and
- the response of governments by adopting more and tighter emissions standards for new vehicles or other incentives to stimulate the introduction of pollution controls on vehicles.

Across the entire globe, motor vehicle usage has increased tremendously. As we approach the 21st century, more than 700 million vehicles are on the world's highways - almost 500 million light duty vehicles, about 150 million commercial trucks and buses and another 100 million motorcycles. Over the last thirty five years, on average, the fleet has grown by about 12 million automobiles per year, 3.7 million commercial vehicles and 2.5 million motorcycles per year.[1] While the growth rate has slowed in the highly

[1] "World Motor Vehicle Data, 1996 Edition," American Automobile Manufacturers Association, 1996.

industrialized countries, population growth and increased urbanization and industrialization are accelerating the use of motor vehicles elsewhere.

One result is that most of the major industrialized areas of the world have been experiencing serious motor vehicle pollution problems. To deal with these problems North America, Europe and Japan have developed comprehensive motor vehicle pollution control programs which have led to tremendous advances in light duty vehicle pollution control technologies. At present, similar technologies are under intensive development and commercial introduction for heavy duty diesel trucks and buses, as well as two stroke motorcycles.

Motor vehicle related air pollution problems are not limited to the highly industrialized countries of the Organization for Economic Cooperation and Development (OECD), however. Areas of rapid industrialization are now starting to experience similar air pollution problems to those of the industrialized world. Cities such as Mexico, Delhi, Seoul, Singapore, Hong Kong, Sao Paulo, Manila, Santiago, Bangkok, Taipei and Beijing to cite just a few already experience unacceptable air quality or are projecting that they will in the relatively near future.

The purpose of this report is to survey what is presently known about transportation related air pollution problems, to summarize briefly the adverse impacts which result, to review actions underway or planned to address these problems, and to highlight future problems.

2. HISTORIC PATTERNS OF VEHICLE PRODUCTION AND USE

A. Trends in World Motor Vehicle Production

Overall growth in the production of motor vehicles, especially since the end of World War II, has been quite dramatic, rising from about 5 million motor vehicles per year to almost 50 million. Between 1950 and now, production increased almost linearly from about 10 million vehicles per year to about 50 million per year, approximately 1 million additional vehicles produced each year compared to the year before.

Over the past several decades, motor vehicle production has gradually expanded from

one region of the world to another. Initially and through the 1950's, it was dominated by North America. The first wave of competition came from Europe, and by the late 1960's European production had surpassed that of the United States. Over the past two decades the car industry in Asia, led by Japan, has grown rapidly and now rivals both those in the United States and Europe. Both Latin America and Eastern Europe appear poised to grow substantially in future decades.

B. Trends in World Motor Vehicle Registrations

As for worldwide vehicle registrations, the long term trends are sharply upward and are actually accelerating. Europe (including Eastern Europe and the USSR) and North America each have about 35 percent of the world's motor vehicle population. The remainder is divided among Asia, South America, Africa, and Oceania (Australia, New Zealand, and Guam), in that order.

In terms of per capita motor vehicle registration for various regions, the United States, Japan, and Europe also account for the lion's share of the ownership and use of motor vehicles. Indeed, the non OECD countries of Africa, Asia (excluding Japan) and Latin America are home to more than four fifth's of the world's population, yet account for only one fifth of world motor vehicle registrations!

3. FUTURE TRENDS IN MOTOR VEHICLE REGISTRATIONS

Worldwide, the number of motor vehicles is growing far faster than the global population - about 5 percent per year, compared with about 2 percent per year. Analyzing trends in global motor vehicle registrations reveals that the global fleet has been growing linearly since before 1970 and that each year for four decades an additional 18 million motor vehicles have been added to the world fleet. If this linear trend continues, the global vehicle population will reach about 1.06 billion by the year 2010.

Analyzing growth in registrations per capita yields an even higher estimate for the world motor vehicle fleet. Each year worldwide registrations grow by about 2.8 vehicles per

thousand persons. If this trend were to continue until 2010, there would be 178 motor vehicles per 1000 persons. If this figure is multiplied by the United Nation's medium variant estimate for global population in 2010 - 7.2 billion -- the motor vehicle fleet will be an estimated 1.2 billion, about 10 percent greater than would result from the strictly linear projection.

In addition to the continued growth in the global population, another factor contributing to the increased vehicle population is the growing affluence in certain rapidly industrializing developing countries, especially in Southeast Asia and Latin America. There is a very good correlation worldwide between the vehicles per capita in a given country and the GNP per capita.

A. Underlying Factors Which Foster Vehicle Growth

The growth in demand for motorized travel in recent decades is well understood. As urban areas populate and expand, land which is generally at the edges of the urban area and previously considered unsuitable for development is developed. The distance of these residential locations from the city center or other sub-centers increases, increasing the need for motorized travel. Motorized travel often in private vehicles supplants traditional modes of travel such as walking, various bicycle forms, water travel, and even mass transit. The need for private vehicles is reinforced as declining population densities with distances from urban centers reduce the economic viability of mass transit.

The evolution of the form of urban areas is influenced by the growth of income and accompanying increases in the acquisitions of private motor vehicles and changes in travel habits. As incomes rise, an increasing proportion of trips shifts, first to motorcycles and, as income increases further to private cars. The trend toward private motorization is not inevitable but is also influenced by public policy towards land use, housing, and transportation infrastructure. While the proportion of middle and upper income households in developing and newly industrialized countries able to afford cars and motorcycles is lower than in industrialized nations, the number of private vehicles still becomes very large as the middle and upper income groups grow in megacities. The number of vehicles and levels of congestion are comparable to or exceed that of major cities in industrialized countries. With the increase in motorized travel and congestion

come increases in energy use, emissions and air pollution.

Focusing on Southeast Asia, the region currently experiencing the most rapid growth in road vehicles, as an example, all projections of population trends indicate both rapid increases and increasing urbanization of that population. In short, these trends generally increase the geographical spread of cities, both large and small, increasing the need for motorized transit to carry out an increasing portion of daily activities. Further, when coupled with expanding economies as is increasingly the case in Asian countries, a greater proportion of the urban population can afford personal motorized transportation, starting with motor cycles and progressing as soon as economically feasible to cars.

B. Trends in the Global Motor Vehicle Fleet (By Region)

Weighing the underlying factors influencing vehicle population growth especially population growth and economic development, projections of the future vehicle population have been made. In making these estimates, it was assumed that vehicle saturation, increased congestion and increasing policy interventions by governments would restrain future growth especially in highly industrialized areas.

As noted earlier, the global vehicle fleet has tended to be dominated by the highly industrialized areas of North America and Western Europe. This pattern is gradually changing not because these areas have stopped growing but because growth rates are accelerating in other areas. By early in the next century, based on current trends, the rapidly developing areas of the world (especially Asia, Eastern Europe and Latin America) and the OECD Pacific region will have as many vehicles as North America and Western Europe. Forty years from now, North America and OECD Europe could represent less than half the global fleet.

4. INCREASING HEALTH AND ENVIRONMENTAL CONCERNS

Cars, trucks, motorcycles, scooters and buses emit significant quantities of carbon monoxide, hydrocarbons, nitrogen oxides and fine particles. Where leaded gasoline is used, it is also a significant source of lead in urban air. As a result of the high growth in

vehicles and these emissions, many major cities around the world are severely polluted. Reviewing the available evidence, the World Health Organization recently released new air quality guidelines for Europe. In addition to tightening requirements overall, the were unable to conclude that there is any acceptable level of particulate; therefore for this pollutant they could not recommend any acceptable threshold.

Beyond direct adverse health effects, there are other concerns with vehicle emissions. Among these is global warming or the greenhouse effect. Greenhouse warming occurs when certain gases allow sunlight to penetrate to the earth but partially trap the planet's radiated infrared heat in the atmosphere. Some such warming is natural and necessary. If there were no water vapor, carbon dioxide, methane, and other infrared absorbing (greenhouse) gases in the atmosphere trapping the earth's radiant heat, our planet would be about 60 F (33 C) colder, and life as we know it would not be possible.

Over the past century, however, human activities have increased atmospheric concentrations of naturally occurring greenhouse gases and added new and very powerful infrared absorbing gases to the mixture. Even more disturbing, in recent decades the atmosphere has begun to change through human activities at dramatically accelerated rates. According to a growing scientific consensus, if current emissions trends continue, the atmospheric build up of greenhouse gases released by fossil fuel burning, as well as industrial, agricultural, and forestry activities, is likely to turn our benign atmospheric "greenhouse" into a progressively warmer "heat trap", as Norway's former Prime Minister, Ms. Gro Harlem Brundtland, has termed this overheating.

Various human endeavors contribute to climate change. Recent estimates indicate that by far the largest contributor (about 50 percent) is energy consumption, mostly from the burning of fossil fuels. The release of chlorofluorocarbons (CFC's), the second largest contributor to global warming, accounts for another approximately 20 percent. Mostly known for depleting the stratospheric ozone layer, these stable, long lived chemicals are also extremely potent greenhouse gases. Deforestation and agricultural activities (such as rice production, cattle raising, and the use of nitrogen fertilizers) each contribute about 13 to 14 percent to global warming.

Carbon dioxide (CO_2) accounts for about half of the annual increase in global warming. The atmospheric concentration of carbon dioxide, now growing at about 0.5 percent per

year, has already increased by about 25 percent since preindustrial times. Half of this increase has occurred over just the past three decades.

Globally, about two-thirds of anthropogenic carbon dioxide emissions arise from fossil fuel burning, the rest primarily from deforestation. In the United States, electric power plants account for about one third of the carbon dioxide emissions, followed by motor vehicles, planes, and ships (31 percent), industrial plants (24 percent), and commercial and residential buildings (11 percent).

The third largest contributor (after the CFC's) is methane (CH_4), accounting for about 13 to 18 percent of the total warming. Sources of this gas include anaerobic decay in bogs, swamps, and other wetlands; rice growing; livestock production; termites; biomass burning; fossil fuel production and use; and landfills. Methane may also be arising from the warming of the frozen Arctic tundra. The atmospheric concentration of methane is growing by about 1 percent annually.

Ozone (O_3) in the lower atmosphere (the troposphere) is the principal ingredient of smog. This gas is created in sunlight driven reactions involving nitrogen oxides, NO_x (as distinct from nitrous oxide, N_2O) given off when either fossil fuels or biomass are burned, and volatile organic compounds from a wide spectrum of anthropogenic and natural sources. In the United States, highway vehicles are the source of about 31 percent of NO_x emissions and about 44 percent of volatile organic compounds. Tropospheric ozone contributes about 8 percent to global warming.

Exactly where nitrous oxide (N_2O) comes from is still uncertain, but prime suspects include the use of agricultural fertilizers and, perhaps, the burning of biomass and coal. A growing source of N_2O is motor vehicles with three way catalysts. Nitrous oxide accounts for about 6 percent of current enhanced warming and also contributes to depletion of the stratospheric ozone layer.

As greenhouse gases accumulate in the atmosphere, they amplify the earth's natural greenhouse effect, profoundly and perhaps irreversibly threatening all humankind and the natural environment. While most scientists agree on the overall features of such warming, considerable uncertainties still surround its timing, magnitude, and regional impacts. Major unanswered questions include whether the additional clouds that are likely to form will have a net cooling or warming effect, how the sources and sinks of

greenhouse gases will change, and whether the polar and Greenland ice sheets will grow or retreat. The complexity of the global climate system is daunting and the interactions between the atmosphere and the oceans are still imperfectly understood.

Unless measures are soon taken to reduce the release of greenhouse gases, by as early as 2030 they could reach levels equivalent to twice the carbon dioxide concentrations of pre industrial times. Two recent events have heightened concerns with global warming. In late November 1995, the IPCC Working Group 1 concluded that 'the balance of evidence suggests that there is a discernible human influence on global climate'. (Science 1995). Even more recently, a provisional report issued by the British Meteorological Office and the University of East Anglia concluded that the earth's average surface temperature climbed to a record high in 1995. In spite of commitments by most industrialized countries to stabilize or reduce CO2 emissions, very little progress has occurred in the transportation sector. Strategies such as mandatory increases in fuel economy or substantial increases in fuel taxes have proven elusive in recent years.

5. MAJOR REGULATORY PROGRAMS ARE MAKING PROGRESS IN REDUCING URBAN AIR POLLUTION

A great deal has been accomplished around the world in reducing motor vehicle pollution control. Achievement of this goal generally requires a comprehensive strategy encompassing emissions standards for new vehicles, clean fuels, strategies designed to assure that vehicles are maintained in a manner which minimizes their emissions and traffic and demand management and constraints. As a result of these efforts, there are clear signs of progress. For example, emissions of CO, HC and NOX from passenger cars in the United States and Germany, respectively, are down substantially in recent years in spite of the continued growth in the vehicle populations in these countries.

6. PROGRESS IN ADDRESSING GLOBAL WARMING IS LIMITED

In contrast with the success in reducing CO, HC and NOx from vehicles, there has been very little progress in reducing CO_2 emissions as will be discussed in the next section.

i. The US Experience

In the US, the Corporate Average Fuel Economy (CAFE) standards increased significantly during the 1970's and early 1980's but have remained fairly flat since the mid 1980's, actually declining over the past few years. In spite of the auto improvements, overall transportation energy consumption has continued to go up. This is due to a variety of reasons. For example, as auto fuel efficiency improved, sales of light trucks have increased substantially. Since many of these light trucks tend to be used much like passenger cars and have much lower fuel efficiency than the cars they are replacing, overall light duty vehicle efficiency gains are less than it would appear. In addition, CAFE did not apply to heavy duty vehicles, this category being subject only to a voluntary program. Further, national legislation was modified during the 1980's to allow speed limits to climb to 65 MPG thereby further undercutting energy conservation since fuel consumption increases as highway vehicle speeds climb. During the last decade the auto industry has been moving back toward the horsepower wars of the 60's, substantially increasing power output and reducing 0 to 60 MPH wide open throttle acceleration times over this period.

Simultaneously, people are using private cars and light trucks to drive to work much more than in the past with the result that public transit usage is down. When considering the improvements in new car fuel economy and the return of gasoline prices to pre OPEC levels, the cost of fuel for driving in real terms is much lower in the US today than at any time in the last two decades further encouraging additional driving. Not surprisingly, annual vehicle miles traveled has been increasing across the US by about 50 billion miles per year and because the amount of driving is increasing faster than the improvement in M.P.G., annual fuel consumption continues to increase.

Significantly, U.S. efficiency improvements began with the industrialized world's least-efficient car fleet. Only after the dramatic improvements observed to date are

typical U.S. cars as generally efficient as those in the same weight class in other countries.

EPA data suggest that the fuel efficiency wars of the late 1970's gave way to horsepower wars in the 1980's. Throughout the decade, manufacturers substantially increased cars' power output. Unfortunately, in the real world, drivers with more horsepower available tend to accelerate their vehicles faster, thus using more fuel and needlessly increasing on-road emissions of nitrogen oxides, volatile organic compounds, and carbon monoxide.

There is little doubt that the rise in sales of trucks and big cars and the decline in U.S. motor-vehicle fuel efficiency both stem largely from the substantial drop in real fuel prices since the mid-1980's. Gasoline prices (expressed in constant 1989 dollars) were about as low in 1989 as they had been in the previous 39 years. Apparently, fuel prices speak louder than the federal CAFE standards that require manufacturers to produce lighter and more efficient vehicles.

ii. Rest of the World

The trends in U.S. vehicle growth and fuel consumption generally resemble global patterns. While most countries' autos were much more efficient than those in the US, the gap has narrowed substantially. The primary reason, is that despite a great deal of rhetoric, gasoline car fuel efficiency has hardly improved anywhere but in the US.

CO_2 from passenger cars accounts for about half of CO_2 emissions from Transport, and about 12 percent of total CO_2 emissions in the European Union.[2] Under a 'business as usual' scenario, CO_2 emissions from cars are expected to increase by about 20 percent by the year 2000 and by about 36 percent by the year 2010 from 1990 levels. In one year, an average medium size car in the European Union emits some 3 tons of CO_2.[3]

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[2] Derived from 'A Community strategy to reduce CO2 emissions from passenger cars and improve fuel economy', COM (95) 689, Communication from the Commission to the Council and the European Parliament, Adopted by the Commission on December 20, 1995.

[3] Assuming 12,600 km per year and an average on road fuel consumption of 9.6 liters per 100 kilometers.

The road transport sector has stood out in recent years as one of the few sectors in the Union experiencing CO_2 emissions growth.

In the UK, a recent government report noted that 'fuel consumption' is rising fastest in the road transport sector, and there has been no improvement in fuel efficiency over the last 20 years. Fuel use for road transport has increased by 90 percent since 1970, accounting for a quarter of total energy consumption. Gasoline prices rose by just 2 percent during that period, compared with an 11 percent rise in household fuel.

In an era of low oil prices (~17$ per barrel) and ready availability of oil, there seems to be very little real interest in addressing energy concerns. This is dramatically illustrated by the continued increase in energy use for personal transportation in many parts of the world.

7. THE DIESEL AS A POTENTIAL SOLUTION TO HIGH CO_2 EMISSIONS

Driven in part by concerns regarding global warming, there is a clear trend toward increased sales of light duty diesel vehicles in many parts of the world. This trend can result in many positive environmental benefits including low fuel consumption, and therefore low levels of CO_2, low levels of exhaust CO and HC (especially during cold start conditions), and very low levels of evaporative hydrocarbons. However, increased diesel sales have a downside, relatively high NOX and particulate emissions. These pollutants continue to receive high priority attention in most areas of the world. As a result, countries around the world are increasingly tightening diesel regulations with the result that technology for reducing emissions continues to advance. However, NOx and PM levels from diesels remain much higher than from gasoline fueled vehicles raising the question whether the improved fuel economy of the diesel is an adequate trade of for the negative impacts on urban pollution.

There is a clear trend toward increased sales of light duty diesel vehicles in many parts of the world. Nowhere is this more true than in Europe, approximately one out of four new cars sold in 1995 was diesel fueled. Further, projections indicate even higher

penetration is likely in future years.[4]

Increased sales of light duty diesels are not limited to Europe, however; the diesel is increasingly capturing the Japanese market, as well. In fact, in the United States where light duty diesel penetration has been almost nonexistent in recent years, there is some indication that diesel technology may be emerging as the front runner in the PNGV sweepstakes.[5]

Will the increased sales of diesels result in substantial reductions in carbon dioxide. Unfortunately, it seems unlikely. When considering total life cycle CO_2 equivalent emissions, diesel cars are estimated to have a 12.8% to 13.7% benefit compared to gasoline cars.[6] As direct injection gasoline engines emerge, the greenhouse gap between diesel and gasoline may even narrow.

8. CONCLUSIONS

Continuing air pollution problems from vehicle related pollution have been stimulating innovative pollution control approaches around the world. As these approaches are implemented, steady progress in reducing certain air pollution problems is occurring. An example is the experience in Southern California's Los Angeles Basin, which has had the most aggressive motor vehicle pollution control program in the world over the past forty years.[7] From 1955 to 1993, peak ozone concentrations were cut in half. The number of days on which Federal ozone standards are exceeded fell by 50 percent from the 1976-78

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[4] 'AID Diesel Car Prospects to 2004', Automotive Industry Data Ltd., 1995

[5] 'Review of the Research Program of the Partnership for a New Generation of Vehicles', Second Report, National Research Council, 1996.

[6] 'Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity', M.A. DeLuchi, Argonne National Laboratory, November 1991.

[7] 'The Automobile, Air Pollution Regulation and the Economy of Southern California, 1965-1990', Jane Hall et al, Institute for Economic and Environmental Studies, California State University, April 1995.

time frame to the 1991-1993 interval. Further, the average annual number of days above the Federal carbon monoxide standard fell from 30 to 4.3 during this same period and lead levels are now 98 percent lower than in the early 1970's. Most remarkably, this achievement occurred while the regional economy out-paced the national economy in total job growth, manufacturing job growth, wage levels and average household income. In short, a strong focus on environmental protection is not only not incompatible with strong economic development, they seem to be mutually reenforcing.

Where great progress has occurred, across the entire world, two motor vehicle related pollution problems stand out as needing the development of more creative and effective approaches. The first is the growing concern with urban particulate. As the available health information continues to raise more and more serious concerns regarding diesel particulate, they will need to get more attention in the future. As stated by the UK government in response to the reports from the Committee on the Medical Effects of Air Pollutants and the Expert Panel on Air Quality Standards, "the central element of any strategy will concentrate on technology based measures to secure further long term abatement of vehicle emissions, particularly from diesel vehicles".[8]

Secondly, the increasing problem of CO_2 emissions from the transport sector cries out for more innovative approaches. As recently noted by the European Commission, "Under a 'business as usual' scenario, CO2 emissions from cars are expected to increase by about 20 percent by the year 2000 and by about 36 percent by the year 2010 from 1990 levels. The road transport sector has stood out in recent years as one of the few sectors in the Union experiencing CO_2 emission growth".[9]

While technological improvements in petroleum-powered vehicles are essential to achieving short-term increases in the vehicle fleet's fuel efficiency, they will not be sufficient for the long haul if the global vehicle fleet continues growing. Focusing on

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[8] Press Release issued on Behalf of Department of Environment, Department of Health and Department of Transport, 'Government Acts On Airborne Particles, Achieving Particle Standard Will Mean Significant Health Benefits', November 8, 1995.

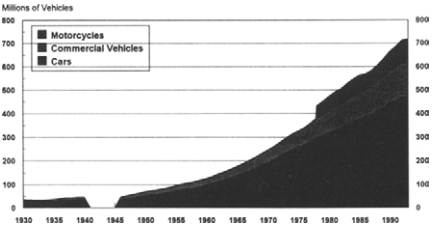
[9] 'A Community Strategy to reduce CO_2 emissions from passenger cars and improve fuel economy', COM (95) 689, December 1995.

increased use of diesel technology seems short sighted in this regard not only because of the increased NOx and PM which diesel technology currently is burdened with but also because the greenhouse gas reduction potential is so marginal. For this reason, longer-term international efforts to develop new transportation energy sources that emit no carbon dioxide will have to be intensified as emissions are reduced. A program of research, development, demonstration, and, ultimately, the introduction of such vehicles should become a matter of high public priority for all the principal vehicle-producing nations. Technologies involving fuel cells and biomass based fuels should play an increasingly important role in solving transportation related environmental problems in the future.

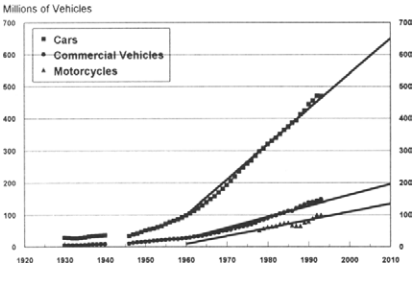
Motor Vehicle Related Air Pollution Issues in the 21st Century

5th US-Dutch International Symposium

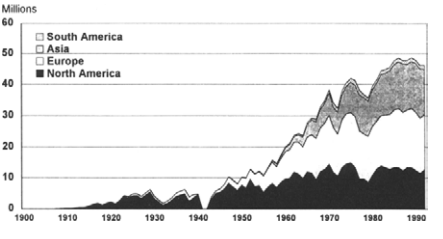
Global Trend In Motor Vehicles



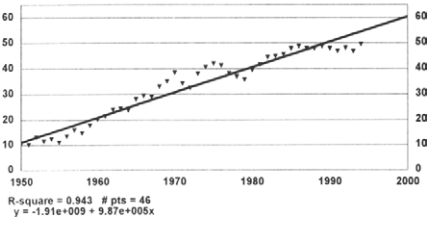
Global Trend In Motor Vehicles



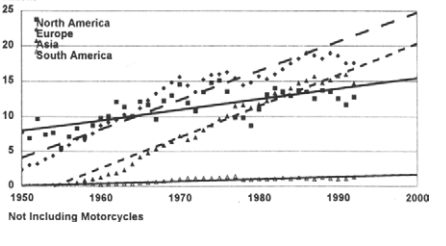
Global Trends In Motor Vehicle Production



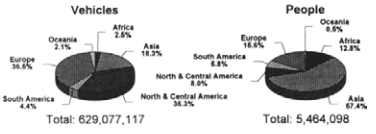
Global Trends In Motor Vehicle Production



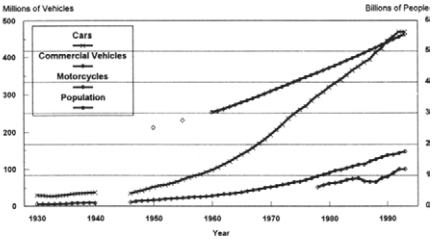
Global Trends In Motor Vehicle Production



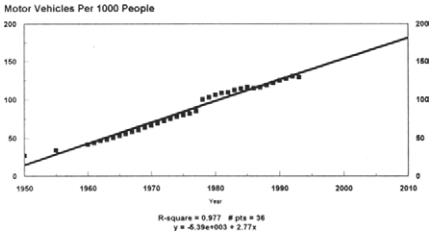
Global Distribution of Vehicles and People



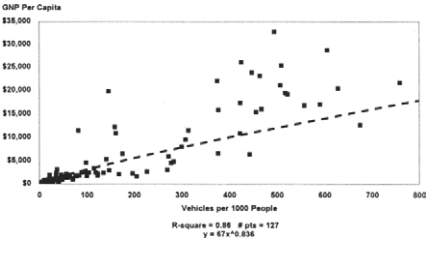
Global Trend In Motor Vehicles and People



Global Trend In Motor Vehicles and People



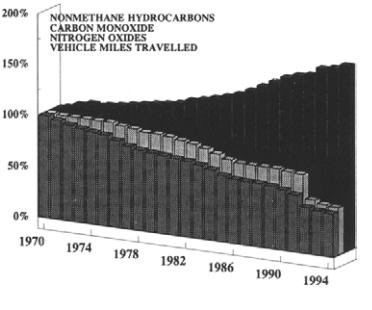
Vehicle Population Versus GNP



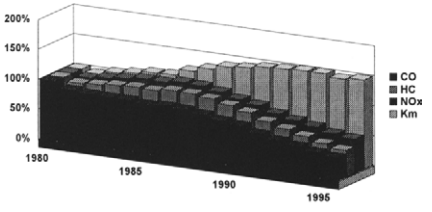
WHO Recommended Air Quality Guidelines For Europe

Compound	Guideline Value	Averaging Time
Ozone	120 Ug/m3	8 hours
Nitrogen Dioxide	200 Ug/m3	1 hour
Nitrogen Dioxide	40-50 Ug/m3	Annual
Sulfur Dioxide	500 Ug/m3	10 min
Carbon Monoxide	100mg/m3	15 min
Carbon Monoxide	60 mg/m3	30 min
Carbon Monoxide	30 mg/m3	1 hour
Carbon Monoxide	10 mg/m3	8 hours
Particulate	No Threshold	

Trends in Exhaust Emissions From US Cars Normalized to 1970

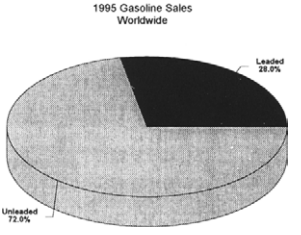


Emissions From Cars In Germany Normalized To 1980

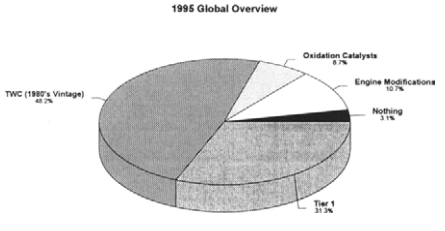


Source: Dr. Ulrich Hoepfner, IFEU, Heidelberg

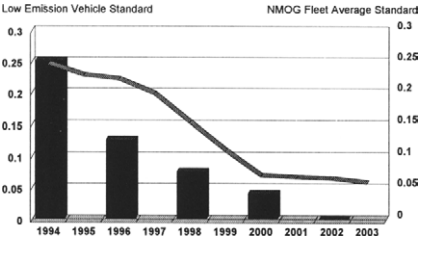
Unleaded Gasoline Is Becoming Dominant



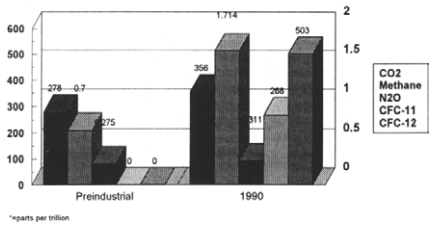
Light Duty Gasoline Vehicle Pollution Controls



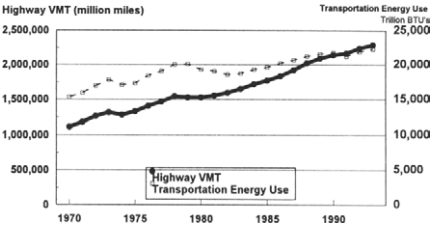
California Low Emissions Vehicle Program - (Grams Per Mile)



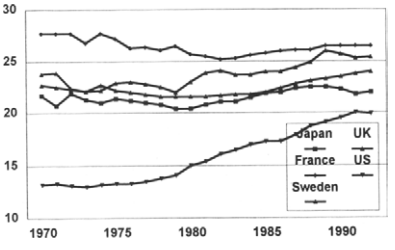
Global Atmospheric Concentrations of Greenhouse Gases - PPM



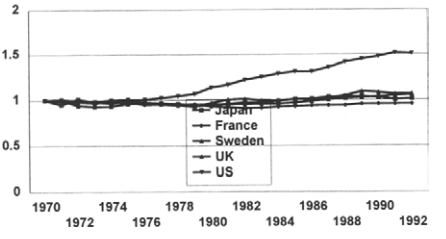
Recent Trends in the United States



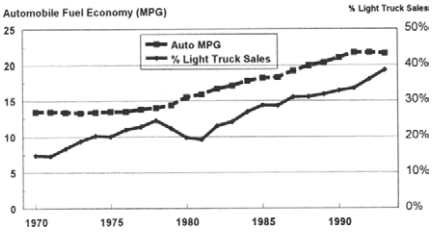
Fuel Economy of Gasoline Automobile Population for Selected Countries (MPG)



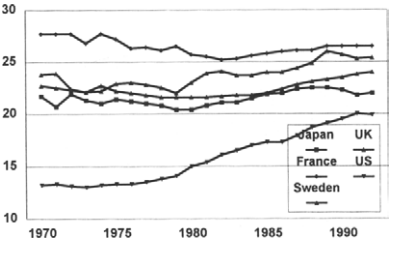
Fuel Economy of Gasoline Automobile Population for Selected Countries (MPG)
Normalized to 1970



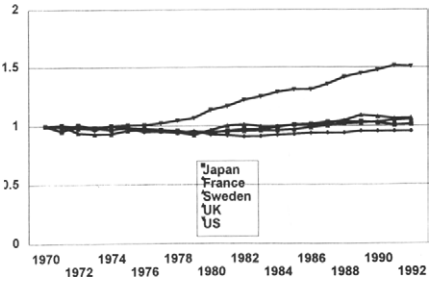
Recent Trends in the United States



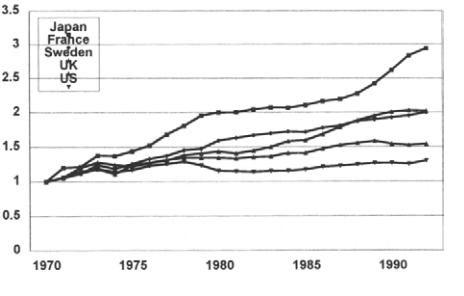
Fuel Economy of Gasoline Automobile Population for Selected Countries (MPG)



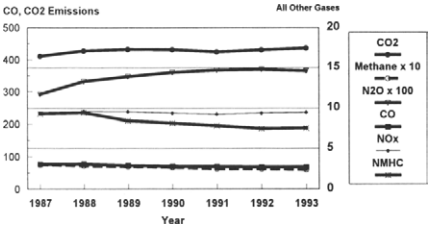
Fuel Economy [illegible] Population for



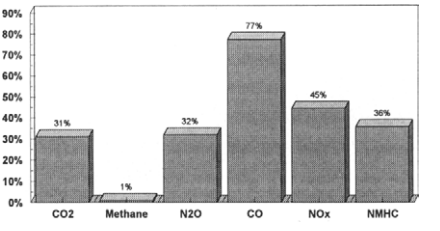
Energy Use By Person [illegible] Selected Countries (trillion



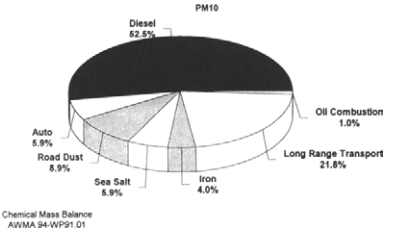
US Emissions of Greenhouse Gases From Transportation



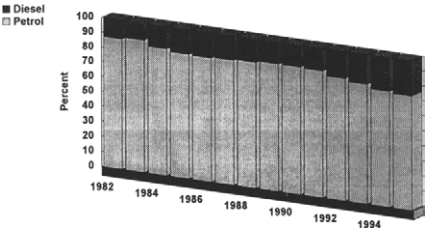
Transportation Contribution To Greenhouse Gases in the US - 1993



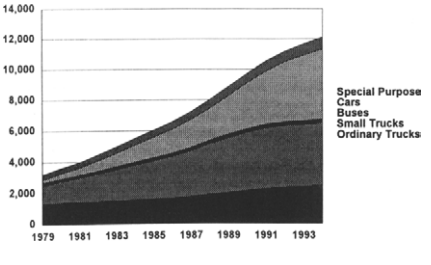
Average Source Contribution To Midtown Manhattan Site



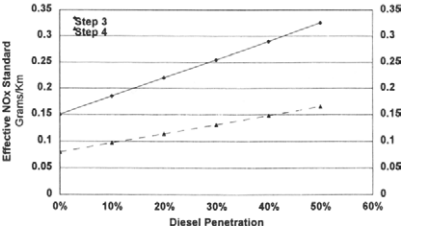
Europe Car Production By Fuel System Type



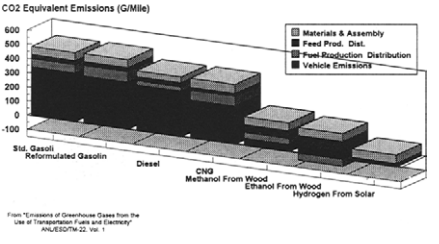
Trend In Diesel Vehicles by Category in Japan (000)



Effect of Diesel Penetration On Effective NOx Standard



Total Fuel Cycle CO_2 Equivalent Emissions For Light Duty Vehicles



From "Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity" ANL/ESD/TM-22, Vol. 1

Conclusions

- Global Vehicle Population Continues To Grow Rapidly
- Greenhouse Gases From Transportation Sector Continue to Grow Rapidly
- Virtually No One Has An Adequate Program In Place To Address Greenhouse
- Focus on Diesels Without Tight NOX/PM Requirements Raises Health Risks Without Seriously Addressing Greenhouse Problem