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You, Your Car and the Environment

Canada

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Environment Update

Over the years Environment Canada has become increasingly aware of its responsibility towards its diverse publics. The aim of *Environment Update* is to inform interested people about the programs and activities of our department. We recognize the value of working cooperatively with Canadian citizens and our colleagues outside of government. We are in fact, creating links. These links will allow us to meet our objective along with those who share our concern for a better environment. Each publication features a specific issue and includes articles on other topics from across Canada reflecting the full spectrum of services of Environment Canada. Environment Update is a bi-monthly publication of the Information Directorate of Environment Canada. Permission is granted for article reproduction though a credit would be appreciated. For articles originating outside of this department, permission should be requested in writing to:
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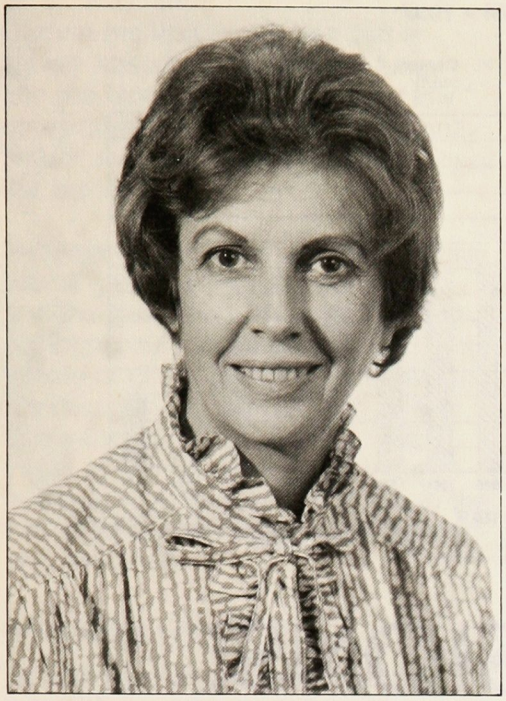


You, Your Car and the Environment

The air we breathe today in our cities is cleaner than it was ten years ago, *but* improvements can still be made.

In Canada, it is possible for each one of us who owns or drives a car or truck to make a positive contribution towards making our air cleaner. Let me explain.

Motor vehicle exhaust is the largest single contributor to air pollution in Canada. The nitrogen oxides emitted from our cars and trucks help to produce acid rain. They also contribute to the production of ozone, which has been found to damage agricultural crops. Carbon monoxide, hydrocarbons and lead pose further problems.

The Canadian Government recently announced its intention to adopt tougher new emissions standards for cars and light duty trucks, but drivers and owners can still further reduce automobile pollution by taking a few simple steps.

For example, smooth driving habits could reduce fuel consumption by 10 to 20 per cent and, at the same time, cut certain emissions by as much as 50 per cent.

Switching from leaded to lead-free gasoline. This one step could double the life of spark plugs and exhaust systems. The real bonus is that we could cut down on the amount of lead being pumped into the air of our cities.

These are only two ways that could make for a cleaner environment. There are many more, including regular and proper maintenance of vehicles and frequent checks on the efficiency of pollution control devices.

Over the next few years, Environment Canada will be conducting a national program to encourage Canadians — car owners, car makers, petroleum refiners, service station owners, automobile associations, and so on to accept environmental responsibility for reducing automotive pollution. I believe the protection and the improvement of our environment is a *shared* responsibility. In this case, much of the onus must be placed squarely on the shoulders of all those involved, especially drivers and owners. They are, or should be, their own air quality control boards.

This issue of *Update* is devoted entirely to this program, and is a first step in trying to achieve the overall goal of increasing public knowledge of the automobile's effects on environmental quality. We are telling Canadians that environmental considerations should be a factor in selecting a new car, in disposing of automotive wastes like oil, plastics, tires and even the car itself.

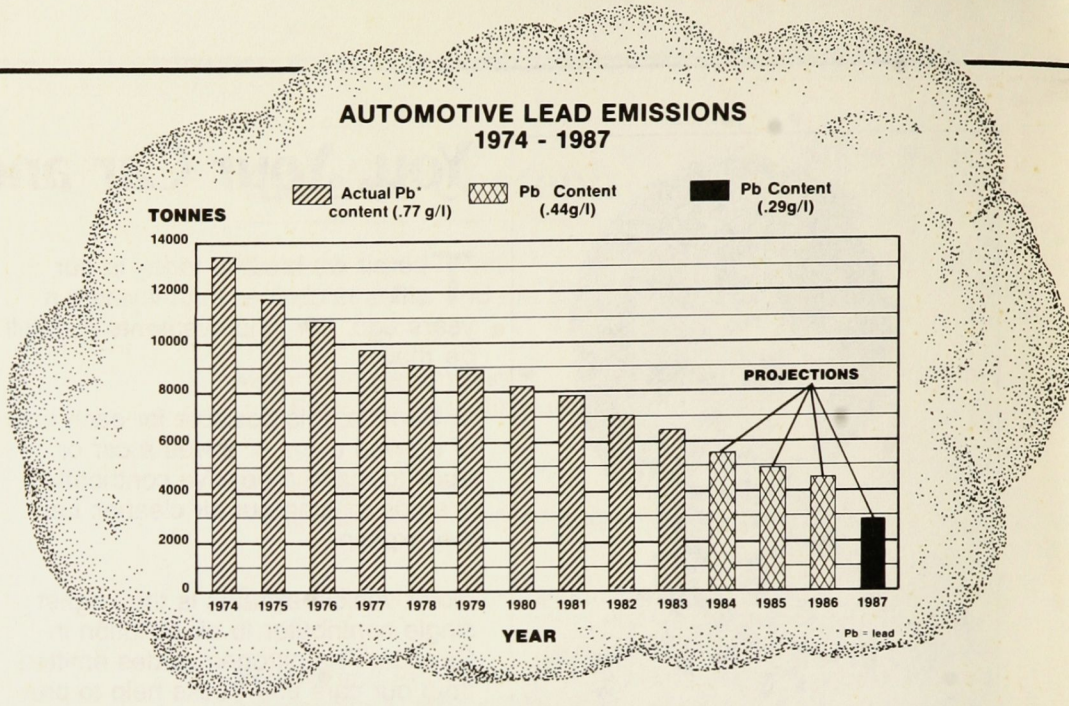
But it doesn't stop there. I hope that the environmental implications of motor vehicle emissions will be included in courses for auto mechanics and student drivers. I would like to see school boards take up this issue, as they have done and are doing with acid rain.

Poll after poll demonstrates, in clear and unmistakable terms, the abiding desire for a healthy environment in this country. I believe Canadians are willing to make the commitments and assume the responsibilities involved in ensuring that we have fresh air, clean water and productive land.

As I see it, with this program, I want to harness public support: to provide the information and the means by which individual Canadians can express their commitment ... ways in which they can work toward a healthier living space for themselves, for their families and for the future.

Suzanne Blais-Grenier

"Motor vehicle exhaust is the largest single contributor to air pollution in Canada. The nitrogen oxides emitted from our cars and trucks help to produce acid rain. They also contribute to the production of ozone, which has been found to damage agricultural crops. Carbon monoxide, hydrocarbons and lead pose further problems."



MOTOR VEHICLE EMISSIONS:

A FACTOR IN POOR AIR QUALITY

Automobiles* are an integral part of the Canadian lifestyle. We use them for business and pleasure, to drive to and from work, to go shopping, to take us on holidays, or just to go for a spin in the countryside. In 1983 about 25 million Canadians drove over 13 million cars.

The industry which produces those vehicles is also very important to Canadians. It employs a hundred thousand people and is worth billions of dollars annually to our economy. Canada produced over a million automobiles in 1983.

Unfortunately, we also pay a price for our reliance on motor vehicles. In Canada, they are responsible for over 20 per cent of our air pollution. Furthermore, most of this pollution is generated in urban areas where the majority of our population lives.

Lead emissions

Perhaps the most dangerous of the air pollutants from automobile exhaust is lead, which is added to gasoline to improve its knock resistance and ensure smooth engine operation. Lead can pose a risk both to human health and the environment.

Once lead is released in the environment, it has a long environmental life. As a result, not only is there widespread human exposure to lead today but future generations will also be exposed to the lead which is already in the environment or which is constantly being added to the environment.

Canada is committed to substantial cutbacks in the amount of lead in gasoline. By 1987 the limit on the use of lead in gasoline will be reduced from 0.77 grams per litre (g/l) to 0.29 g/l. Currently, about 45 per cent of the gasoline used by Canadians is lead-free. Reductions in the use of lead will ensure continued improvements in air quality.

Additional automobile emissions — environmental and health effects

Exhaust from cars contains three additional pollutants that are of particular concern: oxides of nitrogen (NO_x), hydrocarbons (HC) and carbon monoxide (CO). In Canada, automobile emissions cause 20 per cent of the NO_x, 23 per cent of the hydrocarbon emissions and 45 per cent of the carbon monoxide created by human activity. In addition to having their own particular direct negative effects, these pollutants can react with one another, particularly in the presence of sunlight, to create other pollutants. There is also a growing concern about effects on climate which may be caused by increasing amounts of carbon dioxide in the environment.

Nitrogen oxides are capable of damaging human lungs, reducing their ability to function efficiently. There is also evidence which suggests that exposure to NO_x increases our susceptibility to respiratory infections. Children are particularly at risk — even short term exposures to NO_x have resulted in a variety of respiratory conditions in children: coughing, runny noses and sore throats are typical of the problems which may be experienced. NO_x can aggravate asthma symptoms; asthmatics have been found to be especially sensitive to as little as one hour's exposure.

*The designations "automobiles", "cars" and "motor vehicles" in this series of articles also include small trucks, pick-ups and vans weighing less than 2,700 kgs.

Carbon monoxide is a gas that is rapidly absorbed through the lungs into the bloodstream. Even very low concentrations of CO can significantly reduce the oxygen carrying capacity of the blood.

Hydrocarbons result from the evaporation of gasoline from the carburator and the gas tank or from incomplete combustion. They are composed of a variety of chemical substances which are contained in gasoline. At current levels they may not pose a direct threat to human health. However, hydrocarbons do play a key role in the formation of ozone and other "secondary" pollutants.

Secondary effects

As well as being harmful in and of themselves, exhaust pollutants can also have negative secondary effects. After they are released into the atmosphere, various chemical reactions can occur. Substances can change, or combine with one another in a number of ways that may be damaging to people and the environment. Two of the best known and most harmful of these negative secondary effects are acid rain and smog.

Acid rain

Until now, the principal focus in reducing acid rain has been on controlling sulphur dioxide (SO_2) emissions from the smokestacks of industrial plants and utilities. This is because damage caused by sulphur emissions is the most harmful in the long run. However NO_x is responsible for about one third of the acidity in rainfall. SO_2 emissions will be reduced in Canada by 50 per cent by the year 1994 and it is hoped that the United States will take similar action. However NO_x emissions are expected to continue to increase to the end of the century. At present, Canadian annual NO_x emissions total over 1.7 million tonnes, nation-wide. In Eastern Canada, the area under greatest threat from acid rain, they total 950,000 tonnes annually.

NO_x emissions are transformed in the atmosphere into nitrates which are acidic. These fall to earth in the form of acidic precipitation — acid rain and snow. Nitrates deposited during the winter months are of particular concern. They accumulate in the snowpack and when the snow melts in the spring the accumulated acid is released into lakes, rivers and streams, all at once. This jolt of acidity known as "spring shock" occurs at the most critical stage in the life cycle of many aquatic species. The acid bath can kill fish eggs and fry and also harm the eggs of amphibians, such as frogs and salamanders.

The natural resources at risk from acid rain amount to 8 per cent of Canada's gross national product and include agriculture, forestry, fishing and tourism.

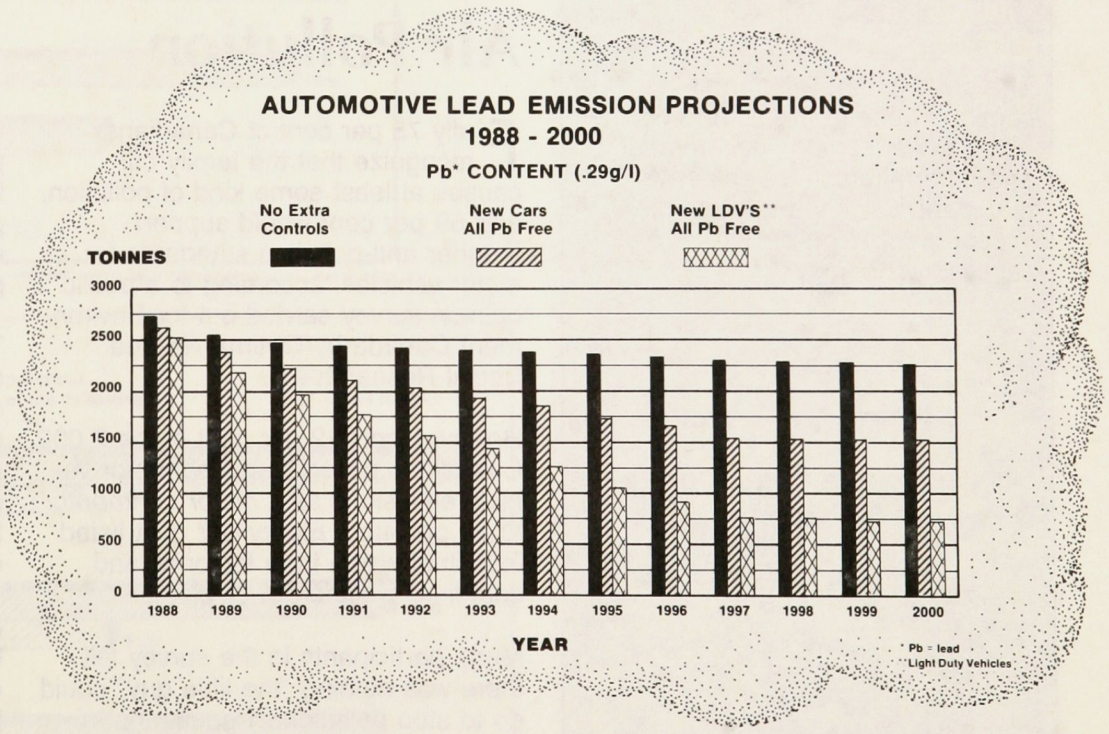
Ozone: An urban and rural problem

Ozone or more commonly, smog, is another problem caused by motor vehicle emissions. Although smog is often associated with cities like Los Angeles, it occurs in Canadian cities as well. Ozone is formed when nitrogen oxides and hydrocarbons react together in the presence of sunlight. In urban areas across Canada, acceptable air quality levels for ozone are being exceeded on a regular basis. They occur with some regularity in the urbanized areas of Ontario, and in urban regions such as Vancouver, Montreal and Quebec City. Episodes have also been recorded in the Maritime Provinces.

Although ozone was at one time considered to be an urban problem, evidence is mounting that it affects rural districts as well. Ozone pollution can stunt tree and crop growth. Ozone-sensitive crops such as corn, wheat, potatoes, soybeans, tomatoes, onions, cucumbers, lettuce, white beans and tobacco are valued commercially in Eastern Canada at about $2 billion a year.

There is also evidence that the combined effects of acid rain, ozone and climatic stress, such as drought, can combine to provide highly damaging effects, particularly to forests. Indications of these effects have emerged in Europe.

Finally, ozone can cause a variety of effects in humans, including eye irritation, coughing and chest discomfort, headaches and respiratory illness.



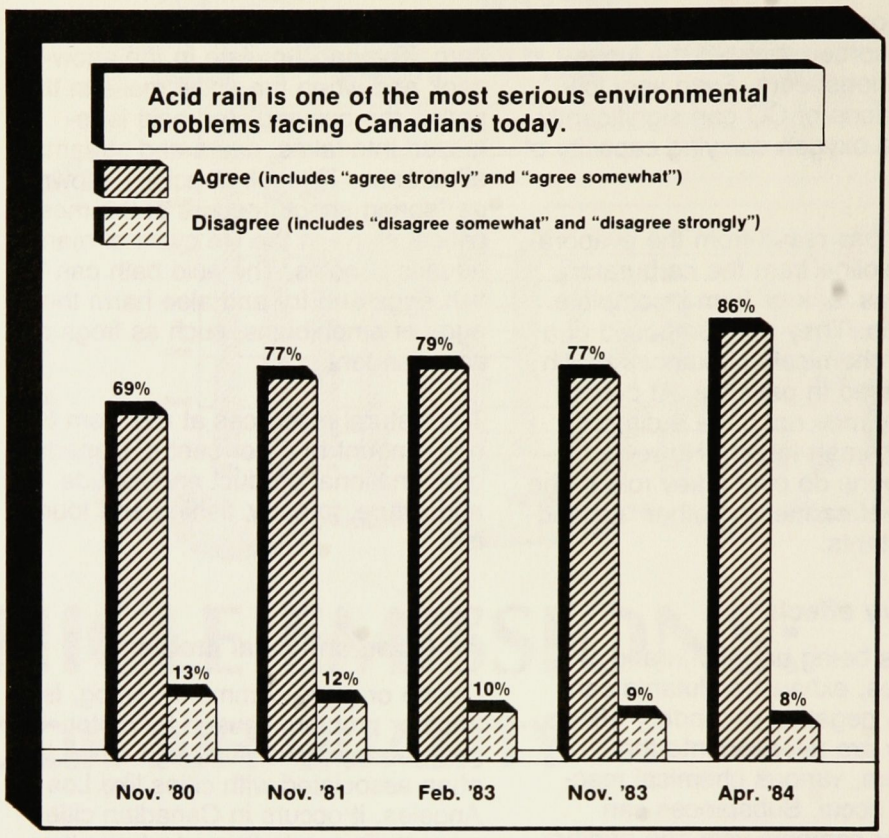
Tougher Emissions Standards Proposed

The Canadian Government announced on March 6, 1985 its proposal to introduce tougher emissions standards. The new standards, to come into effect on September 1, 1987 for the 1988 model year, will reduce automotive pollutants by over 45 per cent by the end of the century.

Current standards of 3.1 grams per mile driven for nitrogen oxides, 2.0 grams per mile driven for hydrocarbons, and 25.0 grams per mile driven for carbon monoxide will be reduced to levels of 1.0 gram per mile driven, 0.4 gram per mile driven and 3.4 grams per mile driven respectively. These standards are as tough as those in any other industrialized nation.

The expected benefits include a significant reduction in the car's contribution to acid rain and smog (ozone) formation, continued improvements in air quality in cities, particularly in the downtown core and other heavy traffic areas, and reduced exposure to lead emissions.

The government will permit the continued use of the octane booster MMT, while industry, government and other interested parties work to expand our knowledge of the impact of MMT on emissions and catalyst technology.



Centre de recherche d'opinion publique (CROP)

PUBLIC OPINION POLLS: Canadians are Worried About Air Pollution

Fully 75 per cent of Canadians recognize that the family car causes at least some kind of pollution, and 59 per cent would support tougher anti-pollution standards for motor vehicles, according to a public opinion survey carried out for Environment Canada by Optima Applied Social Research Inc.

However, only 12 per cent of the 2,000 Canadians polled identified motor vehicle emissions as a *major contributor* to air pollution. Eighty per cent listed industrial waste from factories and coal-fired electric power plants.

Many participants in the survey felt there was nothing "the little guy" could do to stop pollution. "I guess the individual person doesn't feel they can do that much, unless (they) get into a group and become stronger," noted one interviewee. "Back in the 70s when there was an uproar about pollution, governments brought in all kinds of regulations," said another participant. But "it's sort of died out now because people stopped complaining."

Two thirds of respondents (67 per cent) recognized that emission control devices play an important role in reducing the amount of pollution caused by motor vehicles. Another 56 per cent understood that the use of leaded gas reduces the ability of these devices to decrease pollution.

About 70 per cent of the participants had heard about catalytic converters; only 20 per cent were aware of one breaking down. Over half of this 20 per cent had decided to disconnect the device. The most popular single reason for doing so was the belief that it would improve fuel economy.

The survey, completed in July 1984, found that 47 per cent of Canadians wrongly believe that catalytic converters reduce fuel economy. The same proportion mistakenly feel that converters tend to require a lot of maintenance and servicing.

When asked, almost 70 per cent of the participants agreed on the importance of compulsory annual servicing of anti-pollution systems on vehicles. Two thirds wanted to prohibit the use of leaded gas in vehicles made for lead-free fuel. The same number were in favour of prohibiting the disconnection of catalytic converters.

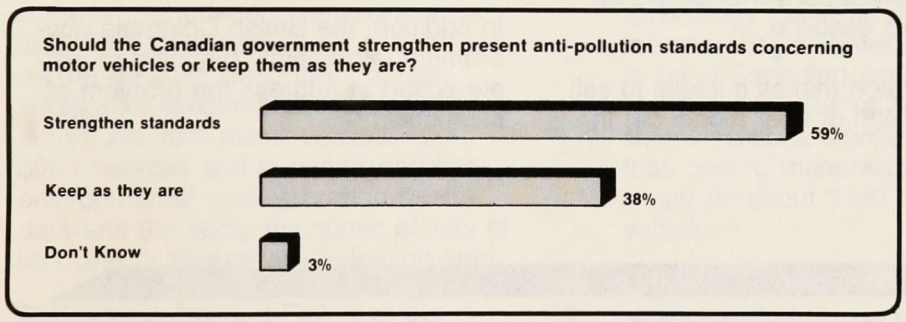
Meanwhile, two additional polls — one by the Gallup organization, the other by the Centre de recherche d'opinion publique (CROP) in Montreal, recently identified an increase in public concern over the dangers of acid rain.

Results of the Gallup poll, conducted in March 1984 on behalf of the Canadian Coalition on Acid Rain, show that almost 75 per cent of respondents believed the federal government should contribute financially to a clean-up program. One-third of those polled were willing to pay at least $5 per month in direct assistance to the clean-up, and almost 70 per cent were willing to donate one day's work per year for the same cause.

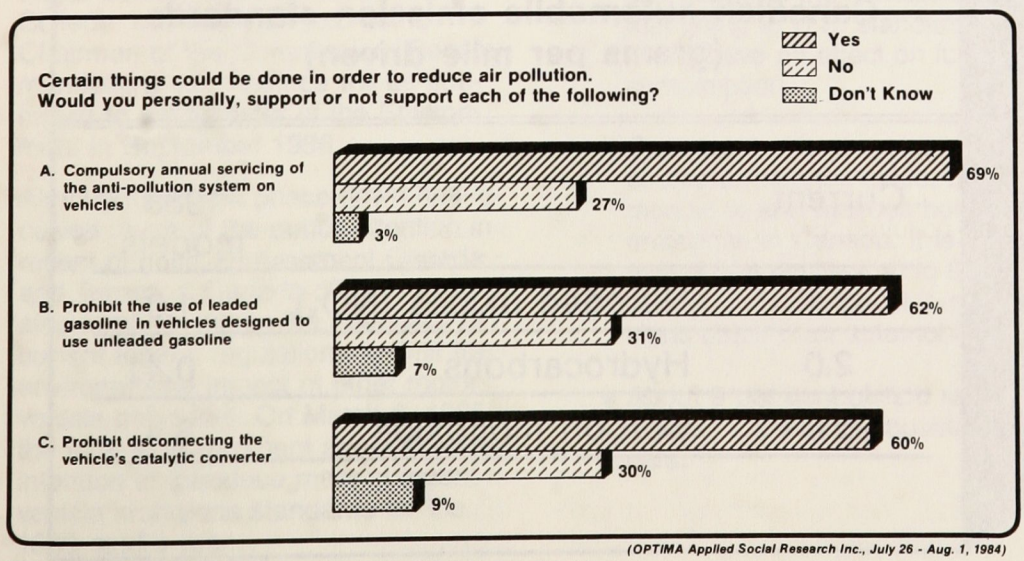
The strongest support for a clean-up came from Ontario residents. Men tended to be more concerned about the acid rain issue than women and those over the age of 50 showed more awareness than any other age group.

The CROP poll was carried out over a four-year period, beginning in November, 1980. At that time 69 per cent of those polled agreed with the statement that "Acid rain is one of the most serious environmental problems facing Canadians today."

By April, 1984, the most recent analysis, 86 per cent of Canadians polled agreed with the statement. Eight per cent disagreed, compared to 12 per cent in the 1980 sampling.



(OPTIMA Applied Social Research Inc., July 26 - Aug. 1, 1984)



(OPTIMA Applied Social Research Inc., July 26 - Aug. 1, 1984)

OZONE:
A concern for Vancouver

Despite a relatively small population and more rain than sun, the Lower Mainland of British Columbia has the highest short-term ozone levels of any major urban centre in Canada.

Vancouver's unique geographical setting also contributes to making the oxidant problem more severe. The mountain ranges act as a barrier to air circulation and tend to trap the pollutants which are then funnelled along the Fraser Valley as far as Chilliwack.

Studies by Environment Canada have determined that the single most important source of oxidants is motor vehicles. At last count in 1983, 1.5 million vehicles were operating in the Greater Vancouver Regional District and the number is increasing.

It is estimated that about one-third of the 73,000 tonnes of nitrogen oxides and one-third of the 92,000 tonnes of hydrocarbons emitted in Vancouver were due to automobile emissions.

The maximum acceptable level of ozone concentration is 0.08 parts per million (ppm) as a one-hour criterion. Environment Canada found that the ozone concentration in the Lower Mainland exceeded 0.08 ppm during 29 days in 1978, 30 days in 1979, 41 days in 1980 and 39 days in 1981. The department's study was based on measurements of ozone and nitrogen dioxide in the Vancouver area. (Most current information available).

The air quality data was derived from a network of air quality and meteorological monitoring stations in the Lower Mainland operated by the Greater Vancouver Regional District and the British Columbia Ministry of Environment. The air quality monitoring system includes five stations provided by Environment Canada under the National Air Pollution Surveillance Network Program.

Federal and Provincial Governments Share Responsibility for Emissions Regulations

When it comes to regulating motor vehicles and their polluting emissions, federal and provincial government agencies have an important role to play.

Substance control at the point of manufacture or importation is an area of federal responsibility. The quantity of lead in gasoline is controlled by Environment Canada. Vehicle emissions (hydrocarbons, carbon monoxide and oxides of nitrogen) fall under the jurisdiction of Transport Canada. But once the car is on the road, or "in-use", the provinces have jurisdiction over vehicle operation and can establish and maintain their own standards.

The Provinces

At the provincial level, Ontario has taken action to test and monitor the performance of "in-use" vehicles. The province's emission control program includes random checks designed to assure compliance with applicable legislation.

Tampering legislation has been in effect in Ontario since 1980. It is illegal to sell a motor vehicle if the pollution control device (the catalytic converter) has been modified or removed. Except in case of repair or replacement, the device must remain on the vehicle. The province's Environmental Protection Act of 1980 also bans the use of leaded fuel in a vehicle equipped with a catalytic converter.

Ontario also operates a compliance testing program, designed to enforce anti-tampering and tailpipe emission legislation. The province has a spot-check program, pretty much limited to the Toronto area, that handles 10,000 out of almost four million automobiles in a year. The penalty in Ontario for tampering with an emission control system or failing to meet tailpipe standards is a $153 fine.

Many American states require compliance testing to their standards before a vehicle licence can be issued. Anti-tampering legislation essentially requires that any component that the manufacturer puts on the vehicle, must remain on the vehicle.

In Quebec, regulations issued in February 1985 make it an offence to remove or modify anti-pollution devices on automobiles. Violators will be subject to fines ranging from $100 to $300 for a first offence to $200 to $1,000 for a second offence and the possibility of one month in prison. Corporations found in violation of this regulation are subject to stiffer fines.

The same fines are imposed on anyone who modifies the opening to the gasoline tank of a vehicle equipped with a catalytic converter or fills up with leaded gasoline.

The regulation makes it illegal to sell or use a 1986 or later model car in which the anti-pollution device which reduces emission of hydrocarbons, carbon monoxide and oxides of nitrogen, has been removed.

Compliance with the new regulations will be enforced by methods to be developed toward the end of 1985.

In addition, the practice of "nozzle switching", where service stations change the diameter of the nozzles of their pumps so that cars equipped with catalytic converters can be fuelled with leaded gasoline, has also been illegal in Quebec since the Spring of 1984.

Similar legislation prohibiting nozzle switching by retailers has been in place in Nova Scotia since 1980 and in Prince Edward Island since 1984.

In addition, the British Columbia government is presently planning to initiate action to address the problem of misfuelling.

Canadian automobile emission standards (grams per mile driven)

Current		1988 models
3.1	Nitrogen oxides (NO_x)	1.0
2.0	Hydrocarbons	0.41
25.0	Carbon monoxide	3.4

Focus on Lead, New Car Emissions:
Pollution Control Initiatives in Progress

Federal efforts to tighten air pollution control regulations have focused on lead in gasoline and automobile emissions. In both cases, emphasis has been placed on assessing available scientific data and on regulating in the interest of assuring human and environmental health in the decades to come.

In spite of falling sales of leaded fuel, researchers are still concerned about the health and environmental impacts of airborne lead. As a first step in dealing with the problem, Environment Canada announced a regulatory phase-down in 1983 which will limit lead in gasoline to a level of 0.29 grams per litre (g/l) beginning Jan. 1, 1987.

The department has also called upon the Royal Society of Canada to form a Commission to carry out a further, comprehensive study on the sources, impacts and effects of environmental lead. The Commission will give advice on the possible need to introduce additional measures to reduce lead emissions from motor vehicles and other sources and to review trends in environmental quality, human health data and the socio-economic effects of reducing or ultimately eliminating lead.

Dr. Kenneth Hare, a Fellow of the Royal Society and Provost of Trinity College, University of Toronto, is Chairman of the Commission. Recommendations and findings will be submitted to the Minister of the Environment in September 1986.

Although the lead phase-down has received much of the public attention in recent months, Environment Canada and Transport Canada officials have also been reviewing the adequacy of current federal regulations to limit the environmental impact of other motor vehicle pollutants. On March 6, 1985 the federal government announced its intention to introduce more stringent vehicle emissions standards for the 1988 model year.

Extensive studies carried out

Highlights:

- A study of past and projected emissions trends looked at urban air quality in four major Canadian centres — Vancouver, Edmonton, Toronto and Montreal. The contribution of automobiles to the emissions inventory will probably decrease to 1990. During that period, emissions from the fleet are likely to improve as older, pre-emission control vehicles are scrapped; although a major economic recession could result in more current or older vehicles being driven more miles. After 1990 emissions are projected to increase again as the number of vehicles increases.

- A survey of emissions control technology identified the cost of incorporating features designed to bring Canadian emission standard vehicles up to current U.S. emissions standards. The total cost to manufacturers would be about $140 per vehicle.

- Studies of the impact of tougher emission controls on fuel economy came to the conclusion that going to U.S. standards would have no effect on fuel consumption.

- Cars are the largest single source of nitrogen oxide, carbon monoxide and hydrocarbons emissions in Canada. It is estimated that in cities up to 90 per cent of carbon monoxide emissions come from automobiles.

- About 9 per cent of acid rain in Eastern Canada is caused by cars.

- Due largely to the past control of car emissions, air quality has improved in Canadian cities, but further improvements are still required to bring air quality to within acceptable levels. Carbon monoxide exceeds maximum tolerable levels in some downtown heavy traffic areas of the country.

- Ozone (smog) is a problem in Vancouver, Toronto and Montreal and other large cities in Canada. Ozone can cause health problems and is responsible for about $20 million in crop damage in Southern Ontario. Cars make a significant contribution to this problem.

Environment Canada is the principle advisor to Transport Canada on the need for and degree of control of automobile emissions. Proposals for bringing regulatory amendments into effect are first published in the *Canada Gazette* Part I, to be followed by final regulations in Part II after a 60-day public comment period. Once the Minister of Transport chooses a course of action, it is then Transport Canada's responsibility to incorporate the changes into the Motor Vehicle Safety Act.

For further information about or submissions to the work of the Commission, please write to:

Dr. Kenneth Hare
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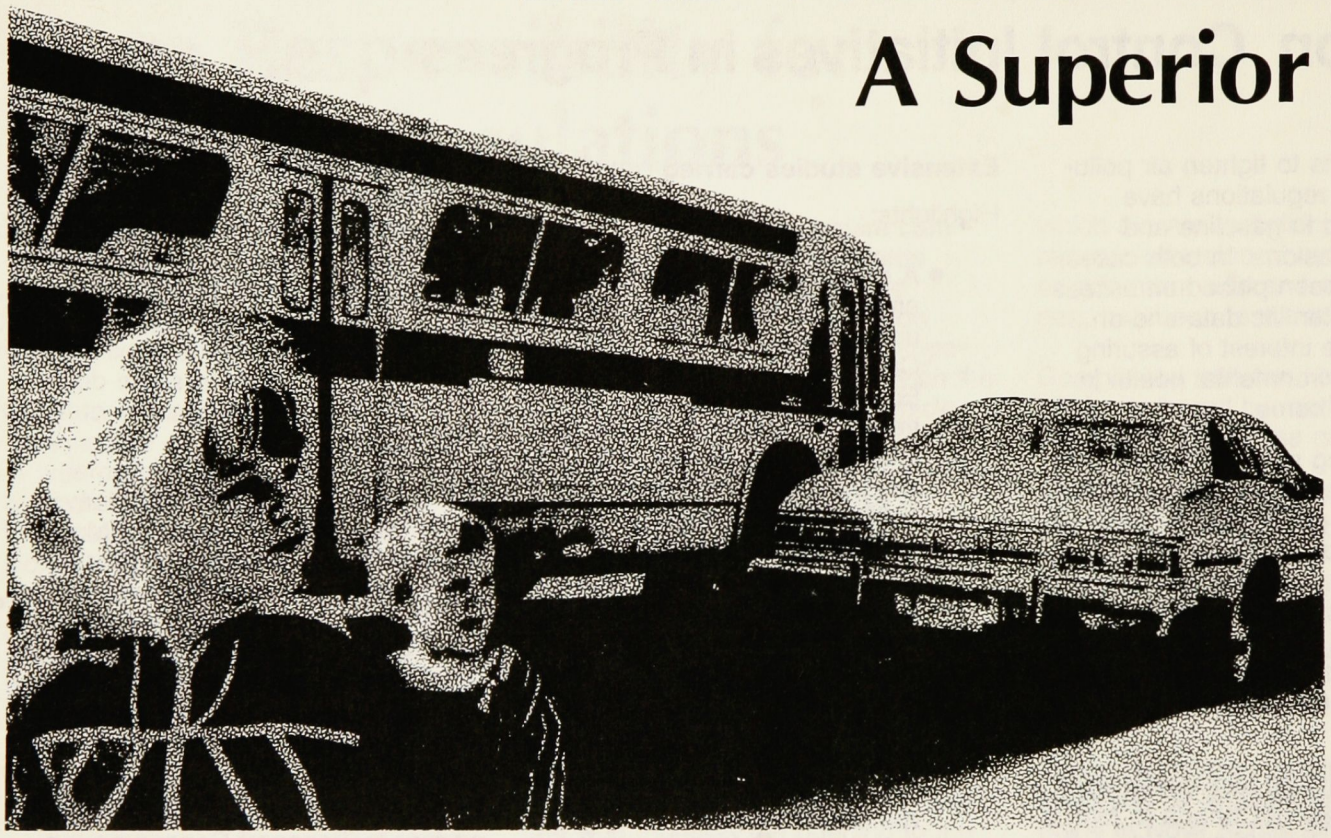
LEAD-FREE GASOLINE: A Superior Fuel



Over eighty per cent of automobiles manufactured today require lead-free fuels for proper operation and emissions control. For vehicle owners that spells savings in prolonged engine life and lower maintenance costs.

"Even if your vehicle was capable of using leaded fuel, using lead-free would save on exhaust system replacement and spark plug changes. The amount of money saved would at least equal the extra cost of the fuel," says Ron Solman, head of Vehicle Systems in EPS' Industrial Programs Branch. "Besides that there is the reduction in lead emissions that you as a vehicle owner achieve as a result of operating on lead-free fuel," he adds.

One organization that has taken an active role in identifying the hazards in leaded gasoline is the Canadian Association for Children and Adults with Learning Disabilities. The group's research and liaison officer for health issues, Barbara McElgunn, says lead in gasoline has emerged as one of the major causes of mental disabilities.

"To get down to 0.29 g/l will be a definite step in the right direction, but I want to see the problem completely eliminated because we'll still be spewing lead into the environment," McElgunn says. "We really think it should go as close to zero as possible without causing undue hardship to heavy trucks or antique cars or whatever we need it for."

When American regulators began phasing down lead in gasoline in 1976, McElgunn notes, "the blood levels in sample populations fell in almost direct proportion to leaded gasoline sales".

Ron Solman says arguments in favour of leaded fuels have persisted in spite of the health problems McElgunn identifies. "People use leaded fuel in lead-free vehicles because they think it gives them better performance. They think it's got a higher octane level (knock resistance) and that it's better for the engine, but the research shows that they're wrong."

The Canadian General Standards Board specifications for the anti-knock properties of leaded and lead-free fuels differ only by one to three octane numbers, depending on fuel type and region. But Solman says refiners often choose to exceed the standard in response to local conditions and to market fuels whose octane ratings can satisfy more customers. "Trying to buy more octane than required by your engine is not necessary," he adds. Octane number is a measure of the engine anti-knock properties of a fuel. Lead in the form of tetraethyl lead has been used since 1921 as a chemical additive to raise the octane number of gasoline.

For Solman and his colleagues at the Environmental Technology Centre near Ottawa, the gradual shift to lead-free gasoline — and to vehicles that require lead-free — raises a number of questions relating to the proper care of a motor vehicle. The list includes such issues as regular maintenance, misfuelling of vehicles equipped with pollution control equipment, and efforts to illegally remove catalytic converters or other equipment from a motor vehicle.

"If you have a vehicle that requires lead-free and you misfuel it, then you do a number of things," Solman warns. "You wreck your converter, and you start to build up deposits within your combustion chamber which begin to affect your spark plug life. The vehicle may not be as driveable; it may not start as well, and you certainly would be required to change your exhaust system more frequently than if you operated the vehicle on unleaded fuel."

The catalytic converter may be the best-known of the pollution control features found on a new lead-free vehicle today, but Solman says misfuelling affects a number of components designed to maximize fuel efficiency and minimize polluting exhausts.

All vehicles in the U.S. and some vehicles in Canada now include a computerized control system that monitors the ratio of fuel and oxygen in the combustion chamber to ensure the most efficient mix. "The sensor signal is read by the computer many times a second," Solman explains, "and corrections are made to the fuel metering system so that you have the correct amount of fuel and oxygen to burn. These sensors are constructed using materials that are similar to those found in a converter. They generate a signal when they're clean and uncontaminated, but if you use leaded fuel you can poison the sensors and cake them up."

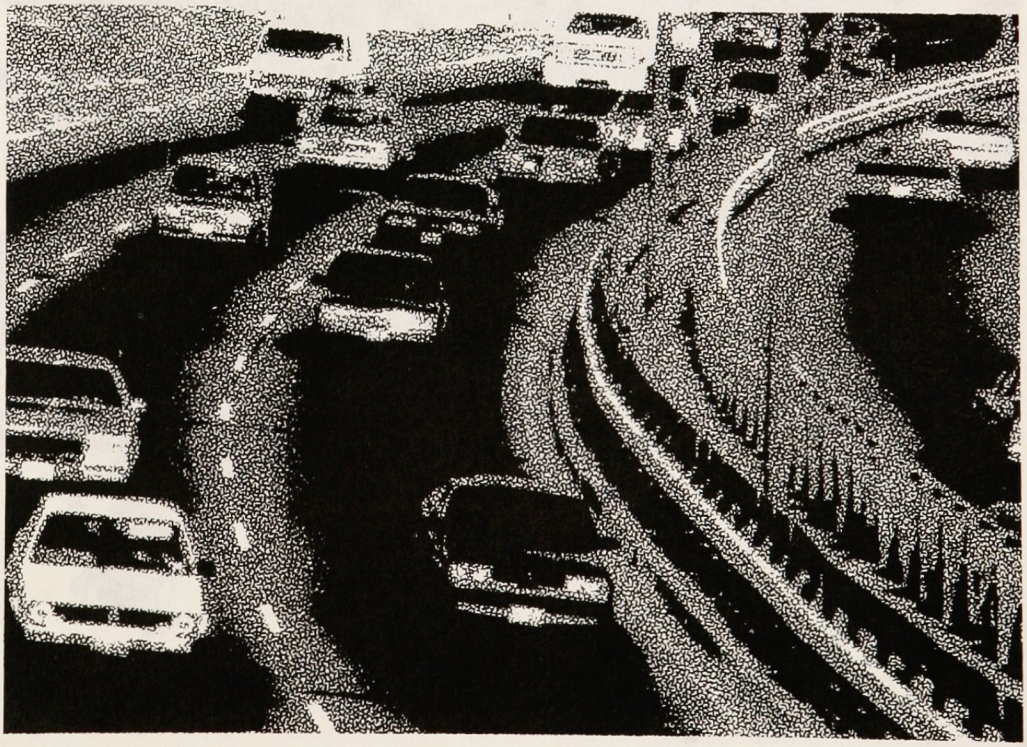
Removing anti-pollution equipment, a mistake

For some motorists, the response to finding all this new equipment in a car is simply to remove it. This is a mistake. Manufacturers design motor vehicles nowadays to meet emission standards and accentuate driveability and fuel economy. "When you start playing with those systems you probably don't win in any respect, and you probably lose in most", notes Solman.

Many people think that cars with a leaded fuel option cannot run on anything else. But manufacturers do not prohibit the use of lead-free gas for those cars that aren't equipped with catalytic converters, Solman says, "because the manufacturer knows this vehicle will last longer, will only require the recommended level of maintenance, and won't cause warranty problems. It's a matter of general reliability and durability."

For the responsible motorist, that means becoming familiar with the manufacturer's maintenance schedule and following it carefully, so as to assure optimum performance of the equipment made available on the vehicle. "I think it's safe to say that playing with the vehicle, making some kind of mechanical or electrical adjustment, has a very dramatic effect on emissions and a much smaller effect on fuel economy," Solman says.

Besides, researchers note that once motorists have paid for an emissions control system, they might as well get their money's worth in the form of superior performance and reduced pollution.



WINTER DRIVING

A Challenge in Emissions Control

When temperatures drop and the snow begins to fly, most motorists become preoccupied primarily with getting to their destination in one piece.

But for researchers at the Environmental Protection Service (EPS), winter driving suggests another challenge in addition to icy roads and snow drifts — how to maintain an automobile to provide maximum comfort and minimum polluting emissions at the same time.

Maintenance, more important in winter

The general principle is that a well-tuned, comfortable car will operate close to its optimal efficiency both for fuel consumption and emissions. The closer a vehicle is to the manufacturer's recommended settings, the better.

The same improvements that automakers incorporate into their cars to control emissions take the vehicle and its systems in the right direction for winter performance. It will start quickly and the choke will come off quickly. If it warms up efficiently, there will be less fuel consumption and less pollution.

Use a block heater

A manufacturer's best efforts can't take the place of thoughtful maintenance and use by a car's owner. The use of a block heater for a couple of hours before using the car is recommended. The efficiency of combustion is reduced, if the engine is cold. In the absence of a block heater, the engine should be run just long enough to ensure smooth operation and reduced engine speed, usually a matter of seconds. Prolonged, high-speed idling after a cold start, before driving away, causes more pollution and uses more fuel than driving off as soon as the engine stabilizes.

All other things being equal, hydrocarbon and carbon monoxide emissions will more than double in the winter time.

With good maintenance and the use of a block heater motorists can use a minimum amount of fuel and have a smooth-running, safe vehicle that won't be stalling and balking. A well-tuned car would also put less strain on the battery and engine starting system.

The need for frequent oil changes in accordance with the manufacturer's instructions to take account of severe weather conditions is especially important for vehicles that are normally used for short trips, where the engine never gets hot enough to boil off the water and residual gasoline that accumulates in the motor oil over a season of cold-weather driving.

Getting the "goods":
Environmental research that really stands up

Researchers at the River Road Environmental Technology Centre annually carry out about 1,500 different types of motor vehicle tests by "driving" test cars on a chassis dynamometer. The data obtained gives Environment Canada an idea of the kinds and amounts of emissions being generated by Canada's 13 million automobiles.

The dynamometer, a treadmill-like device which, in conjunction with sampling equipment and extremely accurate gas analysis, allows computers to tally a vehicle's emissions of hydrocarbons, carbon monoxide and NO_x under simulated driving conditions. Automotive manufacturers use similar equipment to certify vehicles before they are mass-produced; the tests serve as spot checks to monitor actual emissions.

The Centre also carries out tests to identify the effects of tampering with catalytic converters; to monitor city and highway fuel mileage; to assess the performance of in-use vehicles; and to better understand the changes that a vehicle undergoes when it must operate in cold climates.

The Environmental Technology Centre is a valuable centre of expertise on automotive emissions. The research carried out at the Centre is an essential part of federal compliance testing under the Motor Vehicle Safety Act.

Catalytic Converters: Working to Reduce Emissions

Today's motor vehicle is a sophisticated piece of machinery engineered to meet a number of standards set by governments in order to protect the health and safety of its citizens and the environment. These standards are supported by regulations which include control of the nature and amount of substances which are exhausted from the tailpipe of the vehicle.

Automobile exhausts contain among other substances hydrocarbons (HC), oxides of nitrogen (NO_x) and carbon monoxide (CO). These substances are controlled by governments by requiring manufacturers to install on all vehicles air pollution control systems.

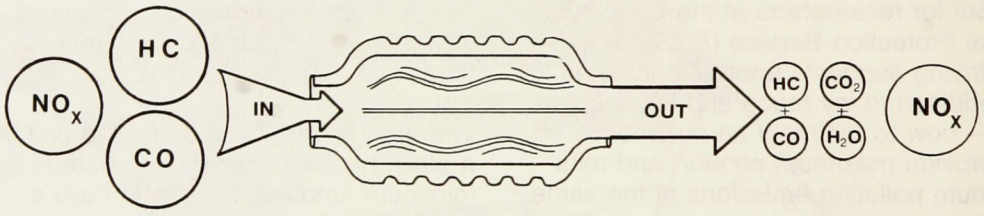
Such systems are complex and involve a number of elements including the catalytic converter. If *any* of these components are tampered with, the whole system may cease to function, allowing hazardous substances to get into the air.

An increasing number of motor vehicles introduced for sale in Canada since 1975 are equipped with a catalytic converter. The purpose of the converter is to reduce the amount of pollutants in the exhaust gases from the engine.

Most cars currently sold in Canada are equipped with oxidation or two-way catalytic converters that reduce the amount of HC and CO emissions only. A catalytic converter which can do the job of burning off hydrocarbons and carbon monoxide while reducing nitrogen oxide is called a three-way catalyst. This three-way converter, in use in the U.S. since 1981, will be used in Canada once the proposed new motor vehicle regulations come into effect on 1988 models.

- Catalytic converters are not mufflers and are not designed to quiet exhaust noise.
- If you remove your catalytic converter you should not expect to gain performance or gas mileage. The converter is part of the exhaust system and not part of the engine; therefore, it should not affect engine performance when operating properly.
- The correct carburator adjustment is critical on all vehicles for proper performance and minimum exhaust emissions. Remember, catalytic converters do not affect engine performance *but* engine performance can affect how well a catalytic converter operates.

OXIDATION CATALYTIC CONVERTER

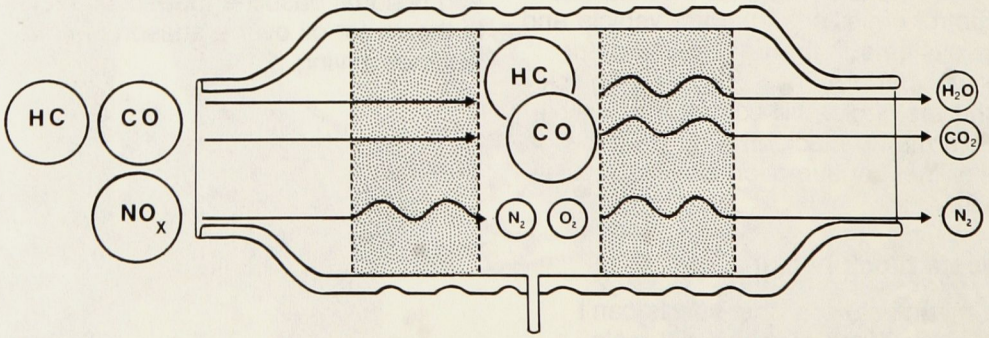


Large amounts of HC, CO and NO_x from the engine go in.

Reduced amounts of HC and CO come out, along with water, CO_2 and NO_x.

The oxidation or two-way catalytic converter reduces hydrocarbons (HC) and carbon monoxide (CO) by converting them into water vapor (H_2O) and carbon dioxide (CO_2). The nitrogen oxide (NO_x) remains untouched and is emitted as exhaust.

DUAL-BED CATALYTIC CONVERTER



Large amounts of HC, CO and NO_x from the engine go in.

Reduced amounts of HC, CO and NO_x come out, along with water, CO_2 and N_2.

The dual-bed or three-way catalyst, consisting of two chambers, reduces hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxides (NO_x) by converting them to water vapor (H_2O), carbon dioxide (CO_2) and nitrogen (N_2). In the first chamber most of the nitrogen oxides are changed into nitrogen and oxygen (O_2), while in the second chamber carbon monoxide and hydrocarbons with extra air added are changed into carbon dioxide and water vapor.

Fuel Economy and Clean Air

"Emissions depend on the design of the engine and the amount of fuel consumed... any improvement in fuel consumption will cut emissions proportionately."

Fuel economy might appear to be a secondary focus for researchers whose primary concern is with catalytic converters, air-fuel ratio sensors, and emissions control standards. But for staff at Princeton University's Centre for Energy and Environmental Studies, driving far and driving clean go hand in hand.

"Anything that reduces fuel consumption, any fuel economy improvements will be environmentally benign to a point," says Frank von Hippel, a senior researcher with the Centre. "Emissions depend on two things — one is the design of the engine and the other is the amount of fuel consumed," von Hippel explains, so that any improvement in fuel consumption will cut emissions proportionately.

Why not 60 m.p.g.?

After years of study, von Hippel has come to the conclusion that about 60 miles per U.S. gallon would be the optimal fuel efficiency for a vehicle at today's energy prices. "In the U.S. I would guess that they're going for an average of about 25 m.p.g.," he notes, "so there's a long way to go." As for cost, "I think that with a combination of technical improvements it would be possible to double the fuel economy of a car which now obtains 25 m.p.g., for an extra cost which is in the same ballpark as the fuel saving."

A shift to diesel engines would cut carbon monoxide and hydrocarbons emissions but would tend to increase oxides of nitrogen (NO_x).

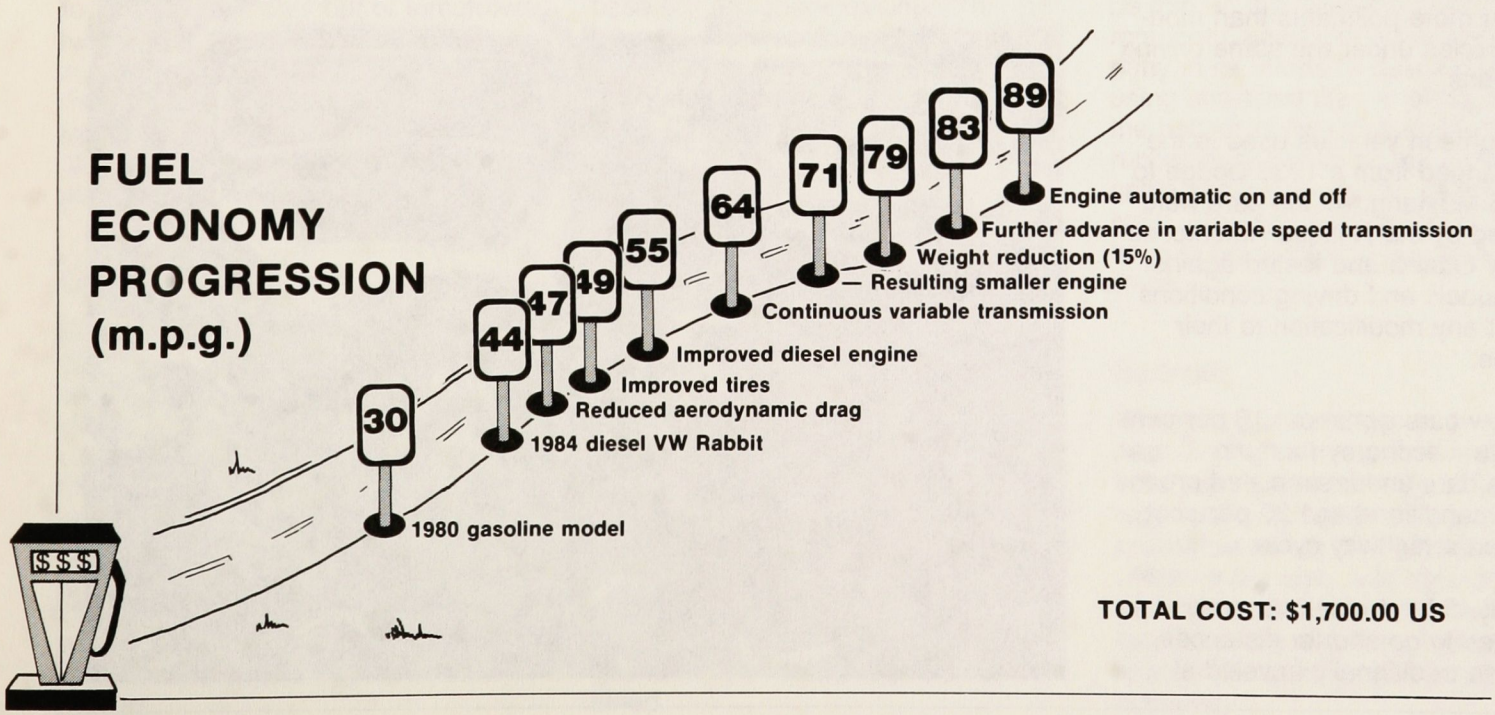
Jeff Alson, assistant to the director of the Emission Control Technology Division at the U.S. Environmental Protection Agency (EPA), notes that NO_x isn't the only pollutant to increase with a switch to diesel fuels. "The black smoke you see behind diesel-powered vehicles is really small particulate matter, so the real trade-off is two pollutants for two. In other words, no real improvement." In the three years since particulate standards were instituted in the U.S., Alson says EPA has concluded that particulates are even more of a concern than NO_x.

Alson also notes that the decrease in U.S. vehicle emissions over the past decade was attributable more to the use of catalytic converters than to improved fuel economy. But "you can say that, in the aggregate, the U.S. has doubled its fuel economy while cutting emissions by a factor of three or four. It's a real success story, and the key is technology."

Beyond 60 m.p.g.

In recent computer simulations, von Hippel and his colleagues have gone beyond the 60 m.p.g. benchmark, to the levels of fuel economy that might suddenly become attractive in the event of another oil price shock. Their conclusions break down into a list of energy efficiency options in order of cost-effectiveness for the amount of fuel conserved for a hypothetical Volkswagen Rabbit. The simulations are based on a 30 m.p.g. composite rating for the 1980 Rabbit in city and highway driving.

- With various improvements to date, including the use of a diesel engine, Volkswagen engineers were able to achieve a composite rating of 44 m.p.g. in their 1984 diesel.



- By reducing aerodynamic drag, the Princeton simulation achieved a fuel economy of 47 m.p.g.
- Improved tires brought the simulation up to 49 m.p.g.
- Adaptation of an open-chamber diesel engine of the type now used in trucks brought overall efficiency to 55 m.p.g.
- Incorporation of a continuously variable transmission soon to be introduced in Europe by Fiat and General Motors permitted constant, computerized matching of road speed and power demand, bringing fuel economy up to 64 m.p.g.
- The efficiency of the continuously variable transmission made it possible to introduce a smaller engine, bringing fuel economy up to 71 m.p.g.
- A 15 per cent reduction in vehicle weight, from 1,080 to 910 kg., increased fuel efficiency to 79 m.p.g. Von Hippel says such a reduction need not compromise passenger safety.
- Further advances in variable speed transmission achieved fuel economy of 83 m.p.g.
- Introduction of a mechanism in which the engine stops when power is not needed immediately following acceleration, and is restarted instantly by a flywheel, raised fuel economy to 89 m.p.g.

After completing the computer simulation, Princeton staff checked with the major automakers to see whether anyone was thinking along the same lines. "It was just a paper exercise, but then we visited Volkswagen, they had built a 78 m.p.g. prototype and it had most of the same features," von Hippel says. "We checked our model against their car, and it's right on."

The total cost of the entire package would be about $1,700 or 1.7 cents per mile over 100,000 miles. Von Hippel admits that fuel economy would not pay the investment back in the two-year time span that many motorists would expect. But he says that just means the structures haven't been put in place to encourage fuel efficiency. "It just shows that the "invisible hand" isn't making it happen," he says. "The fact that it would come out about zero cost (over the life of the vehicle), even at today's low fuel prices, points to a real opportunity for government to push the market."

ANTIQUE CARS:

"Good Old Days" Meant Slower Travel, More Emissions

The grand old autos of yesteryear may have become larger than life in the memory of some Canadians — especially those who believe that cars from the "good old days" gave better gas mileage. According to a series of tests conducted some years ago by Environment Canada's vehicle emissions test laboratory, antique cars used more gas and emitted more pollutants than modern vehicles under the same driving conditions.

The eighteen vehicles used in the tests ranged from a 1938 Dodge to a 1965 Mustang. All the cars were supplied by the Antique Automobile Club of Ottawa and tested against new models and driving conditions without any modification to their engines.

The new cars got about 10 per cent better fuel economy than the antique cars under simulated urban driving conditions and 20 per cent better on a highway cycle.

Not only did the older cars use more gas to go shorter distances, they also traditionally traveled at slower speeds with less traffic and generally carried lighter loads. Highways in the 1930s and 40s were in poor condition compared to today's multi-lane highways.

The study also noted that the addition of emission control systems would make it possible for most of the vehicles to meet today's anti-pollution standards.

The Automobile: A Recyclable "Resource"

From recycled motor oil, to shredded tire rubber, to rebuilt automobile bodies, ways are being found to keep today's cars out of tomorrow's junk heap. The overall effect is to make the automobile a more "environmentally-friendly" means of transportation in an age of diminishing natural resources and increasing waste disposal requirements.

Used motor oil

One of the most promising activities in this area involves recycling used motor oil. Paul Stringer, senior research officer at the National Research Council's fuels and lubricants laboratory in Ottawa, says used engine oil can be re-refined by a number of different processes, all of which are aimed at generating a saleable resource from a depleted and potentially hazardous waste product. About eight Canadian companies are currently involved in re-refining.

"The oils are taken to a re-refinery, the additives and all the contaminants are removed to obtain a product known as base oil," Stringer explains. "This is necessary for engine oils because they're so dirty that you can't do anything else with them."

By the time the oil has been brought down to a base stock, about 70 to 80 per cent of the original volume remains. Once the process is complete, Stringer notes, "the oil can be used for virtually anything that a comparable virgin base stock would be used for."

Rubber tires

Rubber tires are another automotive component that can be recycled. A study commissioned in 1976 by the Environmental Protection Service estimated that up to 200 million kilograms of waste rubber would have been generated by road vehicles by 1985, compared to about 325 million kilograms from all other sources combined.

While efforts are still under way to identify uses for waste rubber, at least one unique success story can already be told. In Pitt Meadows, B.C., Environment Canada assisted one company in its efforts to develop a way of using shredded tires in place of hay at the bottom of livestock stables. The rubber mats minimize the frequency of cattle and horses falling down in their stalls. Consequently, fewer animals have to be destroyed due to broken limbs.

Batteries

Meanwhile, a company in Toronto has been finding markets for lead retrieved from automobile batteries. The firm recycles scrap lead and aluminium, processes about 32,000 tonnes of batteries per year, and recovers about half that weight in lead for resale. The company has also been able to recover the plastic casings from the batteries.

SOME QUESTIONS REMAIN:

Alternative Fuels Offer Potential Emissions Reductions

The search for an "environmentally – friendly" automobile fuel has led technologists to study everything from gas well by-products to Jerusalem artichokes as potential mobile energy sources. While some questions about the environmental impact of alternative fuels have yet to be answered, researchers are pressing on in their efforts to find a secure, economically viable fuel that can equal or improve upon the emissions of gasoline-burning vehicles.

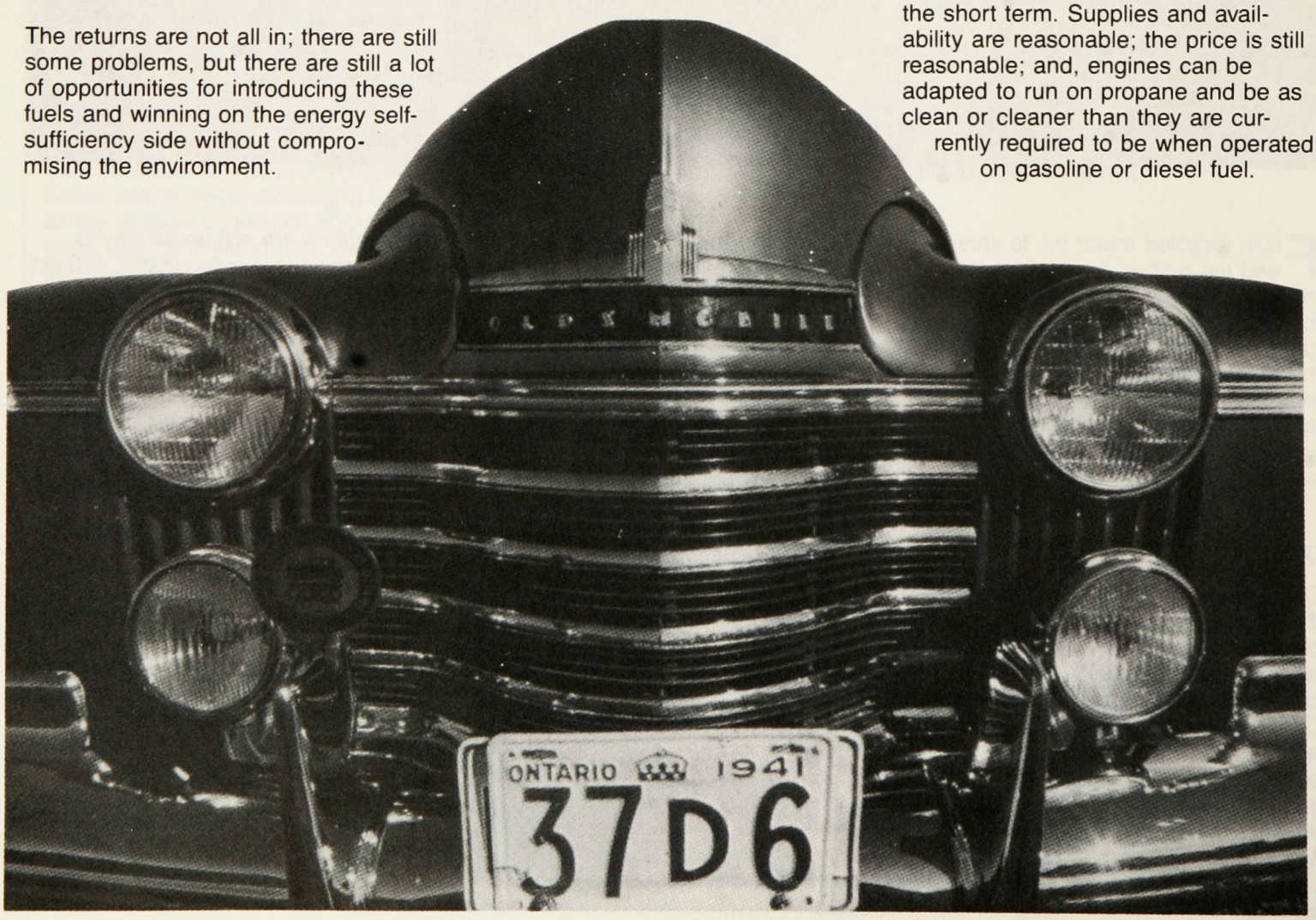
The returns are not all in; there are still some problems, but there are still a lot of opportunities for introducing these fuels and winning on the energy self-sufficiency side without compromising the environment.

Alternative fuels, three categories

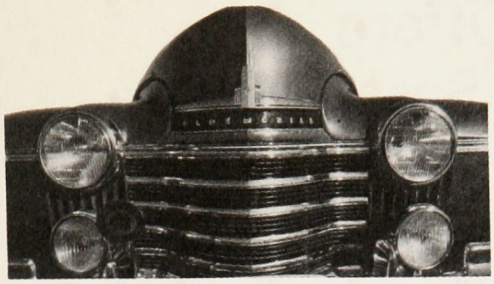
At present, the main alternative fuels in the running break down into three categories. The natural gas derivatives — primarily propane and compressed natural gas (CNG) — can be added to a conventional vehicle with or without a switching mechanism to allow dual fuel operation. The alcohols — ethanol, methanol, and butanol — can be combined with conventional gasoline to make gasohol. Hydrogen — a fuel that is created by splitting water molecules through electrolysis — is considered a far-distant option due to the high cost and low energy efficiency of all the available production processes.

Propane

In Canada, propane has emerged as the most attractive alternative fuel in the short term. Supplies and availability are reasonable; the price is still reasonable; and, engines can be adapted to run on propane and be as clean or cleaner than they are currently required to be when operated on gasoline or diesel fuel.



Use of propane and other natural gas derivatives can result in higher emissions of nitrogen oxides, although, if a conversion is properly done, there will be no more nitrogen oxides (NO_x) emissions than from using gasoline. The real environmental advantage with the gases is that, as a general rule, they produce less carbon monoxide and hydrocarbons.



The future possibilities surrounding renewable fuels and their use in the transportation sector are being actively promoted by groups such as the Canadian Renewable Fuels Association.

The alcohols

Much of the Canadian research on alcohol fuels is centred in Winnipeg where the federal government, in cooperation with the Province of Manitoba, the Manitoba Telephone System, Mohawk Oil Company Limited and other members of the Oxygenated Fuels Association of Canada and the Canadian Renewable Fuels Association are participating with the Manitoba Research Council (MRC) in testing fleets of vehicles running on different gasohol blends and on 90 per cent methanol. The member companies assisting in the demonstration have been supplying alcohols, formulating fuels and some of the vehicles and expertise to the MRC.

In addition to the regulated pollutants — carbon monoxide, hydrocarbons, and oxides of nitrogen (NO_x) — Dave Mathers, Senior Researcher at MRC, says researchers are concerned about emissions of unregulated substances, primarily aldehydes generated from the burning of methanol.

"What we're generally finding is that you can operate a 90 per cent methanol fuel throughout the year," Mathers says. "The problem is some changes in the performance characteristics — driveability and the like — that are a little bit different."

Results of emissions tests on the chassis dynamometer are expected during 1985. Mathers notes that the tests do include measurement of aldehyde emissions, as well as a comparison between vehicles that are and are not equipped with catalytic converters.

While the methanol studies were in progress, MRC was also involved in generating what may have been the most encouraging results to date, based on a 22-month ethanol fleet test using an untailored 10 per cent blend. "We did a cumulative distance of 750,000 kilometres on the gasohol fleet and a million kilometres on the gasoline fleet," Mathers notes. "Performances on gasoline and on gasohol were compared for driveability, fuel consumption, and controlled chassis dynamometer testing."

The results were overwhelmingly positive: No difference in driveability, "no really noticeable difference" in performance, slightly better power output with the gasohol blend, equal engine durability, and "almost identical" maintenance needs. The gasohol blend tested to 1.7 per cent less fuel consumption under simulated city driving conditions and 1.5 per cent less in the highway simulation.

With a 5 to 10 per cent margin for error based on individual driving habits, Mathers says these results suggest ethanol-based gasohol and lead-free gasoline have more or less identical characteristics, "which is good if you want to put a replacement fuel on the market. You don't want it to feel drastically different."

While aldehyde emissions were not tested, Mathers says there was no noticeable difference between the two fuels in carbon monoxide, hydrocarbons or oxides of nitrogen (NO_x) emissions.

If there was a stumbling block identified in the ethanol test, it was the lack of a standard test method for aldehydes. "There have been reports around the world on aldehydes," Mathers says, "but even today the testing technique is very much in doubt."

Some researchers have noted that aldehyde emissions are strong enough to smell in alcohol-fuelled vehicles that lack catalytic converters. Even with converter equipped cars, aldehyde emissions, particularly formaldehyde because of its associated health implications, are of concern.

The research into alternative fuels is ongoing. However, scientists at Environment Canada are cautiously optimistic about the compatibility of these fuels with the goal of a cleaner environment.

Renewably based alternate fuels are now being marketed in Canada. Mohawk Oil Company Limited is producing EM Gasoline, a blend of 3 per cent ethanol, 5 per cent methanol and 92 per cent unleaded gasoline, in Saskatchewan. In Manitoba, gasohol, 10 per cent ethanol and 90 per cent unleaded gasoline, is being distributed. The United States Clean Air Act currently allows the use of these blends which are also accepted by vehicle manufacturers in honoring warranties on emissions control systems and engine durability.

Auto Rebuilding Offers Alternative to the Scrap Heap

Perhaps the biggest recycling opportunity around involves the exterior of the car itself. While materials recycling is already a common practice, recent research has auto rebuilding and remanufacturing as possible alternatives.

It's not yet clear that rebuilding or remanufacturing present viable options in Canada, where the tough climate and road salt take a brutal toll over the life of a vehicle. But it is clear that the potential is great where rust and salt damage are less pervasive.

Our infatuation with newness

"Remaking worn-out products to perform as well as new ones saves materials, energy and money while creating jobs," noted a recent article in *Technology Review*, a U.S. publication. "But our infatuation with newness too often deprives us of these benefits." The article distinguishes between remanufacturing — literally assembling a new vehicle out of reusable parts — and rebuilding, which involves replacing or servicing parts that are no longer performing to specification.

"The assembly and testing processes of remanufacturing are usually very similar to those used in making the product originally," the article stated. "Because the remanufactured product is expected to function like a new one, remanufacturers find themselves in competition both with conventional repair facilities and with makers of new products. In fact, most remanufacturing businesses are outgrowths of either independent repair businesses or the service operations of original equipment manufacturers."

The article, based on a study by the Massachusetts Institute of Technology (M.I.T.), noted that low component cost is an important element of the remanufacturing process. At best, remanufacturing "affords significant employment opportunities, especially for low- and moderate-skilled workers, and solid-waste disposal problems are reduced." The M.I.T. study concluded that, despite low visibility, recycling "has been a viable economic activity in many parts of the world for decades."

AUTO FACTS: A SUMMARY

- The transportation sector in Canada produces 1.1 million tonnes of NO_x per year. Cars alone produce 356,700 tonnes (1980). Adoption of the U.S. standards for cars in Canada would reduce up to 50 per cent of this pollution.
- About 15 per cent of all new cars sold in Canada are equipped with 3-way catalytic converters.
- Automotive lead emissions account for about 60 per cent of the total lead emissions in Canada.
- In Canada close to 95,000 automobile engines were "rebuilt" in 1980. This suggests that 35,625,000 pounds of cast iron was recycled which saved the depletion or consumption of 2,375,000 gallons of propane, 1,548,913 gallons of fuel oil and 7,633 tons of soft coal.
- The factory value of products sold from Canadian "rebuilders" in 1980 was slightly over $350 million.
- Over 13 million motor vehicles were in use in Canada in 1983.
- Of a total population of roughly 25 million (1983) just over 16 million Canadians were eligible to own or operate a car or truck.
- About 90 per cent of all cars built in Canada are exported to the United States — while 50 per cent of all cars sold in Canada are built in the United States.
- Based on 1982 figures just over 102,000 Canadians were employed to work on assembly lines and in the automotive parts industry.
- Typically about 1 million automobiles are manufactured in Canada each year.
- Gross sales of Canadian gasoline in 1983, excluding aviation fuel, amounted to almost 37 billion litres.
- There are roughly fourteen thousand gasoline retail outlets spread across the country.
- It is estimated that the average cost of operating and maintaining a medium-sized car in Canada is almost $5,000 a year.
- Canadian Automobile Association figures indicate that about $20 billion are spent yearly on car purchases, automotive parts, taxes, accessories, gasoline and car insurance.
- Canadian man-made NO_x emissions totalled 1.7 million tonnes in 1980.