Lesson 7: Got Dirty Air? – Extension Activity: Automobiles and Air Pollution Reading Handout

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Automobiles and Air Pollution

Each of today's cars produces 60 to 80% less pollution than cars in the 1960s. More people are using mass transit. Per the Clean Air Act, leaded gasoline was phased out completely as of January 1995, resulting in dramatic declines in air levels of lead, a very toxic chemical. Despite this progress, many types of air pollution that arise — in part from mobile sources have not improved significantly. At present in the United States: motor vehicles are responsible for at least half of the smog-forming volatile organic carbon (VOC) and nitrogen oxide pollutants in the air. Nearly 100 cities exceed the US Environmental Protection Agency's (EPA) National Ambient Air Quality Standard for ozone. Motor vehicles release more than 50% of the hazardous, cancer-causing air pollutants in the air. Motor vehicles release about 90% of the carbon monoxide found in urban air.

What Went Wrong?

Although there has been significant progress since 1970 in reducing emissions per mile traveled, the number of cars on the road and the miles they travel almost doubled in the same time frame. As lead was being phased out, gasoline refiners changed gasoline formulas to make up for octane loss, and the changes made gasoline more likely to release smog-forming vapors into the air. Another reason that pollution levels remain high is that emission control systems do not always perform as designed over the full useful life of the vehicle. Routine aging and deterioration, poor state of tune, and emission control tampering can increase vehicle emissions. In fact, a major portion of auto-related hydrocarbons can be attributed to a relatively small number of "super-dirty" cars whose emission control systems are not working properly.

What Are the Most Dangerous Pollutants from Vehicles?

Air toxics are pollutants that cause adverse health effects. The EPA has focused a large part of its air toxics efforts to date on carcinogens, compounds that cause cancer. Motor vehicles emit several pollutants that EPA classifies as probable or definite carcinogens, including benzene, formaldehyde, acetaldehyde, 1-3-butadiene, and particulates (soot and smoke, especially from diesel vehicles). Ozone is a form of molecular oxygen that consists of three oxygen atoms linked together. Ozone in the upper atmosphere (the "ozone layer") occurs naturally and protects life on earth by filtering out ultraviolet radiation from the sun. But ozone at ground level is the major component of smog and presents this country's most intractable urban air quality problem.

What Are the Effects on Public Health?

Vehicles are such an integral part of our society that virtually everyone is exposed to their emissions. EPA estimates that mobile source (car, truck, and bus) air toxics may cause up to 1,500 cases of cancer each year, about half of the cancers caused by all outdoor sources of air toxics. Ozone is responsible for the choking, coughing, and stinging eyes associated with smog. Ozone damages lung tissue, aggravates respiratory disease, and makes people more susceptible to respiratory infections. Adults with existing diseases and children are especially vulnerable to ozone's harmful effects. Elevated ozone levels also inhibit plant growth and can cause widespread damage to crops and forests.

How Are Pollutants from Vehicles Formed?

Some air toxics are components of gasoline, such as benzene, which is added to gasoline to increase octane. Cars emit benzene as unburned fuel or as fuel vapors that evaporate during refueling. Formaldehyde, particulates, and 1,3-butadiene are not present in fuel but are by-products of incomplete combustion. Ozone is not in fuels and is not a by-product of combustion, but is formed in the atmosphere through a complex set of chemical reactions involving hydrocarbons, oxides of nitrogen and sunlight. In typical urban areas, at least half of those pollutants come from cars, buses, trucks and boats. The rate at which the reactions proceed is related to both temperature and intensity of the sunlight. Because of this, high ozone levels occur most frequently on hot summer afternoons.

What Has Been Done To Control Vehicle Emissions?

The Clean Air Act of 1970 gave EPA the primary responsibility for regulating "mobile sources," which include cars, trucks and buses. The EPA vehicle emission control program has achieved considerable success in reducing both nitrogen oxide and hydrocarbon emissions. Cars coming off today's production lines typically emit 70% less nitrogen oxides and 80 to 90% less hydrocarbons over their lifetimes than their uncontrolled counterparts of the 1960s. Pre-1975 vehicles without catalytic converters, and even pre-1981 vehicles with simple catalysts, emit far more pollutants than newer vehicles. Air toxics from motor vehicles will decrease during the 1990s as older cars wear out. However, without additional control, and with more cars driving more miles, it was predicted that overall emissions of air toxics would increase again by the beginning of this century.

What Else Can Be Done?

Control of hydrocarbon and nitrogen oxide emissions is the most promising strategy for reducing pollution levels in most urban areas. EPA has established more stringent limits on gasoline volatility, tightened tailpipe emission standards, required improvements in inspection and maintenance programs, and required long-lasting catalytic converters. In the most polluted cities, however, these measures will not be sufficient. Further exhaust emission controls for vehicles are approaching the limit of technology. The only way to ensure healthy air is to markedly reduce our use of cars or to switch to cleaner fuels. Some fuels are inherently cleaner than gasoline because they emit less nitrogen oxides or hydrocarbons that are less likely to react in the atmosphere to form ozone. These fuels include alcohols, electricity, natural gas and liquid petroleum (propane). Changes in the composition of gasoline itself (such as reducing fuel volatility or reducing benzene content) also can reduce emissions of most air toxics. Unless we dramatically reduce the amount of pollution vehicles emit in actual use or drastically cut back on the amount we drive, smog-free air will continue to elude many cities.

Clean fuels

What Are Clean Fuels?

The most familiar transportation fuels in this country are gasoline and diesel fuel, but some vehicle fuels — called "clean fuels" — create less pollution than today's conventional gasolines. These include alcohols, electricity, natural gas, and propane. There is still a degree of scientific uncertainty regarding the impacts of these "clean fuels," and, hence, a need to continue research on them.

Why Switch to Clean Fuels?

Cars operating on conventional gasolines emit a complex mixture of compounds that are hazardous and toxic and can lead to the formation of smog. A lot has been done to reduce automobile pollution, including development of innovative emission control technologies and establishment of inspection and maintenance programs. These gains largely are being offset by an increasing number of cars on the road and people traveling more miles each year. Thus, the pollution control measures taken so far have not been sufficient to solve the smog problem in many large cities. Clean fuels have a number of inherent properties that make them cleaner than conventional gasoline. In general, these fuels emit lesser amounts of hydrocarbons that are less reactive (slower to form smog) and less toxic. Emissions from electrical, natural gas, or alcohol-powered vehicles can be as much as 90 percent lower in toxics and smog-forming hydrocarbons than emissions from vehicles fueled with conventional gasoline. In addition, new gasoline formulations ("reformulated gasoline") may be able to reduce emissions from gasoline-powered vehicles by up to 25%. Use of clean fuels also could help to slow the atmospheric buildup of carbon dioxide, a "greenhouse gas" that contributes to the potential for global warming. Combustion of any carbon-based fuel produces carbon dioxide, but in general, fuels produced from biomass (such as crops and trees) and natural gas result in less carbon dioxide accumulation than fuels made from petroleum or coal. Clean fuels have benefits that reach beyond their air quality advantage. New fuels in the marketplace give consumers new choices and could decrease our dependence on imported oil.

Electricity

Battery powered vehicles give off virtually no pollution and offer one of the best options for reducing motor vehicle emissions in polluted cities. Power plants that produce electricity do pollute, but these plants are often in rural areas where the emissions do not drive pollution levels above health standards. Also, efficient emission controls can be installed and maintained more easily on individual power plants than on millions of vehicles. The driving range of today's electric cars is limited by the amount of power the battery can provide. Current batteries take hours to recharge and the cost of electric vehicles is high. Recent developments in electric vehicle technology show much promise for reducing these disadvantages.

Ethanol

Ethanol ("grain alcohol") is the primary automotive fuel in Brazil, and ethanol/ gasoline blends (known as "gasohol") have been used in the United States for many years. Pure ethanol fuel offers excellent performance plus low hydrocarbon and toxic emissions. It can be produced domestically from corn or other crops, potentially minimizing the accumulation of greenhouse gases. With current technology and price structures, ethanol is more expensive than gasoline, but new production technologies offer the hope of significantly reduced cost.

Methanol

Methanol ("wood alcohol"), like ethanol, is a high-performance liquid fuel that emits low levels of toxic and smog-forming compounds. It can be produced from natural gas at prices comparable to gasoline, and also can be produced from coal or wood. All major auto manufacturers have produced cars that run on "M85," a blend of 85% methanol and 15% gasoline, and many auto manufactures have developed advanced prototypes that burn pure methanol ("M100"). Methanol has long been the fuel of choice for race cars because of its superior performance and fire safety characteristics.

Propane

Natural gas is abundant and widely used for home heating and industrial processes. It is easily transported through pipelines and costs about the same or slightly less than gasoline. Compressed natural gas (CNG) vehicles emit low levels of toxics and smog-forming hydrocarbons, but CNG fuel must be stored in heavy, costly tanks. There are significant tradeoffs for CNG vehicles among emissions, vehicle power, efficiency, and range; however, natural gas already is used in some fleet vehicles and appears to have a bright future as a motor vehicle fuel.

Reformulated Gasoline

The petroleum industry is developing gasoline formulations that emit less hydrocarbons, carbon monoxide, and toxics than today's fuels. These new gasolines can be introduced without major modification to existing vehicles or the fuel distribution system. The Clean Air Act required some gasoline modifications to reduce carbon monoxide emissions as early as 1992 and the use of reformulated gasoline in certain polluted cities by 1995.

Are Clean Fuels Feasible?

Clean-fueled vehicles have already been built and widespread use in the near future is feasible. To enable the transition, technologies must be refined so vehicles can achieve optimum emissions performance, consumers must accept the new vehicles and fuels, and government and industry must cooperate to ensure their availability. It will take a concerted effort by all parts of society, but a switch to clean fuels is the most viable way for many cities to attain clean and healthy air.