

WE HAVE TO BREATHE THIS AIR?



OBJECTIVES

- ◆ to compare the pollution from vehicles powered by different fuels
- ◆ to compare the pollution from different modes of transportation
- ◆ to compare emissions from electric vehicles powered by electricity generated by different kinds of power plants
- ◆ to understand that not all electricity is created equal as far as pollution is concerned!

METHOD

This lesson is designed to teach students the environmental impacts of various modes of transportation, as well as the impacts of various fuels used in vehicles or in power plants. Students can work individually or in small groups to read the charts and answer the questions. Students may need assistance in reading the charts, but should do as much as possible without teacher input.



Doug McDonald

QUESTIONS CONNECTED WITH CHART 1: Students are asked to read Chart 1 which shows the percentage of greenhouse gas produced by cars using various alternative fuels, and to draw conclusions as to what would be the least polluting choices. The zero line represents the greenhouse gas emissions of a gasoline-powered car that gets 30 miles to the gallon. Greenhouse gases include carbon dioxide (CO₂), methane and other gases. CO₂ is a waste product of burning any fossil or carbon-based fuel. Methane may be released into the atmosphere when refueling a vehicle powered by methanol, or natural gas. Greenhouse gases increase the ability of the earth and its atmosphere to retain heat, much as window glass in a car does on a sunny day. Many scientists predict "global warming" and major climate changes for the earth as a result of an increase in greenhouse gases.

QUESTIONS CONNECTED WITH CHART 2: Students are asked to draw conclusions from CHART 2 which shows the emissions from electric vehicles if the vehicle is recharged using electricity produced by power plants in California (the California Mix) or if the vehicle is recharged using electricity produced by the power plants in the Northeast (Northeast US Mix). It shows not only the greenhouse gas emissions, but also oxides of sulfur and nitrogen, carbon monoxide and volatile organic components. Radiation is not included on any of the charts as a pollutant. Nuclear power plants produce radiation.

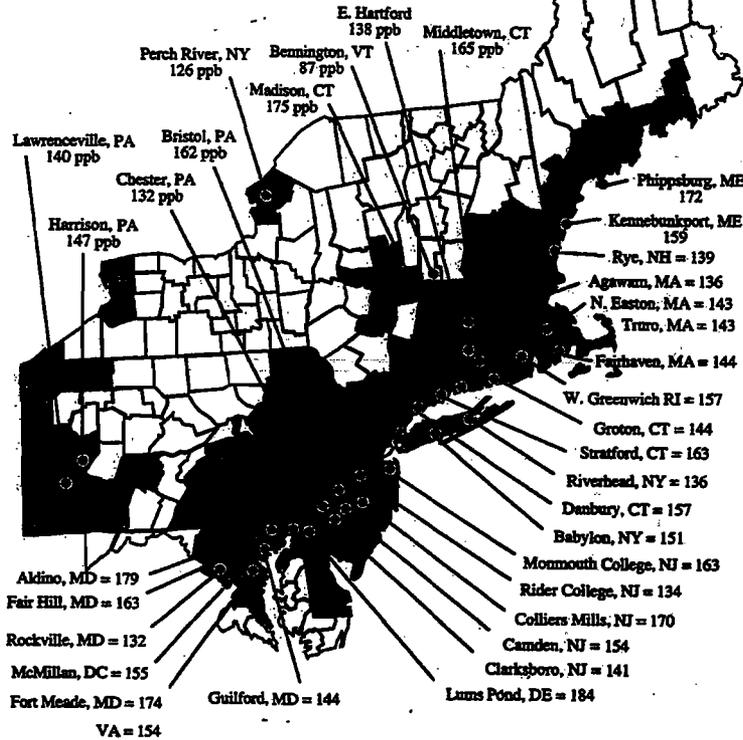
QUESTIONS CONNECTED WITH CHART 3: Students are asked to draw conclusions and make decisions about modes of transportation. CHART 3 shows the pollution (in grams) produced by each of five modes of transport per passenger mile. Students may be unfamiliar with the term "vanpool". This refers to 6-12 passenger vans, usually provided by companies to transport employees to and from work. Public transit also reduces congestion and injuries caused by accidents. 41,000 people die on the highway in accidents each year. It is estimated that 880 million dollars of productive time and fuel cost is lost by people that are stuck in traffic jams. Public transit reduces the amount of pavement needed for roads, parking lots, garages etc. Two percent of the US is paved for the auto. If two percent of the US was covered with photovoltaics (solar cells), enough energy would be generated to meet all of our energy needs.

After students have completed the activities, you may wish to discuss with the entire class the answers they found for the questions. It would be interesting if you were willing to share with your students your own answers to question # 14.

You may also wish to enlarge the following graphics and copy them onto overhead transparencies.

**HIGHEST HOURLY AVERAGE OZONE CONCENTRATIONS
IN THE OZONE TRANSPORT REGION**
Preliminary Data for June 17 - August 21, 1995

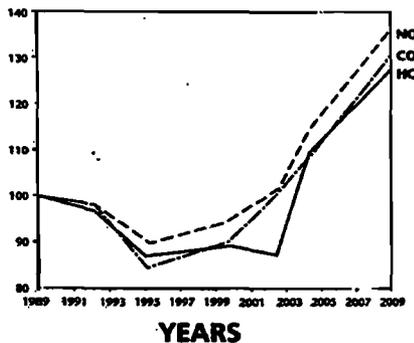
Prepared by NESCAUM 9/14/95
Source: MARSTO-Northeast, a public/private partnership for tropospheric ozone research



Approximately 14% of exceedences are shown. Some sites have multiple exceedences. Data are preliminary and have not been reviewed. Shaded counties are designated as ozone nonattainment areas. Health standard = 120 ppb.

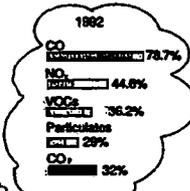
PERCENT OF 1989 EMISSIONS

Transportation emissions shown as a % of the baseline 1989 Emissions



Transportation Share of Total U.S. Emissions, 1992

Still a major contributor, despite reductions in new vehicle emissions achieved over the past decade.



Light-duty vehicles
Other transportation
All transportation modes

Source: U.S. DOE Transportation Energy Data Book, Edition 14, May 1994

"STEERING A NEW COURSE" BY DEBORAH GORDON

WHAT ACTIONS CAN WE TAKE TO CLEAN UP THE AIR?

Air pollution is considered by the American Lung Association to be the number one health threat to Americans today. To many people air pollution is associated with smokestacks and industry, but in many cities the automobile is the single greatest polluter with up to 90% of the urban air pollution caused by the automobile. According to the U.S. Environmental Protection Agency, driving a private car is probably the most polluting daily activity for most people. There are a variety of pollutants that are emitted in the exhaust of gasoline and diesel powered vehicles including: hydrocarbons and nitrogen oxide (NO_x) which react in the air to become smog; carbon monoxide which is a poisonous gas; and carbon dioxide (CO₂) which is a "greenhouse gas" that many scientists believe contributes to global warming.

There are other ways to get around other than driving in a gasoline powered private car that can be less polluting. Some of the choices that you have are: taking public transportation, using your own two feet to walk or ride a bicycle, or driving in cars that use alternative fuels. Let's take a look now at how cars that use alternative (non-gasoline) fuels can change the amount of air pollution emitted (released into the air).

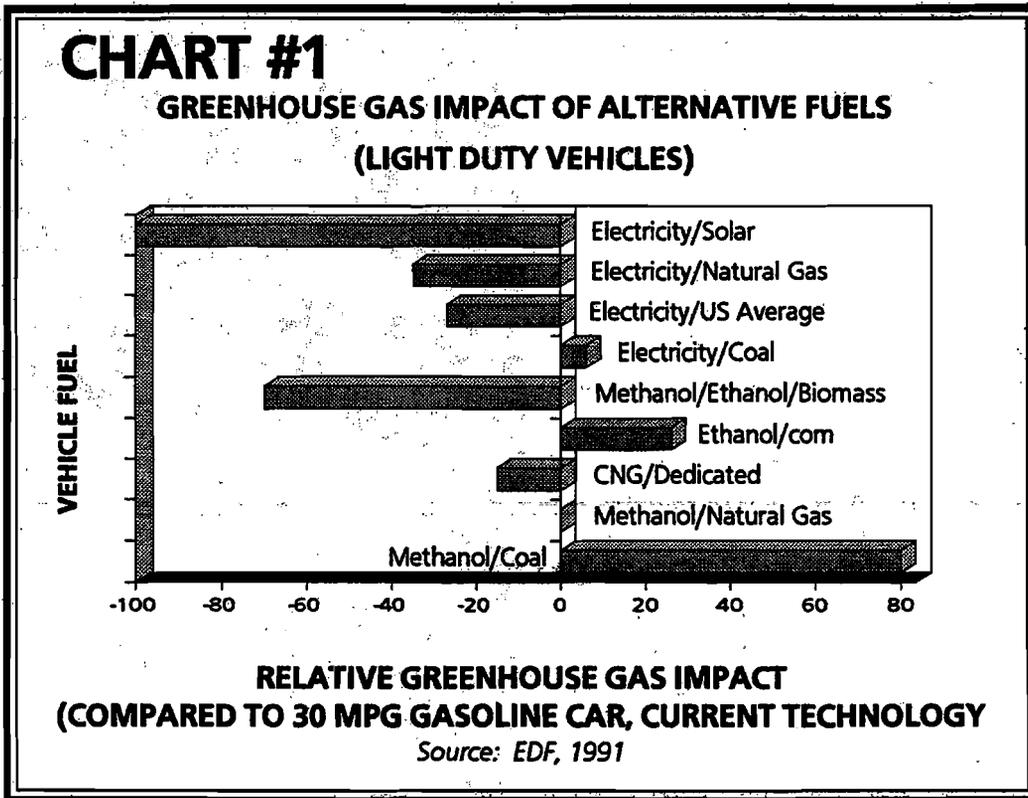
In the chart below the bars represent the percentage increase or decrease in greenhouse gas emissions for each alternative fuel vehicle compared to a 30 mpg gasoline car. The center line represents no change from the 30 mpg gasoline car. Methanol is an alcohol fuel that can be made from natural gas, coal, or biomass (plants). Ethanol is also an alcohol fuel that is made from grains (such as corn) or sugar. The letters CNG stands for "compressed natural gas" which

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is a form of natural gas.

There are several different bars representing electric vehicles (EVs). Although EVs have no tailpipe and do not emit pollution while they are driving—the electricity they use is generated by power plants that do emit pollution. The amount of pollution from an electric vehicle is dependent on the type of power plant that supplies its electricity. As we move into the future, the newer power plants we build will be more efficient and produce fewer emissions. In fact, many power plants such as wind farms and solar plants will produce no pollution. This means that the impact by EVs on air quality should continue to decrease in the 21st century.



1. Using Chart 1, which alternative fuel vehicle do you think has the least amount of greenhouse gas emissions?

2. Which alternative fuel vehicle has the highest amount of greenhouse gas emissions?

3. Look more closely at the electric vehicles in chart 1. Each of the four electric vehicles shown gets its power from different sources of electricity — coal, natural gas, solar, or a mix that is called average U.S. Using Chart 1, can you rank these four electric vehicles from lowest (1) greenhouse gas emissions to highest (4)?

Coal _____ Natural Gas _____ Solar _____ U.S. Average _____

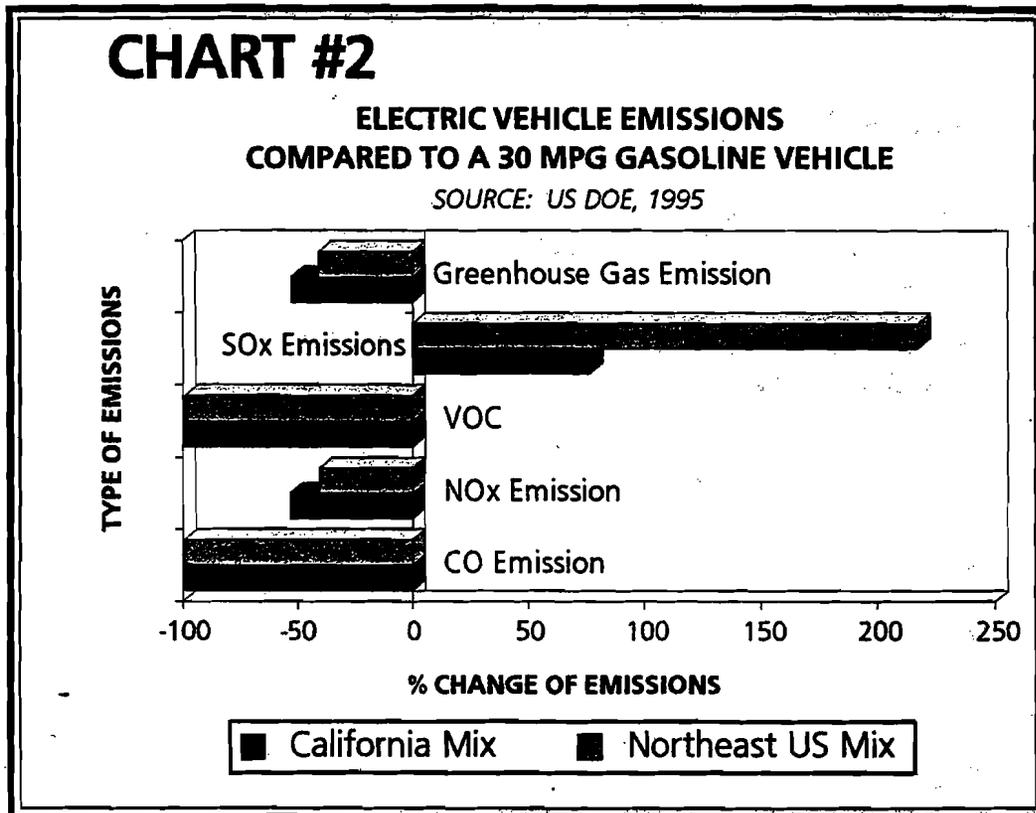
4. What kind of power plants do you think should be built to protect the environment?

5. Which vehicle do you think would be best for the environment? and why?

Lets take a look at how some of the other emissions of an EV compare to a gasoline-powered vehicle. Chart 2 compares the emissions of greenhouse gases, SO_x (Sulfur Dioxide emissions have been shown to be an important cause of acid rain), VOCs (volatile organic compounds are another way of saying hydrocarbons which cause smog), NO_x (Nitrogen Oxides), and CO (Carbon Monoxide, a poisonous gas that makes it impossible for your blood to carry oxygen.).

Chart 1 showed us that the emissions of electric vehicles depends on what kind of power plant was used to produce the electricity. In

Chart 2 compare the emissions of two different mixes of power plants were used to generate electricity for an electric vehicle. Depending on where you live there are different types of power plants that supply your electricity such as power plants fueled by oil, coal, nuclear power, hydropower, or solar power. The emissions from each type of power plant are different: for example coal has higher SO_x Omissions and hygroper has no emissions. The combination of all the power plants that supply energy to the electric system in a certain area is called a generating mix.



6. Would an electric vehicle recharged in California or the Northeast be cleaner?
- 7 a. Which type of emission would be decreased the most if you drove an electric car in California instead of a gasoline-powered car?

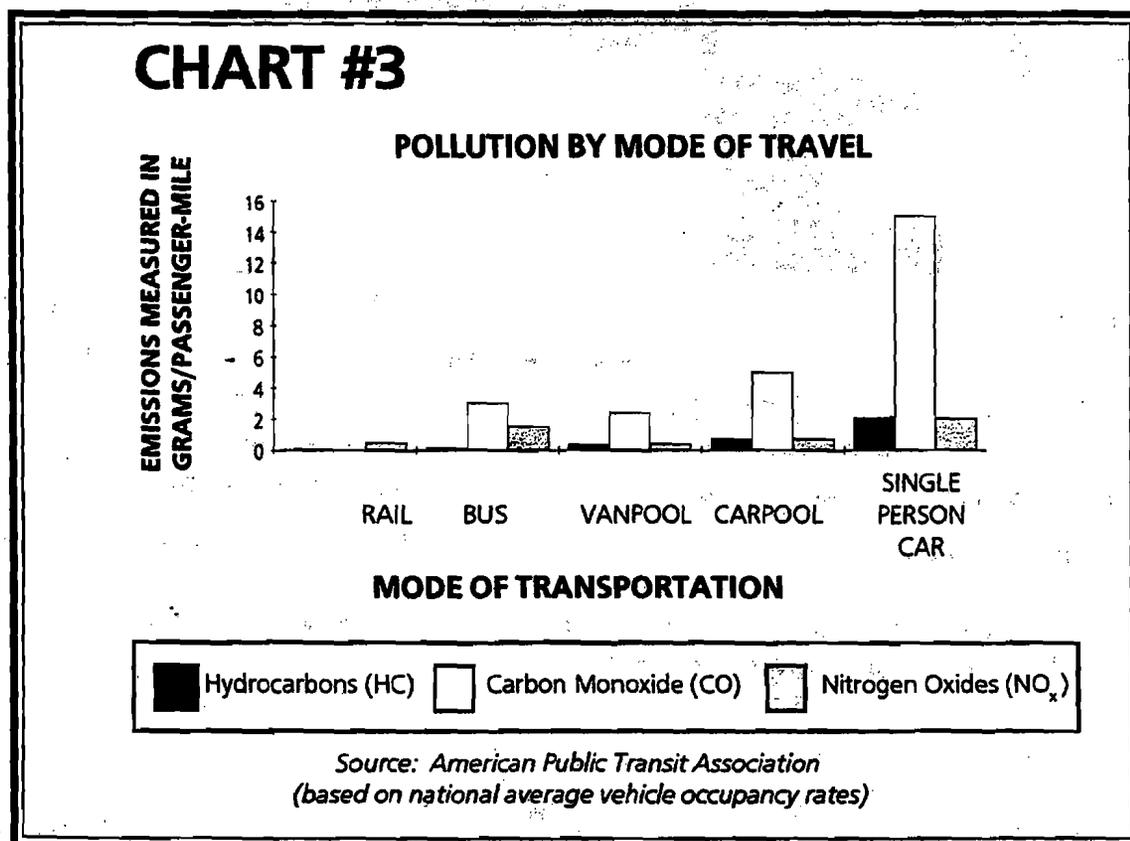
b. By what percentage will the emission be decreased?

8. Smog looks like a layer of haze in the sky in many cities. The main component of smog is ozone which is a noxious pollutant and can cause coughing, stinging eyes, and other health problems. Ozone is a result of emissions of Nitrogen Oxides (NO_x) and VOCs (Volatile Organic Compounds). Find these emissions in the chart above. Do you think an electric vehicle would result in more or less smog? If your answer is "it depends," please describe what it depends on!
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9. Nuclear power plants do not emit carbon monoxide, VOCs, SO_x, or NO_x. Would you consider a nuclear power plant to be non-polluting? If not why not?
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PUBLIC TRANSPORTATION

Using public transportation can also drastically reduce the amount of pollution that is emitted to the air. Look at the following chart to compare the pollution created by using different forms of transportation.



10. If someone you knew lived in a suburb of a large city and commuted to work each day, what would probably be the best mode of transportation for them to use if they wanted to create the least amount of air pollution? _____

11. Which mode of transportation in Chart 3 would create the most pollution? _____

12. What type of emission is the highest? _____

13. Look back at Chart 2. Do electric vehicles increase or decrease this type of emission? _____

4. What other benefits does public transportation have? _____

SUMMARY QUESTION

15. Would you be willing to make changes in your own transportation habits to reduce the amount of pollution you make? Can you suggest changes that you might consider? If you are not willing to make changes, why not?

