Your ECOLOGICAL footprint

How Much Air Pollution Do You Emit?

When we think of air pollution, many of us envision dark smoke belching from a tall stack. Because few of us see smoke coming from our own chimneys, we have a hard time identifying how we contribute to air pollution. Yet nearly all of our activities emit air pollutants, either directly or indirectly. Here we supply information that allows you to determine your emissions of sulfur dioxide and nitrogen oxides and how your emissions, along with your neighbors', affect local air quality.

If you read the section about the five major air pollutants carefully, you probably noticed that most are associated with energy consumption, especially fossil fuels. This implies that the types of fossil fuels you use and the rate at which you use them determine your emissions. Consequently, calculating your emissions of air pollutants starts with the data you used to calculate your emissions of greenhouse gases—the amount of coal, oil, natural gas, and electricity you use.

Calculating Your Footprint

Use this information in conjunction with the emission factors in Table 1 to calculate the amount of sulfur dioxide and nitrogen oxides you emit. Using these conversion factors to calculate your emissions is relatively straightforward. For example, burning a thousand cubic feet of natural gas in your hot water heater generates about 30 grams of sulfur dioxide (1,000 $ft^3 \times .03\ g/ft^3 = 30$ grams). Notice that some of the emission factors are represented as a range instead of the single values for carbon dioxide. The range is dictated by technology. For example, the thermal production of nitrogen oxides depends on the temperature at which the fuel is burned. Because of this effect, burning a pound of bituminous coal in a fluidized bed emits about 0.7 grams of nitrogen oxides. If that same pound is burned in a cyclone boiler, it emits about 7.5 grams of nitrogen oxides.

As with carbon dioxide, you also emit air pollutants when you turn on a light switch or run your refrigerator. The amount of pollution you emit is determined by how the electricity is generated, which varies geographically in the United States. The Pacific Northwest generates much of its electricity from hydropower; therefore, consumers in the Pacific Northwest emit smaller amounts of sulfur dioxide and nitrogen oxides than consumers who use electricity that is generated in the Midwestern portions of the United States, where much electricity is generated using coal. To account for these differences, Tables 2 and 3 show the quantities of sulfur dioxide and nitrogen oxides that are emitted to generate a kilowatt-hour of electricity in various regions of the United States.

Use Tables 1–3 to approximate your emissions of sulfur dioxide and nitrogen dioxide. This number understates your effect because it does not include the pollutants associated with producing the goods and services you consume. You can approximate these numbers based on the total use of energy you will calculate for the next chapter's Your Ecological Footprint. Nor does it include emissions associated with transportation, either directly or indirectly. These emissions depend on the type and age of the vehicle and so cannot be calculated based on the use of energy alone.

Interpreting Your Footprint

The impact of your emissions depends on where you live. If you live in a sparsely populated area that has few natural precursors of air pollution and is upwind from major emitters, your emissions have a relatively small effect on local air quality. On the other hand, if you live in a densely populated area that has many natural precursors of air pollution and is downwind from major emitters, your emissions may be enough to push air quality into the unhealthful category.

The U.S. Environmental Protection Agency represents these geographic variations in air quality with an index for the five major air pollutants. Each day the EPA generates a map that represents air quality with an index that varies between 0 and 500, with 0 being the cleanest air (http://airnow.gov). Values are grouped in six categories that represent the health threat to various groups. For example, values between 0 and 50 fall within the "good" category, which means that air quality is considered satisfactory, and air pollution poses little or no risk to any group. Values between 101 and 150 fall into the category of "unhealthful for sensitive groups," which means that members of sensitive groups such as older people or people who suffer from heart or lung disease are at greater risk, but there is no elevated risk to the general public. At the other extreme, values between 301 and 500 belong in the "hazardous" category. Values in this category trigger health warnings of emergency conditions that are likely to affect the entire population. Under these conditions, the Environmental Protection Agency suggests restrictions on daily activities. For example, when ground-level ozone concentrations cause the air quality index to exceed 150, the air is classified as unhealthful, and this category carries a warning that people in sensitive groups, such as children and adults with respiratory disease, avoid outdoor exertion, while everyone else should limit outdoor exertion.

STUDENT LEARNING OUTCOME

- Students will be able to explain why it is more difficult to calculate their emissions of sulfur dioxide and nitrogen oxides compared to the calculation of their carbon dioxide emissions.

TABLE 1 Emissions per Unit of Fuel

Fuel	Units	Sulfur Dioxide (grams)	Nitrogen Oxides (grams)
Coal	Pounds	0.7–8.6	1.1–7.5
Heating oil	Gallons	32.2	5.4
Natural gas	Cubic feet	0.03	0.03

Source: Data from Electric Power Annual, Energy Information Administration, U.S. Department of Energy.

they spend outdoors (or indoors for some indoor air pollutants). Concentrations are determined by the quantity of pollution emitted and the volume of air into which it is mixed. Here we describe the factors that determine the volume of air into which pollutants mix. Emissions are discussed in the section about policy.

Concentrations are measured two ways—by weight and by volume. Weight measures can be confusing because

TABLE 2 Sulfur Emissions to Generate Electricity (grams per kilowatt-hour)

Regions (States)	Coal	Oil	Natural Gas
New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont)	4.44	1.34	0.00
Middle Atlantic (New Jersey, New York, Pennsylvania)	2.03	0.62	0.00
East North Central (Illinois, Indiana, Michigan, Ohio, Wisconsin)	7.18	0.02	0.00
West North Central (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota)	8.71	0.02	0.00
South Atlantic (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia)	3.74	0.26	0.00
East South Central (Alabama, Kentucky, Mississippi, Tennessee)	5.24	0.05	0.00
West South Central (Arkansas, Louisiana, Oklahoma, Texas)	6.31	0.05	0.00
Mountain (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming)	6.75	0.01	0.00
Pacific Contiguous (California, Oregon, Washington)	0.18	0.00	0.00
Pacific Noncontiguous (Alaska, Hawaii)	0.28	3.11	0.00

TABLE 3 Nitrogen Oxide Emissions to Generate Electricity (grams per kilowatt-hour)

Regions (States)	Coal	Oil	Natural Gas
New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont)	1.40	0.40	0.01
Middle Atlantic (New Jersey, New York, Pennsylvania)	0.64	0.19	0.05
East North Central (Illinois, Indiana, Michigan, Ohio, Wisconsin)	2.27	0.01	0.00
West North Central (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota)	2.75	0.01	0.01
South Atlantic (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia)	1.18	0.08	0.05
East South Central (Alabama, Kentucky, Mississippi, Tennessee)	1.65	0.01	0.02
West South Central (Arkansas, Louisiana, Oklahoma, Texas)	1.99	0.01	0.13
Mountain (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming)	2.13	0.00	0.03
Pacific Contiguous (California, Oregon, Washington)	0.06	0.00	0.04
Pacific Noncontiguous (Alaska, Hawaii)	0.09	0.93	0.15

weight is determined by the number of particles. A cubic meter of air at sea level (such as in Seattle) has more particles, and therefore weighs more than a cubic meter of air a mile above sea level (such as in Denver). To avoid the effects of altitude, scientists also measure pollutants relative to the total number of particles, such as parts per million (ppm) or parts per billion (ppb). The number of particles in a cubic meter of air is kept constant by measuring concentrations at