



Your **E C O L O G I C A L** *footprint*

How Much Carbon Dioxide Do You Emit?

In 2002 the average U.S. citizen emitted about 20 metric tons of carbon dioxide to the atmosphere. At first glance this average may appear much greater than your emissions. Other than running your car, it seems like days or weeks can go by between buying and using energy. But a careful look at how you spend money shows that you emit carbon dioxide almost constantly, albeit at a relatively low rate. These slow but steady emissions add up to the average of 20 metric tons per person per year.

To identify how your actions lead to emissions of carbon dioxide, you need to classify your purchases into two categories: direct purchases of energy and purchases of nonenergy goods and services. Calculating the quantity of carbon dioxide emitted by your direct purchases of energy might seem relatively straightforward. Simply multiply your purchases of motor gasoline, home heating oil, and natural gas by the carbon emission factors that are listed in Table 1. But this approach is fraught with difficulties.

One problem is how to account for the carbon emitted in the process of generating the electricity you use. In some regions of the United States, such as the Northwest, much electricity is generated using hydropower. This source emits little or no carbon dioxide. So carbon emissions per kilowatt of electricity (kwh) use would be low. High rates of carbon dioxide emissions per kilowatt hour prevail in the Midwest, where much electricity is generated from coal, which emits lots of carbon per kilowatt.

To account for these differences, look at the quantity of carbon dioxide emitted per unit of electricity generated (Table 2). These averages are calculated by dividing the total quantity of electricity generated in a region, which includes the quantity generated from fossil fuel, hydroelectric, and nuclear power stations, by the total quantity of carbon dioxide emitted by the fossil fuels that were burned to generate electricity in that region. Multiply these averages by the quantity of electricity you use (shown in your electric bill) to calculate your carbon dioxide emissions associated with electricity use.

In theory you should also include the quantity of carbon dioxide that is emitted to make these fuels available. For example, oil refineries use oil and natural gas to convert crude oil (oil that comes from the ground) into motor gasoline (a form of oil your car's internal combustion engine can use). Similarly, energy is used to mine and transport coal. Luckily for our calculations, the amount of carbon dioxide that is emitted by these activities is small relative to the amount emitted when we burn the coal, oil, or natural gas, so we will ignore them.

But you cannot ignore these indirect emissions when you examine purchases of nonenergy goods and services. Because such goods do not emit carbon dioxide directly, emissions associated with their production constitute their main effect. To calculate these effects, we use input-output tables to trace the use of energy as raw materials are extracted from the environment and fashioned into useful goods and services. (See Chapter 3's Your Ecological Footprint on page 49.) By multiplying these energy flows by their emission rates, you can tabulate the quantity of carbon dioxide emitted as you spend each dollar. The amounts of carbon dioxide emitted per dollar spent on various goods and services are given in Table 3. For example, 0.197 kilograms of carbon dioxide are emitted for every dollar you spend on electrical equipment, which is a type of durable manufactured product (Table 4).

Calculations

Direct Uses

$$\begin{aligned} & \text{___ Carbon dioxide emitted (gasoline) =} \\ & \text{___ gallons/week} \times 2.4 \text{ kg/gal} \times 52 \text{ weeks/year} \end{aligned}$$

$$\text{___ Carbon dioxide emitted (heating oil) = ___ gallons/} \\ \text{month} \times 2.8 \text{ kg/gal} \times \text{___ months/heating season}$$

$$\text{___ Carbon dioxide emitted (natural gas) = ___ ft}^3/ \\ \text{month} \times 0.015 \text{ kg/ft}^3 \times 12 \text{ months/year}$$

$$\text{___ Carbon dioxide emitted (electricity) = ___ kwh/month} \times \\ \text{___ kg/kwh} \times 12 \text{ months/year}$$

Indirect Uses

$$\begin{aligned} & \text{___ Carbon dioxide emitted (biological resources) =} \\ & \text{___ \$/month} \times 0.22 \text{ kg/\$} \times 12 \text{ months/year} \end{aligned}$$

$$\begin{aligned} & \text{___ Carbon dioxide emitted (mineral resources) =} \\ & \text{___ \$/month} \times 0.76 \text{ kg/\$} \times 12 \text{ months/year} \end{aligned}$$

$$\text{___ Carbon dioxide emitted (durable manufacturing and} \\ \text{construction) = ___ \$/month} \times 0.20 \text{ kg/\$} \times \\ 12 \text{ months/year}$$

$$\begin{aligned} & \text{___ Carbon dioxide emitted (transportation services) =} \\ & \text{___ \$/month} \times 0.60 \text{ kg/\$} \times 12 \text{ months/year} \end{aligned}$$

$$\begin{aligned} & \text{___ Carbon dioxide emitted (other services) =} \\ & \text{___ \$/month} \times 0.14 \text{ kg/\$} \times 12 \text{ months/year} \end{aligned}$$

Interpreting Your Footprint

1. Are your emissions greater or less than the U.S. national average?
2. By what percentage would your emissions decline if you used a car that traveled twice as far per gallon?
3. Table 1 in Chapter 8's Your Ecological Footprint (page 148) lists the net primary production of various biomes. Calculate the area of biome that would be needed to take up your carbon emissions. (To calculate this, divide your carbon emissions by net primary production.)
4. The average citizen in Mexico emitted about 4 metric tons of carbon in 2003. How could you rearrange your direct uses of energy and your purchases of nonenergy goods and services to reduce your emissions to a level similar to the average citizen of Mexico?

Student Learning Outcome

- Students will be able to identify how their activities contribute to emissions of carbon dioxide and how they could reduce their emissions should they wish to do so.

TABLE 1 Carbon Dioxide Emissions from Commonly Used Fuels

Fuel	Physical Units Consumed	Carbon Dioxide Emitted
Gasoline	Gallon	2.42 kg
Heating oil	Gallon	2.77 kg
Natural gas	Cubic foot	0.015 kg

TABLE 2 Carbon Dioxide Emissions per Unit of Electricity by U.S. Region for 2004

Regions (States)	Kilograms of Carbon Dioxide per Kilowatt-Hour
New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont)	0.79
Middle Atlantic (New Jersey, New York, Pennsylvania)	0.41
East North Central (Illinois, Indiana, Michigan, Ohio, Wisconsin)	0.81
West North Central (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota)	0.80
South Atlantic (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia)	0.59
East South Central (Alabama, Kentucky, Mississippi, Tennessee)	0.66
West South Central (Arkansas, Louisiana, Oklahoma, Texas)	0.70
Mountain (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming)	0.73
Pacific Contiguous (California, Oregon, Washington)	0.05
Pacific Noncontiguous (Alaska, Hawaii)	0.63

Source: Data for electricity generation and quantity of fossil fuels used from *Electric Power Monthly*, U.S. Department of Energy. Data for energy and carbon dioxide emissions from *Electronic Power Annual*, U.S. Department of Energy.

TABLE 3 Carbon Dioxide Emitted by Producing a Dollar's Worth of Goods or Services

Category	Kilograms of Carbon Dioxide per Dollar
Biological resources	0.223
Mineral resources	0.726
Durable manufacturers and construction	0.197
Nondurable manufacturers	0.297
Transportation services	0.595
Other services	0.139

Source: Data modified from R.W. England and S.D. Casper, "Fossil Fuel Use and Sustainable Development: Evidence from U.S. Input-Output Data, 1972-1985," *Advances in the Economics of Energy and Resources* 9: 21-44. Data were adjusted for the effects of inflation and gains in energy efficiency.

TABLE 4 Examples of Goods and Services Produced by Sectors

Category	Example 1	Example 2	Example 3
Biological resources	Agricultural products	Forestry products	Fishery products
Mineral resources	Metals	Stone and clay	Chemicals and fertilizers
Durable manufacturers and construction	Machinery	Electrical equipment	Construction
Nondurable manufacturers	Textiles and clothes	Rubber and leather	Plastics
Transportation services	Railroads	Motor freight	Air and water transport
Other services	Radio and TV broadcast	Wholesale and retail trade	Medical and hotel services