

Personal Emissions Calculator

Math & Science Lesson

Goal: Students take an inventory and further understand their contributions to greenhouse gas emissions.

Objectives: Students will ...

- Build a personal emissions calculator
- Gather information on their daily habits
- Evaluate their daily habits
- Determine their personal contribution to greenhouse emissions

Materials (for a class of 30):

- 30 copies of Personal Emissions Calculator – What Is a Carbon Footprint?
- 30 copies of Personal Emissions Calculator – Student Grid 1
- 30 copies of Personal Emissions Calculator – Student Grid 2
- 30 copies of Personal Emissions Calculator – Student Instructions
- 30 copies of each wheel piece, downloadable at [HERE](#)
- 15-30 glue sticks
- 30 scissors
- 30 brads or paper fasteners
- Optional: highlighters in a variety of colors
- Each student should bring their completed Personal Emissions – Student Grid 1 (have some completed grids for students who are unable to get the necessary information)
- Optional: 30 calculators
- 30 copies of Personal Emissions Calculator – Ecological Footprints of Nations (2002 Data)

Time Required: 45 minutes

Standards Met: C5, G2, G5, S2, S4, S7, M1, M2, M3, M4, M14

Procedure:

- Prior to class, each student should have completed the Personal Emissions Calculator – Student Grid 1.
- Pass out Personal Emissions Calculator – What Is a Carbon Footprint? to each student. Allow them time to read while you pass out other materials.
- Review the information on Personal Emissions Calculator – What Is a Carbon Footprint?
- Explain that today they will be looking at their own contributions to greenhouse gas emissions and evaluating their ‘carbon footprint’.
- Hand out the necessary materials for students to create their wheels: wheel pieces, glue sticks and scissors to each student.
- Using the information from the kit, ask students to create their Personal Emissions Calculator.

- When students have completed assembling their calculators according to the directions, hand out the Personal Emissions Calculator – Student Grid 2 and allow students time to complete.
- Ask each student to share their personal emission total and write their totals as a list on the board.
- Pass out calculators or have students do addition manually to determine the class average emission total.
- Compare this to the national average listed on the wheel they created and to averages of other countries using the Personal Emissions Calculator – Ecological Footprints of Nations (1999 Data).
- Now have students use the “What Can I Do” side of the wheel to determine different ways they can help reduce emissions.

Extension:

Students can use Monthly Electricity Use – Common Household Appliances to identify exactly where they expend the most energy.

**Adapted from Environmental Protection Agency’s “Climate Change, Wildlife and Wildlands”*

Assessment:

- Completed Personal Emissions Calculator – Student Grid 1
- Completed Personal Emissions Calculator – Student Grid 2
- Completion of Personal Emissions Calculator Wheel

Personal Emissions Calculator

► Averages for Teacher Use

Directions: Fill in the information below for an approximation of the average American family. If students are not able to find this information on their homes, let them use the averages. Keep in mind that many households do not require natural gas.

HOME HEATING	TRAVEL	WASTE DISPOSAL	ELECTRICITY USE
In the box below, write how much money your family spends on natural gas or fuel gas on average each month.	In the box below, write roughly how many miles your family puts on their car(s) on average per week.	In the box below, write how many items your family recycles (for example, plastics, aluminum, etc.).	In the box below, write how much money your family spends on electricity on average each month (check your electricity bill).

Personal Emissions Calculator

► What is a Carbon Footprint?

Your carbon footprint is a representation of the effect you, or your organization, have on the climate in terms of the total amount of greenhouse gases you produce (measured in units of carbon dioxide). Many of your actions generate carbon emissions, which contribute to accelerating global warming and climate change. By measuring your carbon footprint through such tools as the SafeClimate Carbon Calculator, you can get a better sense of what your individual impact is and which parts of your lifestyle deserve the greatest attention. Armed with such information, you can more readily take effective action to shrink your carbon footprint, thereby minimizing your personal impact on the climate. For example, when you drive a car, each gallon of gasoline you burn produces carbon in the form of carbon dioxide. Depending on the fuel efficiency of your vehicle and the miles traveled, a gasoline-powered car can easily generate its own weight in carbon dioxide each year. The average American is responsible for about 20 tons of carbon dioxide emissions each year, a far greater per capita number than that of any other industrialized country. In fact, the U.S. accounts for more than 20% of the world's total greenhouse gas emissions. You can reduce your carbon footprint by driving a more efficient car, or driving less. You can also plant trees or help preserve forests to offset your emissions, since trees are a sink for carbon. The carbon footprint calculator estimates CO₂ emissions for energy use and transportation, and for organizations paper use, because these types of activities are responsible for a significant percentage of U.S. emissions, and are measurable based on readily available information. Your total carbon footprint would account for the energy used to produce all of the products and services you consume, as well as all of your other activities, and would be substantially larger. Home energy use and transportation represent approximately 40% of all U.S. emissions; so for an average person, the emissions from these two activities would have to be multiplied by 2.5 to determine the person's total carbon footprint.

Guide to Carbon Dioxide and other Greenhouse Gases

Carbon dioxide (CO₂) is not the only man-made greenhouse gas – it is simply the one that has accumulated the most in the atmosphere and is presently having the greatest cumulative warming effect on our planet. Human sources of carbon dioxide primarily include the burning of fossil fuels (coal, oil and natural gas), and deforestation. The amount of carbon dioxide in the atmosphere has increased 30% since pre-industrial times. SafeClimate typically quotes greenhouse gas units in terms of carbon dioxide (1 lb. carbon dioxide = 0.2729 lbs. of carbon), as well as converting other greenhouse gases into units of carbon dioxide based on their relative global warming potentials. This standardized approach simplifies things and makes for easier and more meaningful comparisons.

Other greenhouse gases, produced by human activities, include:

- Methane (CH₄), emitted by agriculture, ranching, landfills and energy exploration. Human activities have increased the concentration of methane in the atmosphere by about 145%.
- Nitrous Oxide (N₂O), produced by various agricultural and industrial practices, including the use of nitrogen fertilizers, nylon production and the burning of organic material and fossil fuels. Human activities have increased the level of nitrous oxide in the atmosphere by about 15% above natural levels.

- Tropospheric ozone (O₃), ozone in the lower part of the atmosphere, created by the reaction of sunlight with human-produced pollutants from vehicles and power plants. Tropospheric ozone has probably doubled in the Northern Hemisphere since pre-industrial times.
- Chlorofluorocarbons (CFCs), and other halocarbons such as perfluorocarbons (PFCs), sulfur hexafluoride (SF₆), and hydrofluorocarbons (HFCs) – chemicals used in refrigeration, air conditioning and other industrial processes. The production of chlorofluorocarbons is rapidly being eliminated because of their destructive effect on the ozone layer. Yet other halocarbons, such as HFCs, are now being produced as substitutes, many of which are also greenhouse gases. PFCs are used in semiconductor manufacturing, and are a byproduct of aluminum smelting. SF₆ is an insulating gas used in the transmission of electricity. SF₆ is the most potent greenhouse gas ever measured, roughly 25,000 times more powerful than carbon dioxide.

All of these gases, aside from the halocarbons, are also produced by natural causes – but it is their rapid build-up in the atmosphere over the past few centuries, due to human activities, that are now causing global warming.

The Ecological Footprint

There are many other ways to visualize our individual and overall human impact on the environment. Some environmental and government groups feature a broader concept than the carbon footprint – the ecological footprint, which is an estimate of how much land and water is needed to produce all the resources an individual consumes, and dispose of all the waste and pollution he or she generates. Because of an increasing population and levels of consumption and pollution, human beings are leaving bigger and bigger ecological footprints – at a rate that is increasingly harmful to the planet.

For example, it has been estimated that the typical American uses 25 acres to support his or her lifestyle, almost five times more than is sustainable.

Personal Emissions Calculator

► Student Grid 1

Name: _____

Directions: Complete the grid below. You will have to use your family's electric bill, natural gas bill and an adult's input on car use. You should be able to 'guesstimate' the waste disposal section. Remember that it is important to be honest when completing this grid. You will be assessed on the accuracy of your information. If you cannot find some of the information, your teacher can help you.

HOME HEATING	TRAVEL	WASTE DISPOSAL	ELECTRICITY USE
In the box below, write how much money your family spends on natural gas or fuel gas on average each month.	In the box below, write roughly how many miles your family puts on their car(s) on average per week.	In the box below, write how many items your family recycles (for example, plastics, aluminum, etc.).	In the box below, write how much money your family spends on electricity on average each month (check your electricity bill).

Personal Emissions Calculator

► Student Grid 2

After you make your personal emissions calculator, fill in the pounds of CO₂ your family emits each year (this will be the number in the small box of your personal emissions calculator). Add the first four numbers to calculate your total emissions.

Home Heating	
Electricity Use	
Waste Disposal	
Transportation	
TOTAL EMISSIONS	

Personal Emissions Calculator

► Student Directions

1. Cut out the two large circles and two large rectangular pieces.
2. Cut out the two little rectangular windows on each of the large rectangular pieces.
3. Put glue on the backs of both circles and put them together to make the “wheel” of the wheel card, making sure you align them so the four labels that run along the outside of each circle (Waste Disposal, Home Heating, Electricity Use and Transportation) line up with the corresponding labels on the other side. The Waste Disposal label on one side should line up with the Waste Disposal label on the other side, and so on.
4. Lay the rectangular piece entitled “What Can You Do?” upside-down on the table with the larger of the two cutouts closer to you. If you lift up the edge of the rectangular piece and see the words “Global-Warming – What Can You Do?” right side up, you’ve done it correctly.
5. Put the glued-together wheel on top of the rectangular piece, with the side that has all the questions (such as “On average, how much does your household spend on electricity each month?”) facing up.
6. Lay the other rectangular piece entitled “What’s Your Score?” on top of the wheel, with the smaller of the two cutouts closer to you.
7. Look for the “belly button” on the pasted-together wheel and the two large rectangular pieces. Push a paper fastener (“brad”) through the “belly button” to hold all the pieces together.
8. Glue the large rectangular pieces in all four corners just enough to hold the rectangles together but allowing the wheel to turn freely.
9. If you wish, highlight each line inside the windows in a different color to make it easier to read.
10. Using the information from your grid, calculate your personal emissions and fill in the last line on your grid worksheet.
11. Work with the class to figure your class emission average.
12. Use the “What Can You Do” side of the card to determine how you can help reduce emissions.

Personal Emissions Calculator

► Ecological Footprints of Nations

(2002 Data; incomplete country list)

2002 Data	Population (millions)	Total Ecological Footprint (global ha/person)	Biocapacity (global ha/person)	Ecological Reserve / Deficit (global ha/person)
World	6,225.0	2.2	1.8	-0.4
Argentina	38.0	2.2	6.7	4.5
Australia	19.5	7.0	11.3	4.4
Bangladesh	143.8	0.5	0.3	-0.2
Brazil	176.3	2.1	10.1	8.0
Canada	31.3	7.5	15.1	7.6
Chile	15.6	2.2	5.4	3.2
China	1,302.3	1.6	0.8	-0.8
Denmark	5.4	5.3	3.4	-1.9
Egypt	70.5	1.4	0.4	-0.9
Finland	5.2	6.8	12.3	5.4
France	59.9	5.6	3.2	-2.4
Germany	82.4	4.4	1.8	-2.6
India	1,049.5	0.7	0.4	-0.4
Indonesia	217.1	1.0	1.0	-0.1
Italy	57.5	4.0	1.1	-2.8
Japan	127.5	4.3	0.8	-3.5
Korea Republic	47.4	4.3	0.6	-3.8
Malaysia	24.0	2.4	3.3	0.9
Mexico	102.0	2.4	1.7	-0.7
Netherlands	16.1	4.4	0.8	-3.7
Norway	4.5	5.9	7.0	1.1
Pakistan	149.9	0.6	0.3	-0.3
Philippines	78.6	1.0	0.6	-0.4
Poland	38.6	3.3	2.0	-1.3
Russia	144.1	4.4	7.0	2.6
South Africa	44.8	2.4	2.0	-0.4
Spain	41.0	4.9	1.7	-3.2
Sweden	8.9	5.5	9.8	4.3
Switzerland	7.2	4.7	1.6	-3.1
Thailand	62.2	1.4	1.0	-0.4
Turkey	70.3	2.0	1.4	-0.5
United Kingdom	59.3	5.6	1.6	-4.0
United States of America	291.0	9.7	4.7	-4.9

From: http://www.footprintnetwork.org/gfn_sub.php?content=footprint_hectares

Personal Emissions

► Monthly Electricity Use of Household Appliances

(Heating and lighting not included)

Appliance	Peak Power (W)	Approximate Monthly Use kWh	My Home Use (estimate)
Blender	350	1	~
Broiler	1450	8	~
Coffee maker	900	10	~
Clothes dryer 5 load per week	5000	83	~
Dish Washer hot water not incl.	1200	120	~
Electric Blanket	180	12	~
Food freezer (15ft) ³	340	90 (manual defrost)	~
Food freezer (15ft) ³	450	150 (auto defrost)	~
Electric Food Disposal "garbarator"	450	3	~
Electric Frying Pan	1200	15	~
Electric Hand Iron	1000	12	~
Microwave Oven	1400	16	~
Radio/CD/Stereo	110	9	~
Electric Range	180	70	~
Self-cleaning unit (on range)	4000	4	~
Refrigerator with freezer	330	60 (manual defrost)	~
Refrigerator with freezer	600	140 (auto defrost)	~
Toaster	1200	5	~
TV (bw solid state)	55	10	~
TV (color solid state)	200	36	~
Vacuum Cleaner	630	4	~
Washer (hot water not incl.)	500	8	~
Water bed (heater)	370	150	~
Water heater	4500	400	~
		TOTAL (kWh)	~
Conversion – see note below		TOTAL (CO₂) (kg)	~

To convert kWh to CO₂, We calculate emissions from electricity generation based off figures from the EPA's eGRID emission factors. **On average, electricity sources emit 1.306lbs CO₂ per kWh** (0.0005925 metric tons CO₂ per kWh). State CO₂ emissions per kWh may vary greatly in accordance with the amount of clean energy in the energy supply (Vermont: 0.008 lbs/kWh; North Dakota: 2.24 lbs/kWh). Using the average works for this lesson or, find state numbers at:

http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2010V1_1_year07_SummaryTables.pdf