

Student Activities

Activity 1 Greenhouse Warming: What Is It?

Situation:

An alien from another planet has just arrived and is perplexed by the controversy surrounding the greenhouse effect and global warming. Here's how you can help:

Task 1: Draw a diagram illustrating the greenhouse effect. Label it carefully.

Task 2: Below your diagram write a concise paragraph that explains the diagram. Write neatly and use correct English! Use the back of this worksheet if necessary.

Activity 2

How Much Is Enough?

Overview:

A similar version of this motivating group activity appears in Unit 1 on water pollution (“The White Glove Test,” p.40) In both versions, students use marginal analysis to address the difficult questions, “How clean is a clean environment?” and “How much are we willing to pay for a clean environment?” While carbon dioxide and other greenhouse gases are not “pollutants,” students can use the same marginal analysis to help determine how many scarce productive resources a society should devote to reducing greenhouse gas emissions.

Learning Objectives:

After completing this activity, students will understand that:

1. It requires costly productive resources to reduce greenhouse emissions.
2. Individuals and societies will reduce greenhouse gas emissions by first doing the *least* costly greenhouse reduction activities.
3. It is too expensive, in terms of opportunity cost, to eliminate greenhouse gas emissions completely.
4. Scientists and individuals differ on what is a “safe” level of greenhouse gas emissions.

Notes to the Teacher:

It is important to distribute enough “greenhouse emissions.” You’ll be surprised at how well 25 students clean up a classroom in a minute! You may even want to shorten the cleanup time.

Directions:

1. When your students are gone, litter the classroom floor with a variety of different materials representing “greenhouse gases.” Possible suggestions: balls of scrap paper, popcorn, wood shavings, small dots of paper from a paper punch, paper clips, rice, dry grits, glitter. *It is important to include a significant amount of tiny, “difficult to pick up” types of materials, such as dry grits or glitter.*
2. When students arrive, tell them that the items on the floor represent the “excess” greenhouse gases in the environment. Tell the students that, to reduce the likelihood of global warming, you would appreciate their help in reducing these emissions.
3. Allow three approximately one-minute rounds to “reduce excess emissions.” After each round record on the board the types of items that were found. Discuss what greenhouse gases these items represent. By the end of the third round, most emissions” should be gone.
4. After the third round ask, “Have we eliminated the greenhouse emissions?” After students agree, examine the floor carefully and discover some small bits of glitter, etc. Tell students that some greenhouse emissions still remain. They haven’t removed all of them! Ask students if they want to continue reducing emissions.

5. Discussion questions:

- a. What kinds of greenhouse “gases” did you find? What real greenhouse gases do these represent? (Identify various items: carbon dioxide, methane, nitrous oxide, CFCs, water vapor).
- b. What did you have to do to reduce the greenhouse emissions? (We had to work. It took time. To do a thorough job we needed capital, such as a broom or vacuum cleaner. In real life, it would take costly productive resources to reduce these emissions.)
- c. What type of emission did you reduce first? Why? (The large items. It “cost” less in terms of time and effort to reduce them first. The benefit was also greatest.)
- d. Why did you say that the excess emissions were eliminated, when they actually weren’t? (It seemed like most were eliminated. Only tiny items, such as dry grits or glitter remained.)
- e. Why don’t we spend more time reducing these remaining “greenhouse emissions?” (It takes too much time. The opportunity cost is too great. We have other important things we need to do.)
- f. In real public policy decisions, to avoid possible global warming why don’t we take drastic steps to reduce greenhouse emissions. (The marginal cost of doing so would probably exceed the marginal benefit. At some point, greenhouse emissions would be reduced enough. After that point, scarce productive resources would best be used elsewhere, such as for education, roads, cancer research, etc.)

(An original version of this activity appeared in the article “A Clean Environment, A Matter of Choice,” by Robert W. Reinke and Diane W. Reinke, in the *Elementary Economist*, spring 1989.)

Activity 3

Analyzing Greenhouse Data

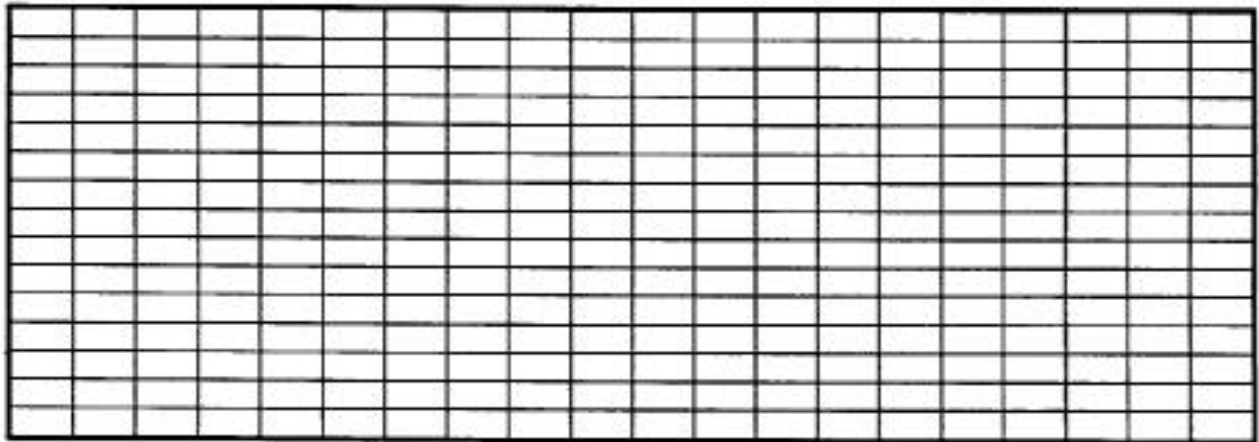
Directions:

In this activity, you will analyze and graph data on observed global temperatures and CO₂ concentrations. Then you will answer questions about this data.

Task 1: In the space below, graph the data in Table 4-2. Label the horizontal axis “Year” and label the vertical axis “CO₂ concentrations.”

Table 4-2: Atmosphere Concentrations of CO₂ During the Last 230 Years

Year	CO ₂ Concentration (parts per million-ppm)
1750	282 ppm
1800	283 ppm
1850	290 ppm
1900	297 ppm
1950	312 ppm
1980	335 ppm
1990	350 ppm

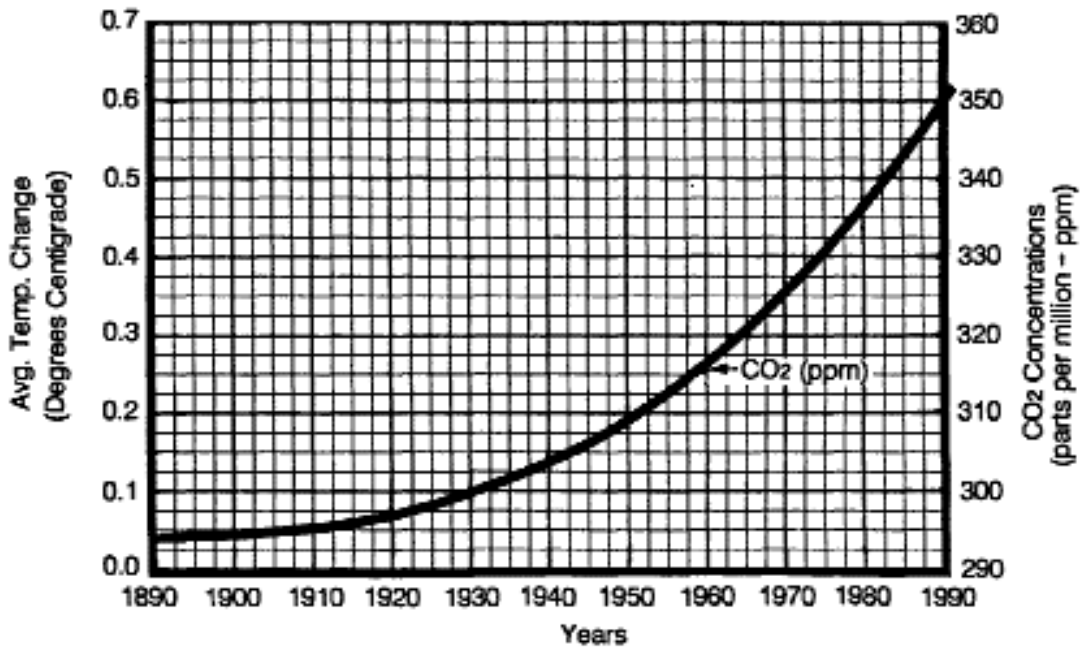


a. What pattern or trend do you notice in CO₂ concentrations? During what years was the trend most pronounced?

Task 2: Table 4-3 gives actual average global temperature changes during the past 110 years, using 1890 as a base year. Below Table 4-3 is a graph showing CO₂ concentrations during this same time period. Graph the data in Table 4-3 on the graph below. Then answer the questions.

Table 4-3: Observed (Actual) Global Average Temperature Change (Based on data in “Climate Impact of Increasing Atmospheric Carbon Dioxide,” Science, August 28, 1991.)

Year	Global Average Temperature (Observed Change—Degrees C)
1890	0.00
1900	0.18
1910	0.20
1920	0.22
1930	0.43
1940	0.54
1950	0.48
1960	0.43
1970	0.40
1980	0.55
1990	0.56



a. During what time period was the observed temperature increase the greatest? _____

b. What time period shows the greatest increase in CO₂ concentrations?

c. Examine the data carefully. Does the data support the conclusion that increasing greenhouse emissions are responsible for the 0.5 degree Centigrade increase in observed temperature during the past 110 years? Explain your reasoning below.

Discuss your conclusions with your teacher and your classmates.

d. What are some other natural phenomena that possibly could explain increases in temperature?

e. Assume you were a weather scientist and were called before a Congressional committee to testify on the global warming issue. Would you recommend public policies that would require reductions in greenhouse gas emissions? Explain your position and support it with scientific evidence.

f. Did the *cost* of greenhouse reduction policies affect your decision in e. above? Explain.

Activity 4

Further Investigations

1. Write or call your United States Representative or Senator and request information about global warming. Indicate you are particularly interested in legislation that addresses this issue.
2. Write various environmental organizations requesting information about greenhouse warming. Analyze their views. What remedies do they recommend for global warming? Do the same for industry groups like coal and petroleum companies. Compare and contrast the difference in viewpoints.
3. Cut out articles from news magazines or newspapers that address global warming. Put them on the bulletin board. Note any new research findings and indicate differences from previous findings.
4. Interview other teachers in your school. Ask them these and other similar questions:
 - a. Can you explain greenhouse warming?
 - b. Do you think greenhouse warming is a real problem?
 - c. Do you think the United States should adopt policies to reduce greenhouse emissions?
 - d. What policies do you recommend? Give specific examples.
 - e. Should the United States impose a carbon tax on fossil fuels to help reduce greenhouse gases?
 - f. Have you made any changes in your personal lifestyles to help reduce greenhouse emissions? Why or why not?
 - g. Should the United States pay other countries to help them reduce their emissions? Why or why not?

Analyze and discuss the teacher's responses. Do they generally agree in their responses?
Where is disagreement the greatest?

5. Some scientists believe that more carbon dioxide in the atmosphere will increase plant growth and return more organic matter to the soil, resulting in many beneficial effects. The leading spokesman for this group of scientists is Sherwood Idso. Research more about this point of view and report these findings to the class.
6. Interview a local official (mayor, city engineer, city development person, etc.) to find out what the local government is doing to become more energy efficient.

Activity 5

Debating The Issues

Below are some controversial statements that you can debate with your classmates:

1. The United States should take immediate and forceful steps to reduce CO₂ emissions even if it means putting some coal miners out of work.
2. The United States should agree to definite emission reductions and submit to definite timetables.
3. Since the richer, industrial countries of the world are responsible for the most CO₂ emissions and have benefited from them, these countries should now pay poorer countries to help them reduce CO₂ emissions.
4. The United States should wait until more definite research has been accumulated before trying to reduce CO₂ emissions.
5. To reduce our dependence on oil (and thus reduce greenhouse emissions), the United States government should require automobile companies to produce automobiles that get 100 miles per gallon.
6. An environment rich in CO₂ would not be harmful to the earth, but actually would be very beneficial. We should be doing nothing at all to discourage CO₂ emissions. If anything, we should *encourage* them!
7. To encourage people to use less gasoline, there should be a \$.50 per gallon tax on gasoline, even if this tax hurts low income people more than others.
8. Reducing the world's population growth will have little effect on global warming.

Activity 6

EEE Actions — You Can Make A Difference!

We all engage in activities in our daily lives that directly or indirectly increase the amount of carbon dioxide in the atmosphere. As you have learned in this unit, some people feel this contributes to global warming. If you want to help reduce the amount of fossil fuels you use (i.e., increase your energy efficiency!), and reduce the amount of carbon dioxide entering the environment, you can do the following:

1. When feasible, walk or ride a bicycle instead of using a motor vehicle.
2. Do all that you can to save energy in your home by:
 - * Conducting a home energy audit to determine energy loss.
 - * Encouraging your parents to buy energy efficient appliances.
 - * Using fluorescent light bulbs — they cost more initially, but should save money in the long run.
 - * Turning off lights as you leave rooms.
 - * Using air conditioning only if you feel it is really necessary.
 - * Not overheating the water in the hot water heater — a temperature of 130 degrees is usually sufficient.
 - * Installing nonfoam insulation in your attic.
3. Try to use public transportation whenever possible.
4. Encourage members in your family to buy automobiles that get good gas mileage. Also, make sure that automobiles in your family are properly tuned and that tires are inflated properly.
5. Trees use carbon dioxide and produce oxygen. If possible, plant a tree where you live.
6. Recycling certain kinds of materials (especially aluminum) can save a lot of energy.
7. Reusing products can also save energy. Try to avoid disposable products.

Activity 7

Case Study The Case of the Carbon Tax

Student Directions:

1. In the case study below legislators are dealing with an issue that is receiving much attention—greenhouse warming. The issue is whether to impose a “carbon tax” on fossil fuels, such as coal, oil, and natural gas.
2. Analyze the case study below and use the Decision Worksheet and the Decision Grid to help determine whether such a tax would be a good idea. Be prepared to defend your decision!

Scenario

Congressman Samuel Peabody of New York was convinced that global warming was the most important issue facing the United States and the world. He was very concerned that rising levels of greenhouse gases, especially carbon dioxide (CO₂), would cause increasing average global temperatures. The result would be more droughts, famines, flooded coastlines, and increased tropical storm intensity. “If we don’t do something now to stop increasing CO₂ emissions, it could be the end of the world as we know it,” he emphasized in a debate on the House floor.

His solution was to introduce House Bill (H.B.) 107, a law that would impose a “carbon tax” on three fossil fuels: coal, oil, and natural gas. The tax would reflect the fuel’s carbon content, since carbon content was roughly proportional to the amount of CO₂ released when fossil fuels are burned. The tax would be imposed at the port of entry for imported fuels, and at the point of primary production for fuels produced in the United States. The bill would set the carbon charge at \$100 per ton, phased in over a period of 10 years. Some of the enormous tax revenues would be used for environmental research and cleaning up the environment even more. To lessen the overall financial burden of the carbon tax, H.B. 107 calls for some reductions in social security and income taxes.

Congressman Peabody insisted that according to Congressional Budget Office (CBO) estimates, this would reduce CO₂ emissions by approximately 20 percent by the year 2000. The much higher prices for fuels resulting from the tax would force people to be more energy efficient, and it would encourage the development of renewable energy sources, such as wind and solar energy. “This bill will ensure that our children and grandchildren have a safe environment to live in. It’s the least we can do for future

Congresswoman Phyllis Adams from West Virginia strongly disagreed. “I also think we should care for our environment,” she said, “but we’re not even sure that greenhouse warming is a fact. It’s just a theory based on computer models. Do we want to spend billions to stop something that may never happen? According to the CBO, your carbon tax would hurt economic growth and employment. The overall effect of the tax, despite some social security and income tax reductions, would be to reduce people’s real incomes. That is especially hard on poor people. Also, certain regions of the country would be devastated, like the



coal mining economies of West Virginia and southern Indiana. Let’s face it — it’s just too expensive forcing our whole economy away from fossil fuels. Until we know more about greenhouse warming, our best policy option is to do nothing at this time. I’m

Congressman Gerald Williams of California also had concerns about economic costs of H.B. 107. He introduced H.B. 219, the “Greenhouse Warming Insurance Policy” bill. It called for a \$10 per ton carbon tax. The tax revenues would fund significant increases in research in the area of both greenhouse climate change and energy efficiency. The bill also included additional funding to distribute this information to producers and citizens. According to Congressman Williams, “This bill costs much less than H.B. 107, and gives us more time to study the issue. It also helps us become more energy efficient in case greenhouse warming becomes a more severe problem.”

Phyllis Adams still disagreed. “It’s still throwing too much money at a problem that may not even exist. There are other more important needs for our tax monies, such as education, better highways, and medical research.”

Samuel Peabody was also upset by H.B. 219. “We cannot afford to wait for the results of global warming research. If we want to stop future greenhouse warming, we must act *now* in a *significant* way. This won’t help much at all.”

The vote is next week. It promises to be close. What policy do you prefer? How would you vote.

Answers to Selected Teaching Activities:

Activity 1: Greenhouse Warming: What Is It?

Refer to the diagram and explanation in the Facts About Global Warming section at the beginning of this unit.

Activity 2: How Much Is Enough?

The key idea to emphasize in this activity is that it is not possible to eliminate greenhouse emissions (or pollution!) completely. The key question to ask is “What is an acceptable level of greenhouse gas emissions?” What makes policy making so difficult is the great uncertainty about the effect of greenhouse gases on global climate change. However, at some point, it will become counterproductive to keep reducing greenhouse emissions. That is because reducing emissions becomes increasingly more costly, while at the same time benefits from the deduction begin to decrease. For a more complete explanation, review the concept of marginalism on page 13.

Activity 3: Analyzing Greenhouse Data

Task 1: a. The obvious trend is the increase in CO₂ concentrations. The greatest increase has taken place during the past 50 years.
b. The primary reason is the burning of fossil fuels that has resulted from increased industrial activity.

Task 2:

- a. The greatest temperature increase was prior to 1940.
- b. The greatest decrease in temperature was from 1940 to 1970.
- c. The data show that, in a *rough* sense, the temperature increase during the past century has occurred as CO₂ levels have increased. However, the actual increase in temperature occurred *before* the greatest increase in CO₂ concentrations! This indicates that some other factors are probably involved. In a 1981 article in *Science*, several scientists made this interesting comment:

Another conclusion is that global surface air temperature rose approximately 0.04 degrees C in the past century, roughly consistent with calculated CO₂ warming. The time history of the warming does not follow the course of the CO₂ increase, indicating that other factors must affect global mean temperature.

Several possibilities which have been given for a delayed greenhouse effect are:

- the cooling effects of increased atmospheric pollution,
 - the delayed warming of the oceans,
 - the cooling effect of an increasing cloud cover caused by the greenhouse effect. Students may want to research these topics.
- d. The most mentioned phenomena is the effect of solar activity. According to the Marshall Institute, “The very close correlation between the solar changes and the changes in temperature suggests that the sun has been the controlling influence the last 100 years, with the greenhouse effect playing a smaller role.
 - e. Students who favor emission reduction policies will rely more on the predictions of the GCMs and the belief that the risk of not reducing emissions is too great. Students who favor few or no reduction policies will rely more on experimental data, which show no definite correlation between greenhouse emissions and global warming.
 - f. Cost would definitely be a factor. Costly greenhouse reduction policies may not be worth the benefits they produce.

Activity 7: Case Study: The Case of the Carbon Tax

Below is a suggested Solution Grid. As in the other case studies you and your students may disagree about different cell markings. Make sure that you discuss the questions in the Key Questions to Ask Students section. Some of the questions relate directly to the Case Study.

Decision-Making Grid Answer Key

The Case of the Carbon Tax

Criteria

Alternatives	Reduces C02	Cost	Fairness	Economic Growth	Promote Energy Efficiency
Implement HB107 (\$100/ton carbon tax)	++	--	-	-	++
Do nothing at this time	--	++	+	+	
Implement HB219 (InsurancePolicy Bill)	+	-	?	?	+

¹⁷George C. Marshall Institute, *Global Warming Update: Recent Scientific Findings* (Washington, DC: The George C. Marshall Institute, 1992), pgs. 25-26.

EEE Resources

General Resources

Environmental Education Coalition, Inc., P0 Box 5753, Fort Wayne, IN 46895

United States Environmental Protection Agency, Public Information Center, 401 M Street, SW, Washington, DC, (202) 260-2080.

Indiana Department of Education, Office of School Assistance, Room 229, State House, Indianapolis, IN 46204-2798, (317) 232-9141

Indiana Council for Economic Education, 1310 Krannert Center, Purdue University, West Lafayette, IN 47907, (317) 494-8540

Indiana Department of Environmental Management, 105 South Meridian Street, P0 Box 6015, Indianapolis, IN 46206, (317)232-8603

Indiana Department of Natural Resources, 402 West Washington Street W255B, Indianapolis, IN 46204, (317)232-4200

National Geographic Society, Educational Services, Washington, DC, 20036, (800) 368-2728

Water Quality Resources

Alliance for a Clean Rural Environment, P0 Box 413708, Kansas City, MO 64170, (800) 545-5410

American Groundwater Trust, 6375 Riverside Drive, Dublin, OH 43017, (614) 761-2215

American Water Works Association, 6666 Quincy Avenue, Denver, CO 80235, (303) 794-7711

Federal Drinking Water Hotline, Environmental Protection Agency, (800) 4264791

Hoosier Environmental Council, P0 Box 1145, Indianapolis, IN 46206, (317) 923-1800

Izaak Walton League, 1401 Wilson Boulevard, Level B, Arlington, VA 22209, (703)528-1818

Lake Michigan Federation, 59 East Van Buren, Suite 2215, Chicago, IL 60605, (312) 939-0838

The Terrene Institute, 1700 K Street, Suite 1005, Washington, DC 20036, (202) 833-8317

U.S. Geological Survey, 423 National Center, Reston, VA 22092, (800) 426-9000 Water Environmental Federation, 601 Wythe, Street, Alexandria, VA 22314, (703) 684-2400

Source: Indiana Department of Education, Energy Environment, & Economics