CO_2 and You

High School Grades

Lesson Summary
Students will participate in a three-day data collection process pertaining to household and vehicle energy consumption. The students will then analyze their energy use with respect to CO_2 emissions and brainstorm ways to adapt to the consequences of global climate change as well as ways to immediately change our lifestyles in an attempt to slow global climate change.

Prior Knowledge & Skills
- Data collection skills
- Knowledge of greenhouse gasses

AAAS Science Benchmarks
The Living Environment
Interdependence of Life
The Designed World
Energy Sources and Use
The Mathematical World
Symbolic Relationships
Habits of Mind
Computation and Estimation

NSES Science Standards
Science and Technology
Understandings About Science and Technology
Earth and Space Science
Geochemical Cycles
Science in Personal and Social Perspectives
Natural and Human Induced Hazards

NCGE Geography Standards
Environment and Society
Standard 14

Teaching Time:
In class: 3+ days
At home: variable

Materials
- Calculator
- Household energy bills
- Student data collection sheets
- Vehicle mileage records

Advanced Planning
Preparation Time: ~10 minutes
1. Review the instructions
2. Gather the necessary supplies.

Recommended Reading: (attached)
The Greenhouse Effect, NASA Facts

CO2 and You

Note: Lessons were designed with specific page breaks - indicated by page numbers such as 2-1. The worksheets and viewgraphs are especially dependent upon this correct page formatting.

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Grade Level:
7-12

Objectives:
The student will be able to:

- Observe and quantify his or her household and vehicle energy consumption.
- Explain the relationship between energy consumption, energy production, and its influences on the greenhouse effect and global climate change.
- Suggest adaptation and mitigation strategies as to how he or she could reduce household and vehicle energy consumption in order to minimize carbon dioxide emissions.

Disciplines:
Earth Systems science, mathematics, physical science

Key Concepts:
adaptation
emissions
energy consumption
fossil fuels
global climate change
greenhouse effect
mitigation
units of measurement

Cognitive Tasks:
Analyzation, computation, critical decision making, data collection, prediction, problem solving, synthesis

Time Requirements:
In class: 3+ days
At home: variable

2-1

Data Sources:
Suggested WWW links for additional background information:

Greenhouse Effect

http://www.uic.com.au/nip24.htm

Energy Consumption
http://www.edisonx.com/html/customer/home/hl_eccin.htm

Background: CO2 AND YOU

Substantial scientific evidence shows that carbon dioxide (CO2) plays a significant role in the *greenhouse effect*. The greenhouse effect is a natural phenomena whereby incoming short wave radiation from the sun is absorbed by the Earth and re-radiated as longer wave infrared radiation. Specific bands of the longer wave radiation are then selectively absorbed in the troposphere by an array of gasses which include CO2, water vapor, methane, ozone, chlorofluorocarbons, and nitrous oxide--the key greenhouse gases. This process has the effect of heating the troposphere to a point higher than would otherwise be the case. The greenhouse effect is therefore responsible for maintaining a temperature range which allows water to exist in its gaseous, liquid, and solid states throughout the planet, believed to be critical for maintaining life in its current forms.

Because of the significant quantities of greenhouse gases introduced through anthropogenic (human created) sources, and their persistence in the troposphere, greenhouse gas emissions and their potential *enhancement* of the natural greenhouse effect have garnered significant public attention. Such enhancement may produce an increased warming which could alter global climatic regimes. For further background information, please refer to the NASA Facts sheet (NF-182), entitled *The Greenhouse*

Effect.

Global climate prediction models, although still in the early stages of refinement, have suggested that global average temperature increases between 1.5 and 4.5 degrees Celsius are possible within the next 100 years. Such an increase, although seemingly small, would radically change regional climates throughout the planet. Effects of this warming may include a rise in sea level, crop stress desertification, increase/decrease in precipitation and storm frequency/severity, ecological stress, water availability, epidemic, and others. Because it is likely that any of these effects would require significant social and economic responses, humans are left with three major courses of action with respect to global warming.

- One response is known as the *do nothing* strategy, which preserves current behavior and assumes that little change in lifestyle will be required in the future.
- The second response is known as *adaptation*, which doesn't prompt changes (believing them unrealistic or ineffective) in current behavior, but requires humans, inevitably in the future, to modify their lifestyle in response to the changes in climate and its consequences. Adaptations may include moving to higher elevations, preparing to weather more frequent/severe storms, growing different crops or relocating major agriculture regions, etc.
- The third response is *mitigation*, with humans making immediate changes in lifestyle to minimize the enhancement of the greenhouse effect and thus reduce the possibility of major *global climate change*. Mitigation strategies would include any measures which would reduce CO2 emissions sharply over the next few decades.

Examination and evaluation of these courses of action represent a valuable exercise in merging scientific understanding with social and political decision making. The accompanying lesson plans provide activities that will help students gain an intuitive understanding of their individual role as a consumer and citizen, and prompt them to consider various courses of action which are likely to become increasingly important during their lifetimes.

name: _____

Part I: Vehicle Fuel Consumption Worksheet

1. Predict the amount of fuel (gallons) your family vehicle(s) consumes in one year.
_____

2. Determine the number of miles each vehicle has traveled in a year's time. The total number of miles traveled in one year is _____.

3. Compute the total number of gallons of fuel consumed in one year using the following equation:

total miles driven divided by average miles/gal. = number of gallons of fuel
_____ = _____

4. The carbon dioxide emissions can then be calculated by using the following formula:

number of gallons of fuel _____ x 17.23 = _____ pounds of carbon dioxide

QUESTIONS:

1. What was the difference between your prediction and your family's actual fuel consumption?

_____

_____

2. Suggest two (2) *adaptation* and two (2) *mitigation* strategies your family could use to reduce your yearly vehicle fuel consumption.

adaptation
a)_____

b)_____

mitigation
a)_____

b)_____

3. How much fuel do you think you and your family would save if you were to implement your suggested strategies?
_____

4. How will this reduce carbon dioxide emissions?

_____

_____

5. Based on the estimated savings, by what percent will this reduce carbon dioxide emissions? _____

name: _____

Part II: Home Heating Consumption - Worksheet

1. What type of energy does your family use to heat your home? _____

2. **Predict** the amount of energy you and your family use to heat your home in one year. (Many families rely on more than one energy source. Make sure you include all carbon dioxide-producing sources - i.e. oil and wood) Use the corresponding unit of measurement listed below in your prediction.

electric heat (kilowatt/hours) = _____

oil heat (gallons) = _____

natural gas heat (cubic feet) = _____

wood heat (cords) = _____

other =_____

3. **Determine** the actual amount of energy you and your family consume to heat your home in one year by consulting bills and other records. List the actual totals for each energy source.

electric heat (kilowatt/hours) = _____

oil heat (gallons) = _____

natural gas heat (cubic feet) = _____

wood heat (cords) = _____

other =_____

4. The carbon dioxide emissions can then be calculated using the corresponding formula listed below:

electric heat - # of kilowatt/hours _____ x 8.87 = _____ pounds of carbon dioxide

oil heat - # of gallons _____ x 21.21 = _____ pounds of carbon dioxide

natural gas - # of cubic feet _____ x .138 = _____ pounds of carbon dioxide

wood heat - # of cords _____ x 6758 = _____ pounds of carbon dioxide

other _____

5. What was the difference between your prediction and you and your family's actual energy consumption?

_____

_____

6. Suggest two (2) *adaptation* and two (2) *mitigation* strategies your family could use to reduce your yearly home heating energy consumption.

Adaptation

a)_____

b)_____

Mitigation

a)_____

b)_____

7. How much energy do you think you and your family would save if you were to implement your suggested strategies?_____

_____

8. How will this reduce carbon dioxide emissions? _____

_____

9. Based on the estimated savings, by what percent will this reduce carbon dioxide emissions?

_____

name: _____

Part III: Energy Consumption: Appliances - Worksheet

1. Predict the total watts/year consumed by you and your family. _____

2. Complete the following chart based on you and your family's energy consumption.

APPLIANCE	WATTS/HOUR	WATTS/DAY	WATTS/ YEAR
air conditioner	_____	_____	_____
blanket, electric	_____	_____	_____
blender	_____	_____	_____
broiler	_____	_____	_____
clock	_____	_____	_____
clock radio	_____	_____	_____
clothes dryer	_____	_____	_____
coffee maker	_____	_____	_____
compact disc	_____	_____	_____
computer	_____	_____	_____
dehumidifier	_____	_____	_____
dishwasher	_____	_____	_____
fan	_____	_____	_____
freezer	_____	_____	_____
hair dryer	_____	_____	_____
space heater	_____	_____	_____
iron, curling	_____	_____	_____

APPLIANCE	WATTS/HOUR	WATTS/DAY	WATTS/ YEAR
iron, steam	_____	_____	_____
microwave oven	_____	_____	_____
oven	_____	_____	_____
mixer	_____	_____	_____
rangetop burner	_____	_____	_____
stereo	_____	_____	_____
sewing machine	_____	_____	_____
shaver, electric	_____	_____	_____
swimming pool	_____	_____	_____
television	_____	_____	_____
toaster	_____	_____	_____
toothbrush	_____	_____	_____
vacuum cleaner	_____	_____	_____
VCR	_____	_____	_____
others	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

TOTAL WATTS/YEAR _____

3. The carbon dioxide emissions can then be calculated using the corresponding formula listed below:

a) First, convert watts to kilowatts: 1000 watts = 1 kilowatt

b) # of kilowatts _____ x 8.87 = _____ pounds of carbon dioxide

Questions:

1. What was the difference between your prediction and your family's actual energy consumption?

_____

_____

2. What is the source of the electric energy that services your home and how is it produced?

_____

_____

3. Make changes in your and your family's lifestyle in an effort to reduce your current level of carbon dioxide emissions. Using the chart below, reduce your energy consumption of at least fifteen (15) appliances.

APPLIANCE	WATTS/HOUR	WATTS/DAY	WATTS/ YEAR
air conditioner	_____	_____	_____
blanket, electric	_____	_____	_____
blender	_____	_____	_____
broiler	_____	_____	_____
clock	_____	_____	_____
clock radio	_____	_____	_____
clothes dryer	_____	_____	_____
coffee maker	_____	_____	_____
compact disc	_____	_____	_____
computer	_____	_____	_____
dehumidifier	_____	_____	_____
dishwasher	_____	_____	_____
fan	_____	_____	_____
freezer	_____	_____	_____
hair dryer	_____	_____	_____
space heater	_____	_____	_____
iron, curling	_____	_____	_____
iron, steam	_____	_____	_____
microwave oven	_____	_____	_____
oven	_____	_____	_____
mixer	_____	_____	_____
rangetop burner	_____	_____	_____

APPLIANCE	WATTS/HOUR	WATTS/DAY	WATTS/ YEAR
stereo	_____	_____	_____
sewing machine	_____	_____	_____
shaver, electric	_____	_____	_____
swimming pool	_____	_____	_____
television	_____	_____	_____
toaster	_____	_____	_____
toothbrush	_____	_____	_____
vacuum cleaner	_____	_____	_____
VCR	_____	_____	_____
others	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

TOTAL WATTS/YEAR _____

4. How will this reduce carbon dioxide emissions? (Be specific)_____

_____

_____

_____

5. Based on the estimated savings, by what percent will this reduce carbon dioxide emissions?

_____

Assessment/Rubric:

1. What is the relationship between carbon dioxide emissions and the greenhouse effect?

2. How does this relationship affect global climate change/warming?

3. What impact will your adaptation and mitigation strategies have on your and your family's lifestyles? (Give at least two examples).

4. As a result of this activity and your findings, would you now recommend mitigation as a feasible response to reduce the potential of global warming?

5. In what other ways might carbon dioxide emissions be reduced?

Extended Activities:

1. Have students share their results, i.e. energy sources, consumption rates, adaptation and mitigation strategies, etc.

2. Have students create a 3-D model of a hypothetical town. The specifications could include a budget, reduced carbon dioxide emissions, alternative energy sources, limited amount of hazardous wastes, and any other variables or conditions which might reinforce lessons in the area of global climate change.

3. Ask each student to select a vehicle that he or she would most like to purchase (could be a preliminary activity). Have each student research information (perhaps on the Internet) regarding the vehicle's fuel consumption and emissions and compare findings with other students to develop a top ten list of energy efficient vehicles.

4. In place of the worksheets, teachers could develop a computer spreadsheet to conduct calculations.

5. Further findings....

- calculate the total class energy consumption for all three parts (vehicle, home heating, and appliances) and compute the total carbon dioxide emissions
- determine the class average of consumption for all three parts and compute emissions
- project energy usage of the town and state based on the class average of consumption
- determine the total energy consumption and emissions of your school
- compute the carbon dioxide emissions produced by school transportation