Illuminating Climate Change: Connecting Lighting and Global Warming

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INTRODUCTION

This lesson will introduce students to the basics of global climate change and build their understanding of the connection between lighting and global warming.

LESSON OVERVIEW

Grade Level & Subject: Grades 9-12: Science and Mathematics

Length: One class period

Objectives:
After completing this lesson, students will be able to:

- Recognize the connection between lighting and global warming
- Analyze and understand relationships between population, energy source, and emissions

National Standards Addressed:
This lesson addresses the following National Science Education Standards.[1]

- **Content Standard**: **NM-ALG.9-12.4**
  Analyze change in various contexts
  - approximate and interpret rates of change from graphical and numerical data.
- **Content Standard**: **NM-DATA.9-12.3**
  Develop and evaluate inferences and predictions that are based on data
  - use simulations to explore the variability of sample statistics from a known population and to construct sampling distributions;
  - understand how sample statistics reflect the values of population parameters and use sampling distributions as the basis for informal inference;
  - evaluate published reports that are based on data by examining the design of the study, the appropriateness of the data analysis, and the validity of conclusions;
  - understand how basic statistical techniques are used to monitor process characteristics in the workplace.
- **Content Standard: NM-NUM.9-12.3**
  Compute fluently and make reasonable estimates

[1] http://www.education-world.com/standards/

    - develop fluency in operations with real numbers, vectors, and matrices, using mental computation or paper-and-pencil calculations for simple cases and technology for more-complicated cases
    - judge the reasonableness of numerical computations and their results.
- **Content Standard: NS.9-12.5 SCIENCE AND TECHNOLOGY**
  As a result of activities in grades 9-12, all students should develop:
    - Abilities of technological design
    - Understandings about science and technology
- **Content Standard: NS.9-12.6 PERSONAL AND SOCIAL PERSPECTIVES**
  As a result of activities in grades 9-12, all students should develop understanding of:
    - Personal and community health
    - Population growth
    - Natural resources
    - Environmental quality
    - Natural and human-induced hazards
    - Science and technology in local, national, and global challenges

Materials Needed:

- White board or chalk board
- Reproducible #1 - **Graphing State CO_2 Emissions** graphing sheet

Assessment: Students will be assessed through the following activities:

- Completing the graphing worksheet on CO_2 emissions
- Contributing to a group discussion after completing the worksheet.

LESSON BACKGROUND

Relevant Vocabulary:[2]

- **Fossil Fuel:** A hydrocarbon deposit, such as petroleum, coal, or natural gas, derived from living matter of a previous geologic time and used for fuel.
- **Global Warming:** An increase in the average temperature of the earth's atmosphere, especially a sustained increase sufficient to cause climatic change.
- **Greenhouse Effect:** Any of the atmospheric gases that contribute to the greenhouse effect.
- **Hydroelectric Power:** Generating electricity by conversion of the energy of running water.
- **Natural Gas:** A mixture of hydrocarbon gases that occurs with petroleum deposits, principally methane together with varying quantities of ethane, propane, butane, and other gases, and is used as a fuel and in the manufacture of organic compounds.
- **Renewable Energy:** Relating to or being a commodity or resource, such as solar energy or wind energy, which is inexhaustible or replaceable by new growth.

[2] *The American Heritage Dictionary of the English Language* (4th ed.). (2000). Boston, MA: Houghton Mifflin Company.

Information:

You can find energy in everything you do. You require energy to eat breakfast, walk or take the bus to school, to do your homework, and to play outside. Energy is very important. In 2006, each person in the United States used 334 million Btu's of energy! But the United States consumes more energy than any other country. In fact, the United States consumes 25% of the world's energy, but only makes up 4.6% of the word's population.[3] Not only are we consuming and depleting nonrenewable energy sources, we are polluting the environment as well. According to the Energy Information Administration, the United States ranks 1st in consumption of petroleum and natural gas and 2nd in the world for coal consumption[4]. It's not easy to connect the simple switching on of a light bulb to a devastating massive hurricane enhanced by global climate change, but it is a link we must now build in our minds.

Over 85 percent of the energy consumed around the world comes from oil, natural gas, or coal. These nonrenewable fuel sources are called fossil fuels because they are found deep inside the earth and formed from the remains of dead plants and animals from hundreds of millions of years ago. When we use fossil fuels for energy they release gases such as carbon dioxide, methane and nitrous oxide. These gases, called 'greenhouse gases,' act together like a greenhouse – trapping heat in the atmosphere – keeping the planet warm. At normal levels, these greenhouse gases have helped keep our earth at the right temperature for millions of years. However, using lots of energy and burning fossil fuels has increased the amount of greenhouse gases in our atmosphere, thus gradually warming our planet.

Resources:

Renewable Energy Background, Earth Day Network, 2008.
Forms of Energy Lesson Plan, Earth Day Network, 2008.

LESSON STEPS

Warm-up: *Global What?*

1. Begin this lesson with a discussion of global warming. Find out what your students already know about the subject and try to fill in the gaps in their basic knowledge of the subject. Here are some questions you can use to get the discussion going:
    a. What is global warming?
    b. What are greenhouse gases?
    c. What types of human activities create greenhouse gases?
    d. What are some of the negative effects of global warming?
    e. What are some steps individuals can take to halt or reverse global warming?

Activity One: *Electricity and Fossil Fuels*

1. Have students write down what they believe are America's different sources of electricity.

[3] http://www.worldpopulationbalance.org/pop/energy/
[4] http://www.eia.doe.gov/
[3] http://www.epa.gov/oms/climate/420f05001.htm#carbon

2. Once they have individually completed their lists, ask students to share what they've written and create a comprehensive class list of energy sources on the board.
    a. Add any sources your students might have missed. Your complete list should include the following[5]:
        i. Coal (49%)
        ii. Natural Gas (20%)
        iii. Nuclear (20%)
        iv. Hydroelectric (7%)
        v. Renewables (2.5%)
        vi. Petroleum (1.5%)

3. Make a list on the board of the percentages listed above (don't list them with their corresponding electricity sources). Ask students to write down which percentages they believe match up with which sources of electricity.

4. After students have finished, write the percentages on the board with their actual corresponding electricity sources.

5. Ask students the following questions:
    a. Which of these sources of electricity are fossil fuels?
    Answer: Coal, natural gas, petroleum.
    b. What is the total percentage of the electricity the United States obtains from fossil fuels?
    Answer: 70.5%
    c. What are the problems associated with getting electricity from fossil fuels?
    Answer: Fossil fuels create undesirable by-products—greenhouse gases (carbon dioxide and nitrous oxide) that contribute to global warming and other pollutants that cause problems like smog and acid rain. Fossil fuels are non-renewable resources.

Activity Two: *Electricity and Climate Change*

1. Hand out **Reproducible #1: Graphing State CO_2 Emissions** and have students complete it individually.

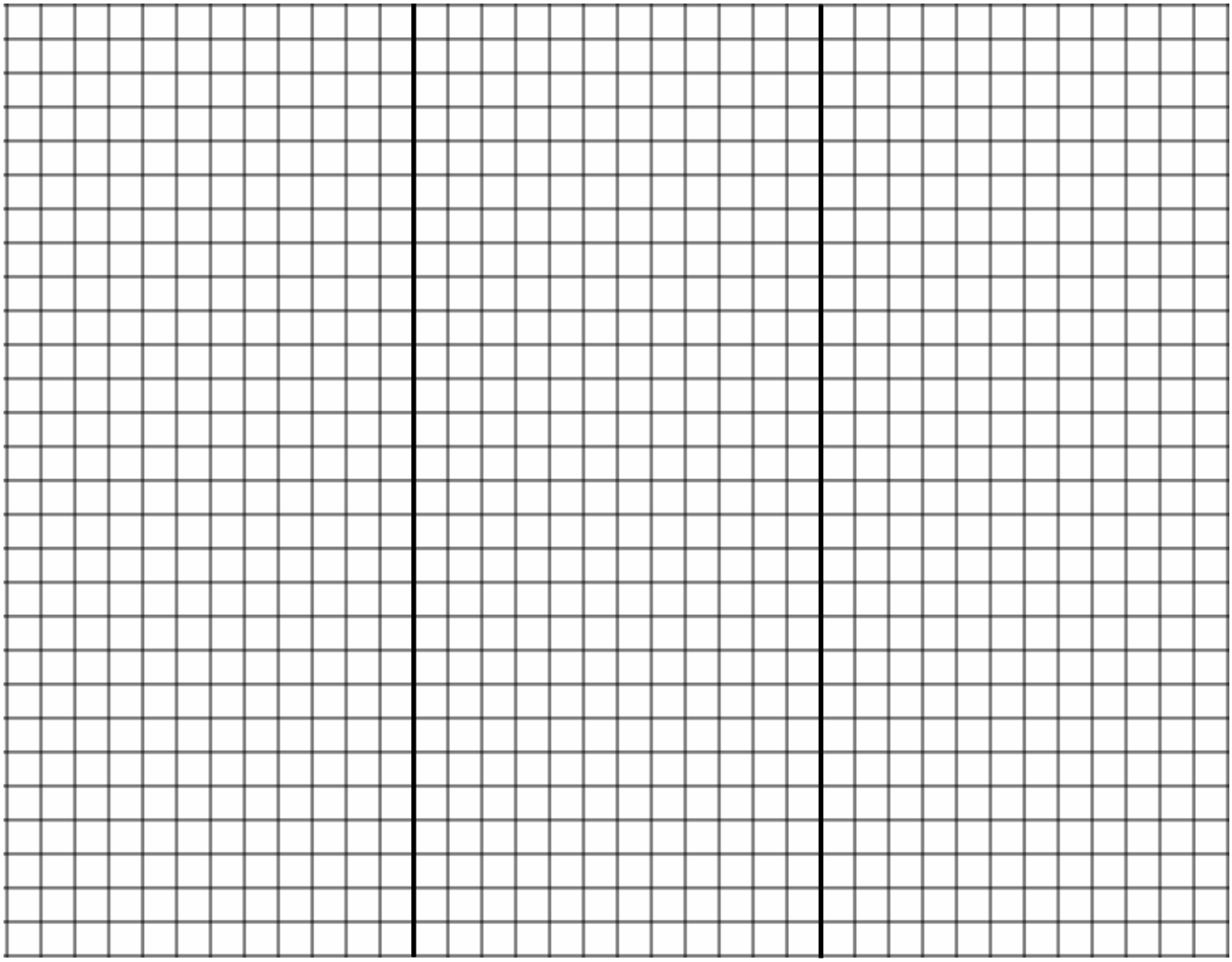
2. After students complete the worksheet, have the class discuss the following questions:
    a. Why do some states produce more CO_2 per capita from electricity than other states?
    Possible Answers: Higher electricity use, dirtier sources of energy (coal vs. solar), etc.
    b. Is it possible to reduce CO_2 emissions from electricity without cutting down on electricity use? How?
    Possible Answers: Yes, using cleaner energy sources and/or using electricity more efficiently.
    c. What can individuals do to help reduce their CO_2 emissions?
    Possible Answers: Use less energy, use energy more efficiently, etc.

[5] Energy Information Administration. *Electric Power Industry Net Generation*. Retrieved 29 October 2008, from http://www.eia.doe.gov/cneaf/electricity/epa/figes1.html

CONCLUSION

Through an exploration of America's energy sources and an analysis of state CO_2 emissions from electricity, students should now have a basic understanding of the connection between lighting and climate change.

Graphing State CO_2 Emissions



Create a bar graph that shows the CO_2 emissions (from electricity) of California, Nebraska, and Ohio in 1995, 2000, and 2005. Use the data from the table below.

CO_2 Emissions from Electricity in Metric Tons (Millions)

	1995	2000	2005
California	37.09	52.82	42.00
Nebraska	16.85	18.90	21.08
Ohio	112.91	121.66	129.31

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Answer the following questions about the data you have graphed.

1. **Describe the trends in CO_2 emissions that you observe for each state. Are carbon emissions increasing? Decreasing?**
    a. **California:** _____
    b. **Nebraska:** _____
    c. **Ohio:** _____

2. **Which state has the highest overall CO_2 emissions from electricity in 2005? Which has the lowest in 2005?** _____
    _____

3. **The chart below shows the populations for each state in 1995, 2000, and 2005.**

	1995	2000	2005
California	31,493,525	33,871,648	35,990,312
Nebraska	1,635,142	1,711,263	1,754,042
Ohio	11,155,493	11,353,140	11,459,776

Divide each state's CO_2 emissions by its population to find the state's CO_2 emissions per capita (per person). Complete the chart below.

	1995	2000	2005
California Emissions Per Capita			
Nebraska Emissions Per Capita			
Ohio Emissions Per Capita			

4. **Describe the trends in CO_2 emissions that you observe per capita for each state. Are per capita carbon emissions increasing? Decreasing?**
    a. **California:** _____
    b. **Nebraska:** _____
    c. **Ohio:** _____

Challenge Question: California has the highest population but the lowest CO_2 emissions per capita. Nebraska has the lowest population but the highest CO_2 emissions per capita. What could be some reasons for this?