Teachers Guide
U.S. and Indiana Fossil Fuel Use and Carbon Dioxide Emissions

Developed By: Dan Shepardson and Melissa Widhalm

Activity Focus: Students learn how different social and electrical sectors in the U.S. and in Indiana use fossil fuel, and how this energy use contributes to carbon dioxide emissions and global warming. Students will also interpret and represent data and information about energy use and carbon dioxide emissions. Students will use models of the greenhouse effect and carbon cycle to explain how the use of fossil fuels results in the emission of carbon dioxide, causing global warming.

Major Concepts: Fossil fuels (natural gas, coal, and petroleum) are energy sources used by the various social (industrial, transportation, commercial and residential) and electric sectors in society. The burning (combustion) of fossil fuels releases greenhouse gases into the atmosphere, specifically carbon dioxide, causing global warming (the enhanced greenhouse effect). Thus, the increase in atmospheric carbon dioxide may be explained then by the increase in fossil fuel use (burning) by humans. The different sectors, however, contribute different amounts of carbon dioxide to the atmosphere. In order to reduce global warming society must reduce its carbon dioxide emissions.

Objectives: After completing this activity students will be able to:

1. State which fossil fuel releases the most carbon dioxide when burned.
2. Explain the global carbon cycle and greenhouse effect.
3. Identify the energy sources used by different social and electric sectors in the U.S. and Indiana and describe how the energy used by the different social sectors emits carbon dioxide to the atmosphere.
4. Develop a plan to reduce carbon dioxide emissions and explain how that might impact fossil fuel use and global warming.

Five Critical Topics: This activity aligns with the following critical topics that every student should know about global warming and climate change.

> Topic 3, Earth's Energy Budget and Greenhouse Effect. Students must understand that some of the heat radiating from Earth's surface toward space is absorbed by greenhouse gases in Earth's atmosphere, thereby increasing the atmosphere's temperature. This process, known as the greenhouse effect, is responsible for making the wide variety of life on Earth possible. However, the greenhouse effect is intensified as humans add carbon dioxide (CO_2) to the atmosphere, resulting in global warming.
>
> Topic 4, The Carbon Cycle. Students must understand how carbon moves through the Earth's climate system, how society uses fossil fuels, and the major sources of CO_2

emissions. The driver of human-caused climate change is our use of fossil fuels, and to mitigate (reduce) global warming this usage must be understood and addressed.

Topic 5, The Scientific Perspective About Climate Change. The scientific community strongly agrees and concludes that human activities are causing global warming, which in turn causes climates to change. Educators need to teach the scientific perspective about climate change. The debate and controversy lie in the social, economic, and political approaches to mitigate and adapt to global warming and climate change.

Materials and Preparation: You will need to prepare the following materials before conducting this activity.

- Copy the *U.S. and Indiana Fossil Fuel Use and Carbon Dioxide Emissions* activity (make 1 copy per student). You may want to make a color copy for each group of students.
- You may want to make a PowerPoint slide for each data set for use in the class discussion.

Procedures: Students may work individually or as a group to complete the activity.

1. Organize students into small groups of 3-4 or have students work independently on completing the activity. If students are working in small groups have them read and discuss as a group each question before recording a consensus response. The exception being the "Engage Your Thinking" questions, in which students' answer individually. Students will work best in the same group throughout the module.
2. Introduce the activity by asking students to identify some of the energy sources they use on a daily basis. List these energy sources on the board and organize by fossil fuel, nuclear, and renewable, and the purpose of their use (e.g., electricity, heating, transportation). If need be, ask students to explain the term fossil fuel. Indicate that in this activity students will be investigating how fossil fuel (energy) use impacts the environment.
3. Have students answer the "Engage Your Thinking" questions before starting the activity. Discuss student responses. Note, what is important here are the students' ideas not that they answered the questions "correctly".
4. Have students read and work through the "Explore and Explain" section. Discuss students' responses to the "Think about it" questions. You may want to have students share their drawing/diagram of the carbon cycle and greenhouse effect. Have students discuss the similarities and differences of their drawings. Depending students' abilities, they may need assistance with graphing. You may want to make a class graph.
5. Have students read and work through the "Extend Your Thinking" section. Ask students to explain their rank orders.
6. If students' aren't already working in a small group, it might be best to group students to complete the "Apply What You Have Learned" section; having students discuss and develop a group consensus plan for reducing carbon dioxide emissions. Discuss the similarities and differences and the pros and cons between each student group.

7. Finally, have students complete the "Reflect on What You Have Learned" questions. Emphasize that students should think about how their ideas have changed, not on getting the correct answer. Ask students to share how their ideas and ways of thinking have changed.
8. Collect student/group responses.

Assessment: To assess students' learning, have students answer the following questions:

1. Which fossil fuel releases the most carbon dioxide when burned?
2. Explain the relationship between the global carbon cycle and the greenhouse effect.
3. Explain the difference between the natural greenhouse effect and the human enhanced greenhouse effect.
4. Which social or electric sector in the U.S. and in Indiana releases the most carbon dioxide?
5. List and describe three actions we could take to reduce our carbon dioxide emissions. Explain why these actions would reduce our carbon dioxide emissions.