Carbon Footprint Activity

Objective

Students will discover how their life choices influence their carbon footprint and how they can lower it.

Skill Level: Middle school and high school	**Prep time:** None **Class time:** 50 minutes

Materials

- Computer with internet access
- Worksheet(s). See Carbon Footprint worksheet document.

Next Generation Science Standards

Disciplinary Core Idea:
ESS3.D: Global Climate Change
ETS1.B: Developing Possible Solutions

Performance Expectations:
MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Practices	Crosscutting Concepts
☒ Asking questions / defining problems	☐ Patterns
☐ Developing / using models	☒ Cause and effect: Mechanism / explanation
☐ Planning / carrying out investigations	☐ Scale, proportion, and quantity
☐ Analyzing / interpreting data	☐ Systems and system models
☐ Math / computational thinking	☐ Energy / matter: Flows, cycles, conservation
☒ Constructing explanations / design solutions	☐ Structure and function
☐ Engaging in argument from evidence	☐ Stability and change
☐ Obtaining / evaluate / communicate	

Background Information

Introduction

Increasing global temperature is a serious challenge for our generation and the generations to come. The temperature of the earth's atmosphere has increased by 1.4 °F since 1900. Even though this change may seem insignificant, this temperature change is believed to already be causing climate change in some parts of the world. Steps can be taken to educate future generations on the many negative effects of global temperature increase and understand its potential causes. Scientists are trying to determine whether this increase is part of a natural cycle, or caused by human activity. Many scientists believe that increases in carbon dioxide in the atmosphere may be responsible for increasing temperatures. Carbon dioxide is produced as a byproduct of burning fossil fuels, something that modern societies require. This means that everyone has a carbon dioxide (or carbon) footprint and it is highly dependent on lifestyle choices such as transportation, diet, and purchases. This activity will help students understand the effect of their life choices on their carbon footprint. It will also help them recognize the lifestyle choices available to them that would lower their carbon footprint. Additionally, students will also be asked to critically think whether the options for lowering their carbon footprint available are actions that they are willing to take.

Background

A carbon footprint is the amount of greenhouse gases (GHGs) an individual, system, or activity is responsible for releasing into the environment. GHGs include carbon dioxide, methane, water vapor, ozone and nitrous oxide. These gases are needed in the atmosphere at their natural levels to regulate the earth's temperature and maintain life in our planet. These gases maintain some of the heat in the atmosphere that is radiated to the earth from the sun instead of letting it be released back into space. GHGs above normal levels may lead to more heat being trapped on the planet, which translates to climate change around the world. For example, 275 parts per million (ppm) of carbon dioxide (CO_2) was present in the atmosphere until about 200 years ago. Scientists have develop models that indicate a safe upper limit is 350 ppm, but there is currently 400 ppm of CO_2 in the atmosphere. Furthermore, some of these gases remain in the atmosphere longer than others. Water vapor leaves the atmosphere every time it rains. Methane, which is primarily produced by livestock and fossil fuel production, can remain in the atmosphere for hundreds of years. The following diagram shows the greenhouse effect and the relative amounts of GHGs in the currently in the atmosphere.

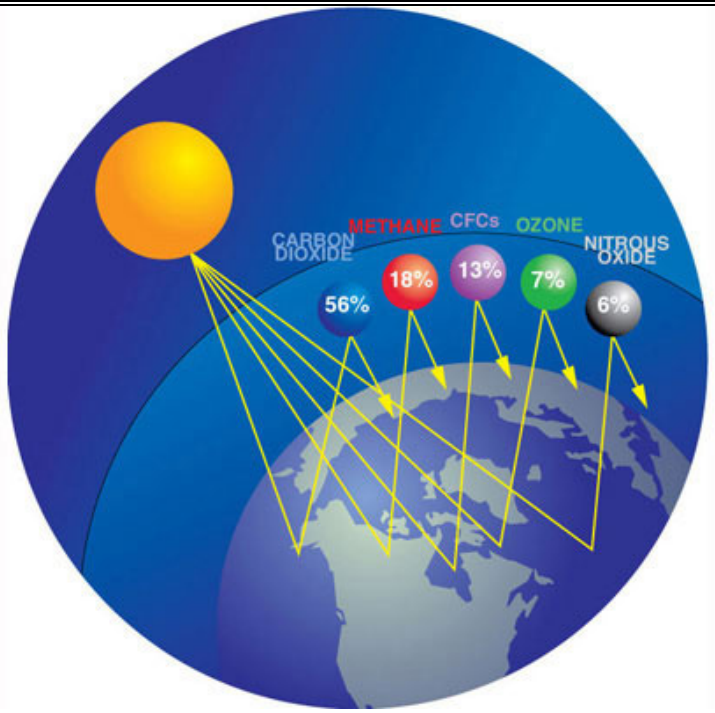

Fig. 1 The relative amounts of GHG produced by human activities. Reference

Diverse energy sources such as coal, petroleum, natural gas, hydroelectricity, solar, nuclear, and biomass have shaped our nation and played an important role in our development. This development has come with a cost, and our nation, like many others, is dependent on fossil fuels for energy. These fossil fuels release high amounts of GHGs when burned for energy. We are releasing carbon dioxide and other GHGs into the atmosphere in a relatively short amount of time, while it took nature millions of years to sequester that energy in the form of coal, petroleum, and natural gas. Figure 2 demonstrates the lengthy process of creating coal.

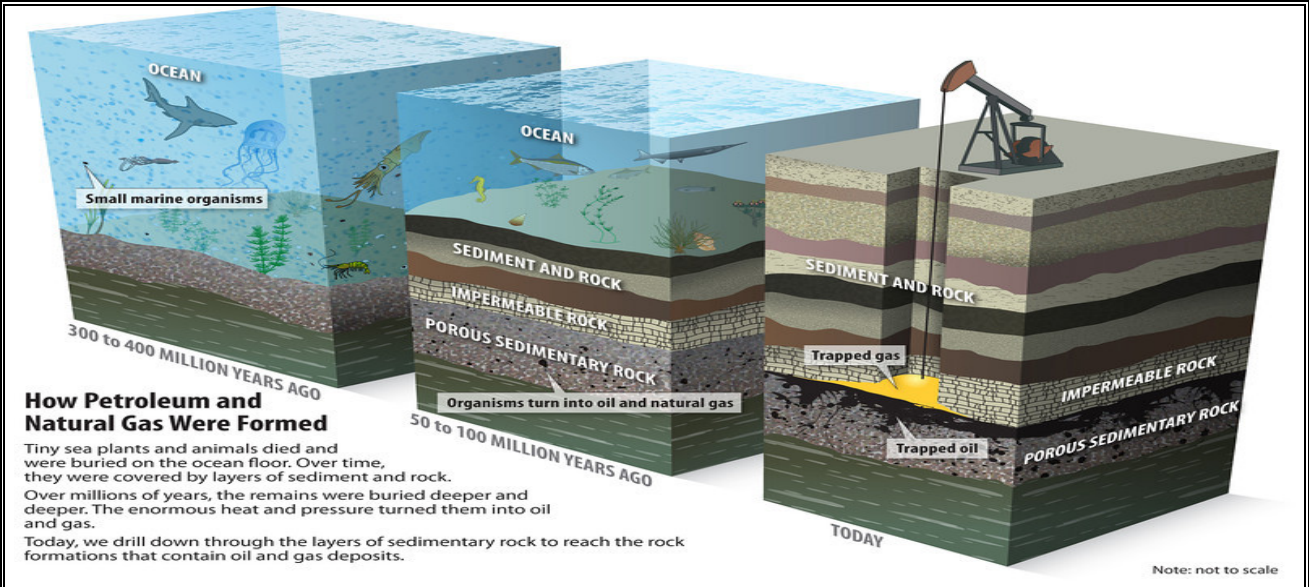

Fig. 2 The process by which coal is produced. Reference

Nature does play an important role in sequestering carbon, but it can't keep up with our rapid burning of fossil fuels. Recent studies have showed that the natural processes for absorbing carbon dioxide are not keeping up with the increased rate of emissions. This leads to an accumulation of GHGs in the atmosphere.

Three of our country's primary energy sources of our country – petroleum, natural gas and coal – are burned to produce energy. This energy is used to do work such as powering a TV or a game system, driving school buses, etc. This is why the amount of energy we consume greatly affects our carbon footprint. Household activities that produce a carbon footprint are those that require electricity, such as lighting, heating and cooling a house, showering, etc. For most individuals, most GHGs are produced in an indirect way, like in the production of electricity to run appliances or transport goods. However, GHGs gases can also be produced directly when burning gasoline to fuel a car or burning wood in a fireplace for heat. A carbon calculator and lifestyle questionnaire estimate the amount of GHGs released over a period of time. Recognizing the amount of GHGs produced by the way we live our lives is an important step in stopping climate change. Knowing about the consequences of everyday actions will empower students to have a meaningful consideration of what they can do help combat climate change. Since there are various types of GHGs, for convenience, most carbon calculators convert all GHGs to carbon dioxide equivalents (CO_2e), or the amount of CO_2 that would cause the equivalent amount of damage as the other GHGs.

Engage

Carbon emissions have dramatically increased over the past decades as nations such as China, India, and Brazil have become industrialized. Industrialized nations require more energy due to technological advances and economic prosperity. Goods that require energy, such as TVs, cars, and other appliances are more readily available to everyone. Industrialized nations house an increased amount of infrastructure such as roads, bridges and buildings that require large amounts of raw materials and energy to build. In addition to this, industrialized nations tend to consume more meat products, which require a large amount of energy and resources to produce. Higher amounts of GHGs may be producing climate change. This increase in temperatures is dangerous for humans and other species as it can cause raised ocean levels, droughts, natural disasters and extreme temperatures.

Since climate change is an irreversible process, there must be an organized mitigation effort in order for life to survive on this planet. High carbon emissions are a byproduct of highly industrialized nations. The United States has high carbon emissions due to our dependence on fossil fuels as our primary source of energy. Problems arise when trying to mitigate our carbon footprint while still maintaining the lifestyle we are used to. One could live a virtually zero carbon emission life, but it would be extremely challenging and inconvenient in our culture. Further, the life choices that lead to less CO2e emissions are not available to everyone, especially in rural and low socioeconomic communities.

The challenge is to find things that are readily available to lower our carbon footprint and that we are also willing to do. Some of these things are simpler than others. For example, it might be easy and fairly inexpensive to change incandescent light bulbs with fluorescent or LED ones. However, flying in an airplane has a disproportionately large effect compared to other forms of transportation. For many of us, this is not an easy choice and we have to fly to visit family or to go on vacation. One does not have to alter the way one lives their life completely to have a meaningful part in lowering climate change. For instance, upgrading to energy efficient appliances can save large amounts of energy annually. In many cases, lowering our carbon footprint has additional benefits in addition to preventing further climate change. For example, biking to school and eating less meat and processed food are beneficial for your health as well as for the environment.

Explore

Experiment Questions:

How can we minimize our carbon footprint while keeping our standard of living?

Procedure:

1. Start with a discussion about carbon footprints and the evidence linking it to increasing global temperature. Make sure students understand that it is neither good nor bad to have a large carbon footprint, that the type of life they want to live is a personal choice, and that they won't be judged upon that.

2. Students should hypothesize what activities in their daily lives have the largest carbon footprint and fill out the page 1 of the attached document to calculate their personal carbon footprint.

3. Have students discuss and compare their calculations. What surprised them?

4. Have students brainstorm things that they and/or their families can change in their lifestyle to lower their carbon footprint.

5. Students should fill out page 2 of the carbon footprint worksheet document and follow through with their plan. They should have their parents help them fill out the household questionnaire on page 3. Teacher can also send a letter home to ask the parents to help the students determine how much their household spends on the things asked and ensure them that their information will remain confidential. Students fill out page 3 of the attachment.

6. Students estimate the calories they eat from meat, dairy, etc.

7. Each student should use the Berkeley carbon calculator to determine his or her household's carbon footprint. (Click link)

8. Students reflect on this activity on page 4 of the attachment.

Explain

- Define in your own words: Mitigation, global warming and greenhouse effect.
- Discuss with the students and make a list of what alternatives are available for them to mitigate their carbon footprint in your community.
- Why might some of these alternatives not be convenient or possible for some students?
- What activities or behaviors in your daily life are having the greatest impact on climate change? Which activities or behaviors in your daily life have the least impact?
- Do you think someone in a larger city such as New York City would have a harder or easier time changing their life to have a lesser carbon footprint than someone from a rural community?

- Do you think your friends and family are aware of actions to take to reduce climate change? What do you think you can do to inform them?
- How did this assignment change how you feel about the issue of climate change?

Elaborate

- Students can experience the climate time machine and write how higher sea levels and temperatures might present a problem for life on planet earth.
- Discuss how the energy demands of your community might differ from those of a larger city. What might be the differences in the primary uses of energy? Watch this video.
- How might our country compare to others in carbon emissions and energy use? What are possible causes?
- What are carbon credits? How might these help mitigate an individual's carbon footprint? Do you think this is an effective method of combating global warming?
- Calculate the carbon footprint of one of your school lunches. Estimate the carbon footprint if everyone at your school ate that lunch every day for a year. Perform calculations if the lunch was changed to a nutritious salad. What do you think you can do to influence to what food your school offers you?

Resources

Additional Resources:

- PBS: You Can Make a Difference Video (Click links)
- NASA Global Climate Change
- Carbon Footprint Activity
- NOAA: Ocean Absorbing Over Half of Greenhouse Gases

Resources Used:

- PBS: Carbon "Kidprints" Activity
- Climate Time Machine
- TeachEngineering Activity: What Kind of Footprint? Carbon Footprint
- Alliance to Save Energy: How Big is Your Carbon Footprint Activity
- Carbon Footprint Estimator
- How Carbon Footprints Work
- What is My Carbon Footprint?
- Your Family's Carbon Footprint