NATIONAL GEOGRAPHIC

RESOURCE LIBRARY I ACTIVITY : 1 HR 15 MINS

Putting the "Fossil" in Fossil Fuels

Students begin their exploration of fossil fuels by looking at video and photographs of the Darvaza gas crater in Turkmenistan and pondering what makes it burn. This is followed by an analysis of the Keeling Curve, a graph of global carbon dioxide levels in the atmosphere over time. Students are asked to consider: Why are atmospheric carbon dioxide levels increasing? Where does the carbon in carbon dioxide ultimately come from? What effects does carbon dioxide have on the planet? Finally, in a class discussion prompted by a thought-provoking photograph, students complete a *Know & Need to Know* chart on fossil fuels.

GRADES

6, 7, 8

SUBJECTS

Earth Science

CONTENTS

1 Image, 1 PDF, 1 Video, 1 Link

OVERVIEW

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For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/putting-fossil-in-fossil-fuels/

In collaboration with

educurious
learning that connects

DIRECTIONS

This activity is a part of the Carbon Trackers unit.

1. Introduce a real-life puzzling phenomenon related to fossil fuel.

- Show the video and photos of the Darvaza gas crater in Turkmenistan from the *Entering the 'Door to Hell'* article. Ask students to consider the following questions as they watch, and to be prepared to share their thoughts:
    - *How long to do you think the crater has been burning?*
    - *What do you think is causing the crater to continue burning?*
    - *Where do you think the energy in the fire comes from?*
    - (Natural gas is coming out of the Darvaza gas crater. Scientists lit it on fire in 1971, hoping to burn off all the natural gas, but it hasn't stopped burning since, indicating a larger reservoir of natural gas than originally assumed. Natural gas is a fossil fuel.)
- Pause to elicit students' ideas in response to these questions.
    - In their initial responses, students may mention the idea of "gas" burning in the crater. If so, verify their answer and introduce the term "fossil fuel" and its definition: coal, oil, or natural gas. Fossil fuels formed from the remains of ancient plants and animals.
- Connect the burning crater to the unit driving question: *Where does the energy in fossil fuels come from and where does it go?*
    - Now that you have mentioned fossil fuels (in the form of natural gas) as a source of energy for the burning gas crater, direct the conversation toward the driving question of where that energy comes from.
    - Explain that in order to answer the question and adequately share the answers with others, students will conduct a thorough investigation over the course of the unit.

2. Engage students to broadly consider the energy sources of different types of transportation.

- Distribute the *Energy Observations* handout to small groups of two to three students.
- Prompt students to brainstorm where the vehicles in the pictures get their energy and write their ideas on the line below each picture.
- Lead a class discussion for students to share their ideas for each vehicle. (Correct answers are that every vehicle shown runs on fossil fuels. It is not important that students identify the exact type of fossil fuels.)
- To segue into the next step, ask students where they think the energy and matter goes after being used in these ways.

3. Guide students through analyzing a graph and considering the impacts of atmospheric carbon dioxide.

- Display and discuss the *Atmospheric CO_2 at Mauna Loa Observatory* chart from the National Oceanic and Atmospheric Administration (NOAA) showing carbon dioxide in the atmosphere. Focus on the graph on the right side.
- Ask: *What do you think this graph is showing?*
    - Assist students in understanding the graph axes and what they represent. The chart shows the steadily increasing concentrations of carbon dioxide in the atmosphere (in parts per million) observed at NOAA's Mauna Loa Observatory over 60 years, beginning in 1959. The x-axis is the year and the y-axis shows parts per million of atmospheric carbon dioxide.
- Ask guiding questions to prompt students to share their ideas about what the graph means. Students may or may not know the answers at this point; the questions are intended to cue their thinking on carbon and to give you a sense of their prior knowledge on the topic. Ask:
    - *Do you think this increase in atmospheric carbon dioxide is the result of the energy use you explored in the* Energy Observation *handout? Why do you think carbon dioxide has increased in the Earth's atmosphere over the past 60 years?* (Correct response*:* Human activities like fossil fuel combustion, cement production, deforestation, and destruction of permafrost soils are adding carbon dioxide gas and other greenhouse gasses to the atmosphere.*)*
    - *Where do you think the carbon in the atmospheric carbon dioxide comes from? Is this the same thing that we saw coming out of the Darvaza gas crater?* (Correct responses may include: combustion of fossil fuels, gases emitted during volcanic eruptions, wildfires, and/or respiration of living organisms.)

    - *Do you think this increase in atmospheric carbon dioxide is helping and/or hurting the Earth's living things or both?* (Responses may include: increased atmospheric carbon dioxide is causing the average global temperature to increase, which in turn causes changes in regional climates. Living things may have difficulty adjusting to some of these changes, so in that sense, one could say the increase is "hurting" the planet. Increased carbon dioxide helps plants grow, so the rise in atmospheric carbon dioxide could be seen as "helping" the planet.)

- Record and display students' ideas (using chart paper, whiteboard, or a shared online document).

4. Display and discuss the photo *Putting the "Fossil" in Fossil Fuels*.

- Elicit students' ideas about how the photo connects to carbon and carbon dioxide by asking: *What do you think this photo is showing?*

    - Explain the setting of the photo if needed. (Coal, a fossil fuel, forms in seams underground. These are miners in a coal seam mining for coal. In the process, they discovered an ancient fossilized tree trunk.)

- Ask: *Given what you see in this photo, what do you think coal is made of?* (Correct response: Coal is formed from partially decayed and compacted plant matter.)
- Ask: *Where do you think the carbon in fossil fuels, like coal, ultimately comes from?* (Correct response: Since coal is made from plant matter, the carbon comes from the plant material.)
- Explain that coal is a fossil fuel, like the gas in the Darvaza gas crater, and is made of plant material that has partially decayed and been compacted over millions of years.

5. Introduce students to the lesson driving question and the culminating project that will anchor all learning objectives together.

- Tell students that they have now identified fossil fuels as a source of carbon and energy that can power things like cars, tractors, and factories. They have also learned that carbon in the form of carbon dioxide moves from fossil fuels into the atmosphere.
- Next, introduce the lesson driving question: *Where is Earth's carbon stored and how does it move among different reservoirs?* Explain to students that by investigating how different kinds of matter and energy move around our planet, they will learn to create a cohesive model that can be used to help others understand how the Earth works and how humans

impact it. This first lesson will focus on tracking carbon in fossil fuels and beyond, and each subsequent lesson will dive deeper into the unit driving question: W*here does the energy in fossil fuels come from and where does it go*?

- Describe the culminating project for this unit. The class will be split into three teams, each researching a specific global matter and energy cycle (water cycle, rock cycle, photosynthesis, and respiration). Each team will create a model that illustrates how their assigned cycle works on Earth; each model should include a visual representation of the cycle, labels and arrows to show how it changes over time, and a paragraph describing why that cycle is important on Earth. The three teams will then connect the models into a large whole-Earth model. Each team will prepare a presentation for the target audience to help them understand global matter and energy cycles.
- Opportunity for Action: Teams may have the opportunity to further inspire others to learn about matter and energy cycling on Earth by transforming their scientific model into an art piece for display in a local museum, science center, cafe, or the school.

6. Create a *Know & Need to Know* chart based on students' understanding and questions about fossil fuels.

- Ask: *What do you already know and what do you need to know about fossil fuels to help you thoroughly understand how fossil fuels fit into our global system of matter and energy cycling?*
- Create a class *Know & Need to Know* chart based on students' understanding and questions about fossil fuels.
    - Use the Think-Pair-Share process described below to elicit and record students' ideas and questions related to the unit, which can be revisited over time.
    - Ask students to think on their own and then discuss with a partner:
        - *What do we already know about fossil fuels?*
        - *What do we need to know about fossil fuels in order to create a thorough and accurate model of how energy moves through Earth's systems into and out of fossil fuels?*
    - Circulate as students work to help with guiding questions, such as:
        - *What are fossil fuels made of?*
        - *What kinds are there? How are they made?*

    - *How much of them do we have on Earth?*
    - *Where are they found?*
    - *How are they used by humans?*
    - *What impacts do our use of them have on the planet?*
    - *How are they useful to humans?*

- Prompt students to share their ideas and questions in a class discussion, recording their thoughts on the class *Know & Need to Know* chart.
- Keep the chart in a visible place in the classroom or easily accessible online to reference students' expertise and questions from the beginning of the unit. Tell students that they will more formally revisit the chart throughout the unit as they learn new content and develop new questions.

Tip

Step 6: Consider providing sentence stems for the *Know & Need to Know* chart. For example:

"I know that _____, and I wonder if _____?"

Tip

Think-Pair-Share is a learning strategy where students work individually and collaboratively to enhance comprehension of the material. For some great tips on how to do an effective Think-Pair-Share activity, see *AdLit.org*.

Tip

You may also allow students to write their questions on sticky notes so that those who do not wish to share verbally can do so. They can put their notes on the board and you can collect and read them aloud as you move through the exercise.

Informal Assessment

Teachers will assess current and prior knowledge by looking over the *Know & Need to Know* chart that student pairs use to articulate their initial understanding about fossil fuels. This graphic organizer, along with offerings of ideas, allows the teacher to get an initial sense of prior knowledge and understanding in this topic area.

Extending the Learning

Extending Step 3: What causes the "wiggles" on the Keeling Curve? Use the graph of atmospheric carbon dioxide to have students consider the causes of annual fluctuations.

- Return to the *Atmospheric CO_2 at Mauna Loa Observatory* chart from NOAA showing carbon dioxide in the atmosphere. This time focus on the graph on the left. Ask students why they think the wiggles on the graph are there and what could explain the fluctuations?

- Use a Think-Pair-Share strategy to give students a chance to posit thoughtful answers.
- Follow their initial thoughts by showing NASA's *A Year in the Life of Earth's CO_2* video.
- Explain that photosynthesis (which they will explore in depth later in the unit) removes carbon dioxide from the atmosphere. In spring and summer, when there is more vegetation throughout the Northern Hemisphere, photosynthesizing organisms take in more carbon dioxide. In the Northern Hemisphere's fall and winter, leaves fall from many trees and plants die, resulting in less carbon dioxide consumption overall.

OBJECTIVES

Subjects & Disciplines

Earth Science

Learning Objectives

Students will:

- Understand that average carbon dioxide levels in Earth's atmosphere have been increasing, on average, over the past 60 years.
- Articulate their initial ideas and generate questions related to fossil fuels and carbon.

Teaching Approach

- Project-based learning

Teaching Methods

- Brainstorming
- Discussions
- Information organization

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
    - Media Literacy
- Critical Thinking Skills
  - Analyzing
  - Remembering
  - Understanding
- Science and Engineering Practices
  - Analyzing and interpreting data
  - Asking questions (for science) and defining problems (for engineering)
  - Constructing explanations (for science) and designing solutions (for engineering)

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.7.1:**

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 4:**

Systems and system models

• **Crosscutting Concept 5:**

Energy and matter: Flows, cycles, and conservation

• **ESS2.A: Earth Materials and Systems:**

All Earth processes are the result of energy flowing and matter cycling within and among the planet’s systems. This energy is derived from the sun and Earth’s hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth’s materials and living organisms.   The planet’s systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth’s history and will determine its future.

• **ESS3.C: Human Impacts on Earth Systems:**

Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things.

• **MS-ESS2-1:**

Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.

• **Science and Engineering Practice 1:**

Asking questions and defining problems

Preparation

What You'll Need

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, Monitor/screen, Projector

PHYSICAL SPACE

- Classroom

SETUP

The culminating project for this unit involves a student presentation. Determine the audience in advance so students can begin the project with the audience in mind. Options for the project audience include parents, a younger class, community members, or other teachers, given that it's purely an opportunity for students to take on the teaching role to explain complex systems. Choose an audience for whom your students would find it important and interesting to explain the global carbon cycle, the rock cycle, the water cycle, photosynthesis and respiration, the formation of fossil fuels, and the impacts of fossil fuel combustion on the atmosphere (e.g., greenhouse effect).

GROUPING

- Large-group learning
- Small-group learning
- Small-group work

OTHER NOTES

Facilitating the Opportunity for Action: If you decide to have your students transform their scientific model into an art piece for public display, consider appropriate locations (a science museum, an art museum, a local energy company's lobby, a local gallery, or coffee shop) ahead of time, so you are clear on material/space constraints for the final product. You might show and describe to students examples of artists creating work inspired by or intended to communicate scientific concepts in an inspiring and engaging way. There are some interesting pieces in the article *9 Artists Using Science as Inspiration*.

For the final art pieces, students can do them individually for maximum creativity or return to three separate teams to translate the scientific/educational model into an artistic/inspirational model. In general, the goal of the artistic representation would be to make science accessible to a varied audience, to offer inspiration for engaging with it, and to give students an opportunity to represent scientific systems in alternate ways.

RESOURCES PROVIDED: UNDEFINED

- Gateway to Hell

RESOURCES PROVIDED: HANDOUTS & WORKSHEETS

- Energy Observations

RESOURCES PROVIDED: IMAGES

- Putting the 'Fossil' in Fossil Fuel

RESOURCES PROVIDED: ARTICLES & PROFILES

- NOAA: Monthly Average Mauna Loa CO2

BACKGROUND & VOCABULARY

Background Information

Fossil fuel use is an important current issue as it plays a vital role in our global energy systems. Fossil fuels are formed predominantly from plant and animal material buried, preserved, and altered over time through the high pressure and temperatures of various geologic processes. Thus, the carbon in fossil fuels ultimately comes from plants and animals.

Humans burn fossil fuels primarily because they release high-quality, concentrated, usable energy, which has played a positive role in industrialization. However, carbon dioxide released into the atmosphere due to fossil fuel use has grown dramatically over the past 60 years of continuous measurement, and this has negative impacts on the global environment.

Prior Knowledge

["Students should be familiar with the fact that carbon is an element on the Periodic Table of Elements, and is an atom that bonds with other atoms to form various compounds."]

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition

Term	Part of Speech	Definition
carbon	*noun*	chemical element with the symbol C, which forms the basis of all known life.
carbon emission	*noun*	carbon compound (such as carbon dioxide) released into the atmosphere, often through human activity such as the burning of fossil fuels such as coal or gas.
coal seam	*noun*	coal deposit. Also called a coal bed.
combustion	*noun*	burning, or the process of a substance reacting with oxygen to produce heat and light.
emission	*noun*	discharge or release.
energy	*noun*	capacity to do work.
fossil fuel	*noun*	coal, oil, or natural gas. Fossil fuels formed from the remains of ancient plants and animals.
organic	*adjective*	composed of living or once-living material.
photosynthesis	*noun*	process by which plants turn water, sunlight, and carbon dioxide into water, oxygen, and simple sugars.

For Further Exploration

Articles & Profiles

- NOAA: Climate Change: Atmospheric Carbon Dioxide

Books

- Book: How to Build a Habitable Planet

Instructional Content

- National Geographic: Changing Climate: A Guide for Teaching Climate Change in Grades 3-8